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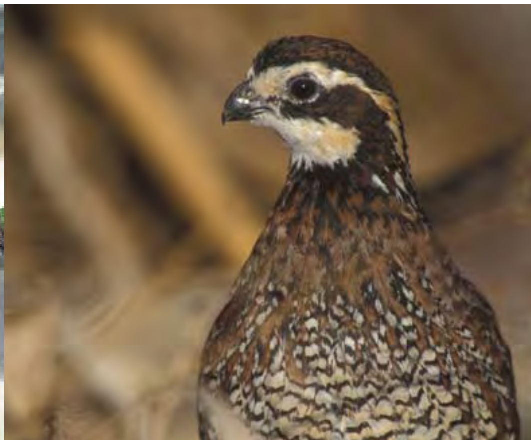
Iowa Climate Change Advisory Council
Final Report

12/23/08





December 23, 2008

The Honorable Chester J. Culver and
The State of Iowa General Assembly
State Capitol Building
1007 East Grand Ave
Des Moines, Iowa 50319

Dear Governor Culver and Legislators,

In the 2007 legislative session, you signed into law SF 485, which established the Iowa Climate Change Advisory Council (ICCAC). This Council was charged with identifying policies and strategies for Iowa to respond to the challenge of global climate change by reducing its greenhouse gas (GHG) emissions and spurring economic growth through technological innovation. ICCAC formed subcommittees and considered policy options in five areas: Energy Efficiency and Conservation (EEC); Clean and Renewable Energy (CRE); Transportation and Land Use (TLU); Agriculture, Forestry, and Waste Management (AFW); and Cross-Cutting Issues (CC). Enclosed is the Final Report of the Council.

In the Final Report, the Council presents two scenarios designed to reduce statewide greenhouse gas emissions by 50% and 90% from a 2005 baseline by the year 2050. For the 50% reduction by 2050, the Council recommends approximately a 1% reduction by 2012 and an 11% reduction by 2020. For the 90% reduction scenario, the Council recommends a 3% reduction by 2012 and a 22% reduction 2020. These interim targets were based on a simple extrapolation assuming a linear rate of reduction between now and 2050.

In providing these scenarios for your consideration, ICCAC approved 56 policy options from a large number of possibilities. There are more than enough options to reach the interim and final emission targets in both the 50% and 90% reduction scenarios. Direct costs and cost savings of these policy options were also evaluated with the help of The Center for Climate Strategies, who facilitated the process and provided technical assistance throughout the entire process, and who developed the Iowa Greenhouse Gas Emissions Inventory and Forecast in close consultation with the Iowa Department of Natural Resources (IDNR) and many Council and Sub-Committee members. About half of the policy options presented in this report will not only reduce GHG emissions but are highly cost-effective and will save Iowans money. Still other options may require significant investment but will create jobs, stimulate energy independence, and advance future regional or federal GHG programs.

Please feel free to call upon us if you have questions about the report. We stand ready and willing to help in any future charge to the Council to prosper our economy and improve our environment, while reducing Iowa's greenhouse gas emissions.

Sincerely yours,

Jerald L. Schnoor
Chair, ICCAC

On behalf of ICCAC Members:

Franklin Cownie, Vice Chair
Marian Gelb, Secretary
Roxanne Carisch
Richard Cruse
Jennifer Easler
Thomas Fey
Teresa Galluzzo
Shelley Hackett
Thomas Hadden III
Nile Lanning
Robert Loyd
David Miller
Richard Ney
Norman Olson
Julie Smith
Dawn Snyder
Roya Stanley
William Stigliani
Krista Tanner
Stephanie Weisenbach
Cathy Woollums

c: State of Iowa General Assembly
Richard Leopold, Director, DNR

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Acknowledgments

The Iowa Climate Change Advisory Council (ICCAC) gratefully acknowledges the following individuals and organizations who contributed significantly to the successful completion of the ICCAC process and the publication of this report:

Special thanks to ICCAC Chairman Jerry Schnoor, for his stellar leadership throughout the process, and to Vice Chair Franklin Cownie and Secretary Marian Gelb. ICCAC also recognizes the many individuals who participated in the sector-based Subcommittees, all of whom are listed in Appendix C. Although this report is intended to represent the results of the ICCAC's work, the ICCAC would be remiss if it did not recognize and express appreciation for the time and effort each Subcommittee member spent in discussion, study, deliberation and in formulating recommendations during this process.

Our great appreciation also goes to Richard Leopold, Director of Iowa Department of Natural Resources, and his dedicated staff of Jason Marcel and Marnie Stein who supervised and coordinated all state activities associated with the ICCAC process, served as liaisons to the Subcommittees, arranged meetings and assisted with meeting summaries. Many thanks also to Barbara Stock, Karrie Darnell, Nick Page, and Amanda Hostetler of the Iowa DNR, who assisted in arranging meeting facilities, recording meetings, and other meeting support logistics throughout the process.

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Rachel Anderson
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Randy Strait
Dan Wei
Luana Williams

Finally, the ICCAC would like to thank a number of donor organizations that supported the service of CCS to the ICCAC including the Normandie Foundation, the Kendeda Fund, and the Rockefeller Brothers Fund.

Iowa Climate Change Advisory Council Members

Note: Each member was appointed to represent a specific stakeholder organization or interest group. These are noted in italics after each member's name.

Executive Committee

Jerald Schnoor, *Center for Global and Regional Environmental Research, University of Iowa,* Professor

Franklin Cownie, *Local Government,* Mayor, City of Des Moines

Marian Gelb, *Environmental Organization,* Executive Director, Iowa Environmental Council

Additional Current Voting Members

Roxanne Carisch, *Rural Electric Cooperatives,* CEO, Electric Distribution Co-op, Calhoun County Electric Cooperative Association

Richard Cruse, *Department of Agronomy, Iowa State University*, Professor

Jennifer Easler, *Iowa Office of Consumer Advocate,* Attorney

Thomas Fey, *Public Member,* Lobbyist/Consultant, Fey & Gomez, Inc.

Shelley Hackett, *Iowa Association of Business and Industry,* Environmental Engineer, John Deere Waterloo Works

Teresa Galluzzo, *Public Member,* Research Associate, Iowa Policy Project

Thomas Hadden III, *Public Member,* Executive Director, Metro Waste Authority

Nile Lanning, *International Brotherhood of Electrical Workers,* Retired Line Foreman, Alliant Energy

Robert Loyd , *Alternative Energy Equipment Manufacturing,* Plant Manager, Clipper Turbine Works and Clipper Windpower

David Miller, *Iowa Farm Bureau,* Economist, Director of Research and Commodity Services,

Richard Ney, *Iowa Renewable Fuels Association,* Environmental Engineer/Consultant, Sebesta Blomberg & Associates, Inc.

Norman Olson, *Iowa Energy Center*, Iowa State University, Biobased Chemical and Fuels Research

Julie Smith, *Iowa Association of Municipal Utilities,* Attorney

Dawn Snyder, *Conservation Group,* Education Programs Director, Woodbury County Conservation Board

Roya Stanley, *Iowa Office of Energy Independence,* Director

William Stigliani, *Center for Energy and Environmental Education, University of Northern Iowa*, Professor and Director

Krista Tanner, *Iowa Utilities Board*, Board Member

Stephanie Weisenbach, *Public Member*, Program Coordinator, 1000 Friends of Iowa

Cathy Woollums , *Investor-Owned Utilities*, Senior Vice President, Environmental Services, MidAmerican Energy Holding Company

Non-Voting Members

Robert Hogg, State Senator, Iowa Legislature
Steve Kettering, State Senator, Iowa Legislature
Donovan Olson, State Representative, Iowa Legislature
Ralph Watts, State Representative, Iowa Legislature

Past Members

James Burns, *Iowa Public Transit Association,* Public Transit Director, Region 12 Council of Governments – resigned June 2008
Ed Fallon, *Public Member* **–** resigned January 2008
Joanne Howard, *Iowa Association of Business and Industry,* Environmental Engineer, Deere & Company – resigned February 2008

Iowa Department of Natural Resources (DNR) Staff

Marnie Stein, Senior Environmental Specialist, DNR Air Quality Bureau
Jason Marcel, Supervisor, DNR Air Quality Bureau

Acronyms and Abbreviations

\$/kWh	dollars per kilowatt-hour
\$/MM	millions of dollars
\$/MWh	dollars per megawatt-hour
\$/t	dollars per metric ton
\$/tCO_2e	dollars per metric ton of carbon dioxide equivalent
AAR	American Association of Railroads
AASHTO	American Association of State Highway & Transportation Officials
ac	Acre
AEO2007	*Annual Energy Outlook 2007*
AEO2008	*Annual Energy Outlook 2008*
AFW	Agriculture, Forestry, and Waste Management [Subcommittee]
AFUE	annual fuel utilization efficiency
AFW	Agriculture, Forestry, and Waste Management
AIA	American Institute of Architects
ANL	Argonne National Laboratory
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
B20	fuel blend of 20% biodiesel and 80% gasoline
B100	fuel consisting of 100% biodiesel
BAU	business as usual
BBtu	billion British thermal units
BMP	best management practice
BBtu	billions of British thermal unit
BELC	Business Environmental Leadership Council
BOC	Building Operator Certification
BRT	bus rapid transit
Btu	British thermal unit
C	Carbon
CAA	Clean Air Act
CAFE	corporate average fuel economy
CAFO	concentrated animal feeding operation
CARB	California Air Resources Board
CC	Cross-Cutting Issues [Subcommittee]
CCS	carbon capture and storage
CCSR	carbon capture and storage or reuse
CCX	Chicago Climate Exchange
CDD	cooling degree-days
CEBCS	Commercial Buildings Energy Consumption Survey
CEEE	Center for Energy and Environmental Education

cf	cubic feet
CFL	compact fluorescent light
CH_4	Methane
CHP	combined heat and power
CMAQ	Congestion Mitigation and Air Quality
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CPP	critical peak pricing
CRE	Clean and Renewable Energy [Subcommittee]
CRP	Conservation Reserve Program [USDA]
CSA	community-supported agriculture
CTRE	Center for Transportation Research and Education
CUTR	Center for Urban Transportation Research
DART	Des Moines Area Rapid Transit
DG	distributed generation
DNR	[Iowa] Department of Natural Resources
DOE	[United States] Department of Energy
DOT	[Iowa] Department of Transportation
DSM	demand-side management
E10	fuel blend of 10% ethanol and 90% gasoline
E85	fuel blend of 85% ethanol and 15% gasoline
EE	energy efficiency
EEC	Energy Efficiency and Conservation [Subcommittee]
EEP	energy efficiency plan
eGRID	Emissions & Generation Resource Integrated Database
EIA	Energy Information Administration [US DOE]
EISA	Energy Independence and Security Act of 2007
EOR	enhanced oil recovery
EPA	[United States] Environmental Protection Agency
EPAct	Energy Policy Act of 2005
EPRI	Electric Power Research Institute
EPS	environmental portfolio standard
ES	Energy Supply
FAA	Federal Aviation Administration
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FIA	Forest Inventory and Analysis [USFS]
ft	Foot
FTE	full-time-equivalent
FY	fiscal year
gal	Gallon
GAP	Gap Analysis Program
GHG	greenhouse gas
GJ	Gigajoule

GM	genetically modified
GPS	global positioning system
GREET	Greenhouse gases, Regulated Emissions and Energy use in Transportation [model]
GWh	gigawatt-hour [one million kilowatt-hours]
GWP	global warming potential
HB	House Bill
HDD	heating degree-day
HDPE	high-density polyethylene
HDV	heavy-duty vehicle
HFC	Hydrofluorocarbon
HOV	high-occupancy vehicle
HR	House Resolution
HUD	[United States] Department of Housing and Urban Development
HVAC	heating, ventilation, and air conditioning
HWP	harvested wood product
I&F	Inventory and Forecast
IAC	Industrial Assessment Center
IAMU	Iowa Association of Municipal Utilities
ICCAC	Iowa Climate Change Advisory Council
ICCC	Iowa Clean Cities Coalition
ICCT	International Council on Clean Transportation
ICLEI	Local Governments for Sustainability [formerly International Council for Local Environmental Initiatives]
IDALS	Iowa Department of Agriculture and Land Stewardship
IDED	Iowa Department of Economic Development
IDNR	Iowa Department of Natural Resources
IDED	Iowa Department of Economic Development
IEC	Iowa Energy Center
IECC	International Energy Conservation Code
IESNA	Illuminating Engineering Society of North America
IGCC	integrated gasification combined cycle
IOU	investor-owned utility
IPCC	Intergovernmental Panel on Climate Change
ISU	Iowa State University
IUB	Iowa Utilities Board
K-12	kindergarten through 12th grade
kg	Kilogram
kW	Kilowatt
kWh	kilowatt-hour
lb	Pound

LCFS	low-carbon fuel standard
LDPE	low-density polyethylene
LDV	light-duty vehicle
LED	light-emitting diode
LEED	Leadership in Energy and Environmental Design [Green Building Rating System™]
LEED-ND	Leadership in Energy and Environmental Design for Neighborhood Development
LFG	landfill gas
LFGcost	landfill gas cost model
LFGTE	landfill gas-to-energy
LIHEAP	Low-Income Home Energy Assistance Program
LMOP	Landfill Methane Outreach Program [US EPA]
LNG	liquefied natural gas
LRR	low-rolling resistance
LULC	land use land cover
MAC	mitigation abatement cost
MAPP	Mid-Continent Area Power Pool
MEC	Manufacturers Energy Consumption Survey
metric ton	1,000 kilograms or 22,051 pounds
MGA	Midwestern Governors Association
MJ	Megajoule
MM	Million
MMBtu	millions of British thermal units
$MMtCO_2e$	million metric tons of carbon dioxide equivalent
mpg	miles per gallon
mph	miles per hour
MRF	material recovery facility
MSA	metropolitan statistical areas
MSW	municipal solid waste
MW	megawatt [one thousand kilowatts]
MWh	megawatt-hour [one thousand kilowatt-hours]
N	Nitrogen
N_2O	nitrous oxide
N/A	not applicable
NAHB	National Association of Home Builders
NAS	National Academies of Science
NEED	National Energy Education Development
NEI	National Emissions Inventory
NEMA	National Electrical Manufacturing Association
NESCAUM	Northeast States for Coordinated Air Use Management
NG	natural gas

NGCC	natural gas combined cycle
NGO	nongovernmental organization
NGTT	natural gas combustion turbine
NHTS	National Household Travel Survey
NIH	National Institutes of Health
NO_3	Nitrate
NO_x	oxides of nitrogen
NOAA	National Oceanic and Atmospheric Administration
NPV	net present value
NRC	Nuclear Regulatory Commission
NRCS	[USDA] Natural Resources Conservation Service
NREL	National Renewable Energy Laboratory [US DOE]
NRI	National Resources Inventory [USDA]
NSF	National Science Foundation
O&M	operation and maintenance
OCA	[Iowa] Office of Consumer Advocate
ODS	ozone-depleting substance
OEI	[Iowa] Office of Energy Independence
ORNL	Oak Ridge National Laboratory
P	phosphorus
PET	polyethylene terephthalate
PFC	perfluororocarbon
PHEV	plug-in hybrid electric vehicle
PIRG	Public Interest Research Group
PRI	Program-Related Investment
PURPA	Public Utilities Regulatory Policies Act
PV	photovoltaic
R&D	research and development
RCI	Residential, Commercial, and Industrial
REC	rural electric cooperative
REC	renewable energy certificate
RECS	Residential Energy Consumption Survey
ReEC	Renewable Energy Education in the Community
REFIT	renewable energy feed-in tariff
RISE	Revitalize Iowa's Sound Economy
RFIB	Renewable Fuels Infrastructure Board
RFS	renewable fuel standard
RPS	renewable portfolio standard
RTA	Regional Transit Authority
SB	Senate Bill
SC	Subcommittee

SEC	State Energy Council
SEER	seasonal energy efficiency ratio
SF_6	sulfur hexafluoride
SIT	State [GHG] Inventory Tool [US EPA]
SO_2	sulfur dioxide
SO_x	oxides of sulfur
STASGO	State Soil Geographic Databases
STB	Surface Transportation Board
T&D	transmission and distribution
t	metric ton
tC	metric tons of carbon
tCO_2	metric tons of carbon dioxide
tCO_2e	metric tons of carbon dioxide equivalent
tCO_2e/MWh	metric tons of carbon dioxide equivalent per megawatt-hour
TDR	transfer of development rights
TLU	Transportation and Land Use [Subcommittee]
TOD	time-of-day
TOD	transit-oriented development
ULI	Urban Land Institute
UNFCCC	United Nations Framework Convention on Climate Change
UNI	University of Northern Iowa
USDA	United States Department of Agriculture
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
USFS	United States Forest Service [USDA]
USGS	United States Geological Survey [U.S. Department of the Interior]
VEGA	Vehicle Energy and Greenhouse Gas Assessment
VMT	vehicle miles traveled
VOC	volatile organic compound
WARM	WAste Reduction Model [US EPA]
WTE	waste to energy
WWTP	wastewater treatment plant
yr	year

Executive Summary

Background

The Iowa General Assembly enacted Senate File 485 in 2007 and House File 2571 in 2008. This legislation creates the Iowa Climate Change Advisory Council (ICCAC) which consists of twenty-three (23) voting members appointed by the Governor that serve three-year staggered terms. The Council is also comprised of four (4) non-voting, ex-officio members from the General Assembly.

As specified in Iowa Code section 455B.851, “The council shall submit the greenhouse gas emission reduction proposals to the governor and the general assembly by January 1, 2009.” The proposals include the following:

- After consideration of a full range of policies and strategies, including the cost-effectiveness of the strategies, the council shall develop multiple scenarios designed to reduce statewide greenhouse gas emissions by fifty percent and ninety percent by 2050.”

- The Council shall also develop short-term, medium-term, and long-term scenarios designed to reduce statewide greenhouse gas emissions and shall consider the cost-effectiveness of the scenarios.

- The Council shall establish 2005 as the baseline year for purposes of calculating reductions in statewide greenhouse gas emissions.

The ICCAC began its deliberative process at its second meeting on December 17, 2007 following an organizational meeting via teleconference on October 15, 2007. ICCAC met a total of eight times, with the final in-person meeting held on November 10, 2008, followed by a conference call on December 10, 2008 for review of this report. About 75 additional teleconference meetings of ICCAC’s five supporting Subcommittees (SCs) were also held to identify and analyze various potential policy actions in advance of the ICCAC’s November 10, 2008, final decisional meeting.

The five SCs considered information and potential policy options in the following sectors:

- Energy Efficiency and Conservation (EEC)
- Clean and Renewable Energy (CRE)
- Transportation and Land Use (TLU);
- Agriculture, Forestry, and Waste Management (AFW); and
- Cross-Cutting Issues (CC) (i.e., issues that cut across the above sectors).

The Center for Climate Strategies (CCS) provided facilitation and technical assistance to the ICCAC and each of the SCs. The SCs consisted of ICCAC members and selected additional members. Members of the public were invited to observe and provide input at all meetings of the

ICCAC and SCs. The SCs served as advisers to the ICCAC and helped generate initial options on Iowa-specific policy options to be added to the catalog of existing state actions; priority policy options for analysis; draft proposals on the design characteristics and quantification of the proposed policy options; specifications and assistance for analysis of draft policy options (including best available data sources, methods and assumptions); and other key elements of policy option proposals, including related policies and programs, key uncertainties, co-benefits and costs, feasibility issues, and potential barriers to consensus.

Key Outcomes

In fulfillment of the requirements of this legislation the Council has prepared this Report which includes the following key outcomes:

- The Iowa Greenhouse Gas (GHG) Emissions Inventory and Forecast has been prepared which outlines baseline conditions as of 2005[1] and projected emissions through 2025 if no changes to the business as usual reference case are made. These projections were prepared in close consultation with the Iowa Department of Natural Resources (IDNR) and many Council and Sub-Committee members offered specific recommended improvements during its development. ICCAC recommends that the GHG Emissions Inventory and Forecast be updated annually.
- Approval of a comprehensive package of multi-sector policy options to reduce GHG emissions and address related energy and commerce issues in Iowa. ICCAC approved 56 policy options for inclusion in this Final Report. The ICCAC Members present and voting approved 32 of these policy options unanimously, approved 11 more with a super-majority vote (support of 80% or more of the members present and voting), and 13 additional options with a simple majority supporting it. One option failed to gain ICCAC approval. Explanations of objections are in included in Appendices F through J of this Report, which contain detailed accounts of the ICCAC's options along with descriptions of key uncertainties in the analysis.
- Evaluation of the direct costs and direct cost savings of the policy options in Iowa. The ICCAC analyzed quantitatively the direct costs or cost savings of 37 of its 56 policy options. Although the total net cost associated with the 37 policies analyzed is estimated at about $ 4.8 billion between 2009 and 2020, the weighted-average cost-effectiveness of the 37 policies is estimated to be approximately $8.80/t$CO_2$e reduced. Many of the policies are estimated to yield significant cost-saving opportunities for Iowans. Other policies will incur net costs.
- The Council developed two GHG Reduction Scenarios. One scenario was specified by the enabling legislation to achieve a 50% reduction from the baseline year [2005] by 2050. The Council developed a second GHG reduction scenario to achieve a 90% GHG reduction below the 2005 baseline year by 2050. The Council chose 2012 and 2020 as its short-term and mid-term intervals, respectively.

[1] Year 2005 was selected as the base year for the GHG reduction scenarios and cost-effectiveness analysis because emissions inventory data are more complete for year 2005 than for previous years.

- For a 50% reduction by 2050 scenario the Council recommends approximately a 1% reduction by 2012 and an 11% reduction by 2020. For the 90% reduction scenario the Council recommends approximately a 3% reduction by 2012 and a 22 % reduction by 2020. For both scenarios, a simple linear extrapolation was used from Iowa's estimated 2009 emissions to the targets of 50% and 90% reductions in 2050, which allowed delineation of interim targets for each scenario in 2012 and 2020. The assumption of linearity was made because there were plenty of reductions in the approved policy options to achieve the interim targets, and a more extensive analysis was beyond the scope of this report. The ICCAC based its options on its review of the potential overall emission reduction estimates (as compared to the GHG emissions inventory and forecast) for 38 of 56 policy options for which emission reductions were quantified, and its review of goals and targets adopted by several other states. Of the 56 policy options, 38 were analyzed quantitatively to have a cumulative effect of reducing emissions by about 20 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) in 2012 and 105 ($MMtCO_2e$) in 2020. Together, if the 38 quantified policy options and the recent federal and state actions (or their functional equivalent) are successfully implemented, the 2020 emission reduction scenario is achievable based on results of analysis of ICCAC proposals conducted through the ICCAC and Subcommittee process.
- In addition, the ICCAC recommends that the state report biennially to the Governor and the state legislature on the state's progress in reducing GHG emissions under these scenarios.

Iowa GHG Emissions Inventory and Reference Case Projections

In April 2008, CCS completed a draft GHG emissions inventory and reference case projection to assist the ICCAC and SCs in understanding past, current, and possible future GHG emissions in Iowa, and thereby inform the policy development process.[2] The ICCAC and SCs reviewed, discussed, and evaluated the draft inventory and projections methodologies, as well as alternative data and approaches for improving the draft inventory and projections. The final report[3] incorporating comments provided by the Subcommittees that were approved by the ICCAC at their September 2008 meeting and incorporated into the final report during October, is available at: http://www.iaclimatechange.us/Inventory_Forecast_Report.cfm . At the 7th ICCAC meeting in November 2008 the Council received the final I-F Report and agreed to file and forward it to the Governor and Legislature.

The inventory and reference case projections included detailed coverage of all economic sectors and GHGs in Iowa, including future emission trends and assessment issues related to energy, the

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[2] Center for Climate Strategies. *Draft Iowa Greenhouse Gas Inventory and Reference Case Projections, 1990–2025*. Prepared for the Iowa Climate Change Advisory Council. April, 2008. Available at: http://www.iaclimatechange.us/Inventory_Forecast_Report.cfm.

[3] Center for Climate Strategies. *Final Iowa Greenhouse Gas Inventory and Reference Case Projections, 1990–2025*. Prepared for the Iowa Climate Change Advisory Council. October, 2008. Available at: http://www.iaclimatechange.us/Inventory_Forecast_Report.cfm. See pages 13 and 14 of this report for a list of the the revisions that the ICCAC made to the inventory and reference case projections; these revisions are also identified at the end of Chapter 2 of the ICCAC final report.

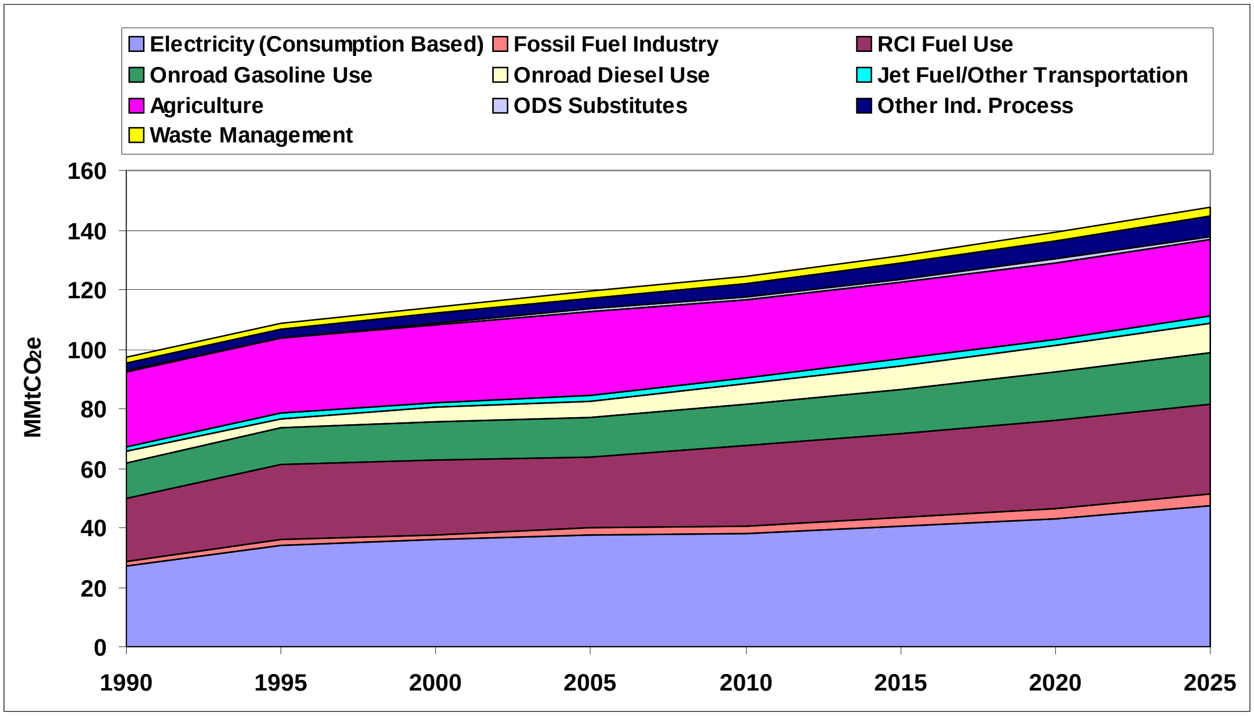
economy, and population growth. It is important to note that the emission estimates reflect the GHG emissions associated with the electricity sources used to meet Iowa's demands, corresponding to a consumption-based approach to emissions accounting. Another way to look at electricity emissions is to consider the GHG emissions produced by electricity generation facilities in the state—a production-based method. The study covers both methods of accounting for emissions, but for consistency, all total results are reported as consumption-based.

As illustrated in Figure ES-1, under the reference case projections, Iowa's gross GHG emissions continue to grow steadily, climbing to about 148 $MMtCO_2e$ by 2025, 52% above 1990 levels. This equates to a 1.1% annual rate of growth from 2005 to 2025. Relative to 2005, the share of emissions associated with electricity consumption and the transportation sector both increase slightly to 32% and 20%, respectively, in 2025. The share of emissions from the industrial processes and fossil fuel industry sectors is projected to increase to 6% and 3%, respectively, by 2025. The share of emissions from the RCI fuel use sector and the waste management sector is projected to remain the same at about 20% and 2%, respectively, of Iowa's gross GHG emissions in 2025. The agriculture sector is the only sector in Iowa whose emission share in 2025 is projected to decrease from its emission share in 2005 (from 23% in 2005 to 17% in 2025).

Emissions associated with electricity consumption are projected to be the largest contributor to future GHG emissions growth, followed by emissions associated with the transportation sector, as shown in Figure 2-4. Other sources of emissions growth include the RCI fuel use sector and the increasing use of HFCs and PFCs as substitutes for ozone-depleting substances in refrigeration, air conditioning, and other applications. The agriculture sector is the only sector in which emissions are projected to decrease from 2005 to 2025. Table 2-2 summarizes the growth rates that drive the growth in the Iowa reference case projections, as well as the sources of these data. Figure ES-2 depicts the 2005 distribution of sources in Iowa compared to the United States (U.S.) .

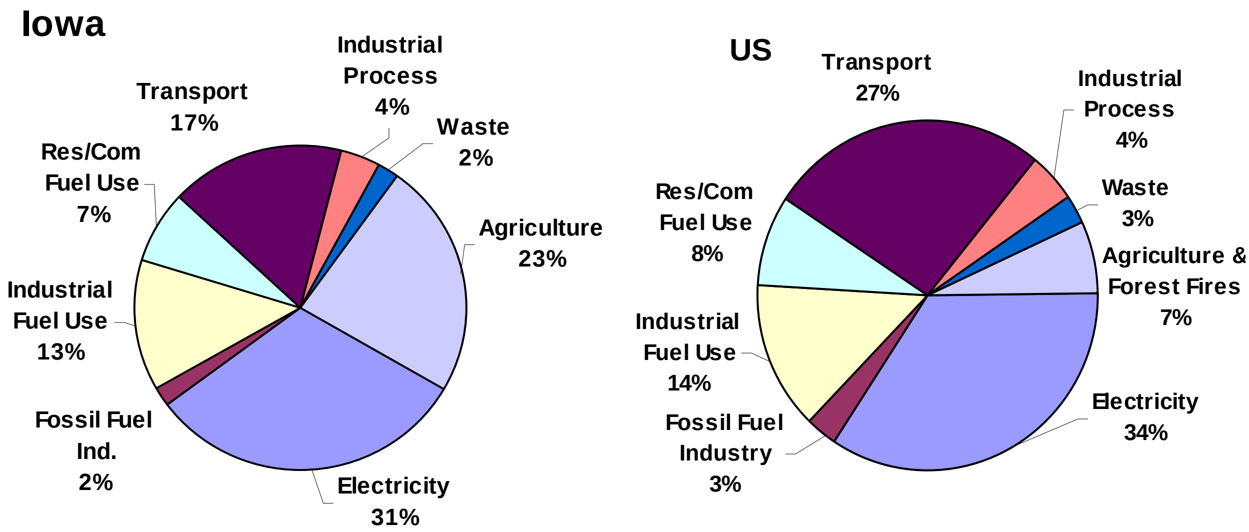
Estimates of carbon sinks within Iowa's forests, including urban forests and land use changes as well as agricultural soils, have also been included in this report. The current estimates indicate that about 27 $MMtCO_2e$ were stored in Iowa soils, forests and agricultural biomass in 2005. When all statewide emission sources and sinks are considered, this leads to *net* emissions of 92 $MMtCO_2e$ in Iowa in 2005, an amount equal to 1.4% of total US net GHG emissions.

Figure ES-1. Gross GHG emissions by sector, 1990–2025: historical and projected (consumption-based approach) business-as-usual/base case



ODS – ozone depleting substances

Figure ES-2. Gross GHG emissions by sector, 2005: Iowa and U.S.



Recent Actions

The federal Energy Independence and Security Act of 2007 (EISA) was signed into law in December 2007. This law contains several requirements that will reduce GHG emissions as they are implemented over the next few years. During the ICCAC process, sufficient information was identified (e.g., implementation schedules) to estimate GHG emission reductions associated with implementing the Corporate Average Fuel Economy requirements and energy efficiency requirements for new appliances and lighting associated with the EISA's Title IV (Energy Savings in Buildings and Industry) and Title V (Energy Savings in Government and Public Institutions) requirements in Iowa.

Iowa has recently embarked on statewide public sector energy efficiency initiatives in response to concerns about energy costs. The state is implementing two energy efficiency initiatives under Executive Orders 6 and 41. Executive Order 06[4] by Governor Culver establishes a Green Government Initiative in Iowa that is targeted at three areas (buildings, materials and biofuels). Several Task Forces have been established to address the specific areas. Executive Order 41[5] by Governor Vilsack requires that all state agencies reduce energy consumption in state buildings.

Together, these federal and state requirements are estimated to reduce gross GHG emissions for all sectors combined in Iowa by about 3.4 $MMtCO_2e$ (a 2.4% reduction) from the business-as-usual emissions in 2020.

In addition, Iowa utilities have been pursuing energy efficiency programs for some time. These investments are not quantified in the analysis because EEC subcommittee members indicated that the energy impacts from these efficiency programs are already incorporated into the utility load growth forecasts which were used for the reference case inventory and forecast (eg they are already in the baseline).

ICCAC Policy Options (Beyond Recent Actions)

The ICCAC developed 56 policy options. The ICCAC Members present and voting approved 32 of these policy options unanimously, approved 11 more with a super-majority vote (support of 80% or more of the members present and voting), and 13 additional options with a simple majority supporting it. One option failed to gain ICCAC approval and is not included in this report. At this time these policy options have not been prioritized nor ranked in any order of preference. Explanations of objections are in included in Appendices F through J of this Report, which contain detailed accounts of the ICCAC's options.

Of the 56 policy options, 38 were analyzed quantitatively to have a cumulative effect of reducing emissions by about 20 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) in 2012 and 105 ($MMtCO_2e$) in 2020.

[4] State of Iowa, Executive Department. Executive Order Number Six, February 21, 2008. Available at http://publications.iowa.gov

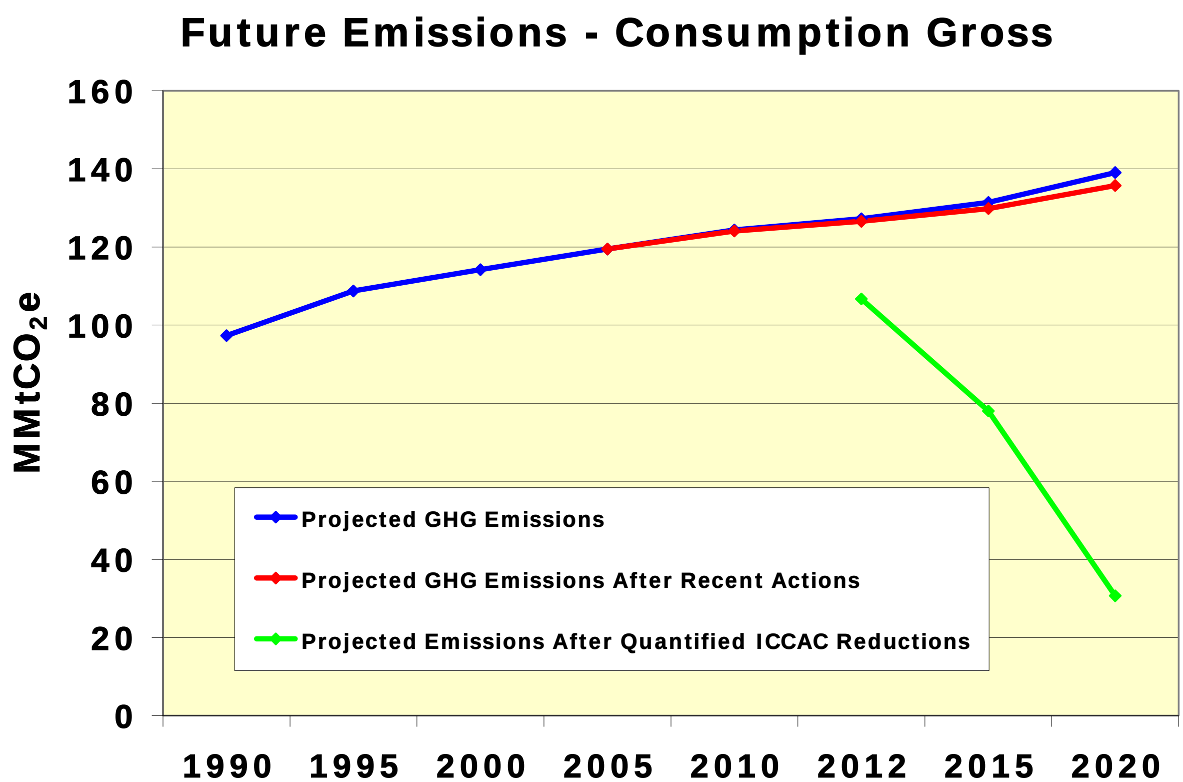
[5] State of Iowa, Executive Department. Executive Order Number Forty-one. April 22, 2005. Available at http://publications.iowa.gov/2619/1/EO_41.pdf

Figure ES-3 presents a graphical summary of the potential cumulative emission reductions associated with the recent federal and state actions and the 38 policy options relative to the business-as-usual reference case projections. Table ES-1a provides the numeric estimates underlying Figure ES-3 for the 50% reduction by 2050 scenario and Table ES-1b provides the same estimate for the 90% reduction scenario by 2050. In Figure ES-3:

- The blue line shows actual (for 1990, 1995, 2000, and 2005) and projected (for 2010, 2012, 2015 and 2020) levels of Iowa' gross GHG emissions on a consumption basis. (The consumption-based approach accounts for emissions associated with the generation of electricity in Iowa to meet the state's demand for electricity)
- The red line shows projected emissions associated with recent federal and state actions that were analyzed quantitatively.
- The green line shows projected emissions if all of the ICCAC's 38 options that were analyzed quantitatively with respect to their GHG reduction potential are implemented successfully and the estimated reductions are fully achieved. (Note that other ICCAC options would have the effect of reducing emissions, but those reductions were not analyzed quantitatively, so are not reflected in the green line.)

For the policy options offered by the ICCAC to yield the levels of estimated emission reductions shown in Table ES-2, they must be implemented in a timely and thorough manner. Table ES-3 depicts the final policy options of the Council and their associated GHG reductions and costs/ savings for each sector.

Figure ES-3. Annual GHG emissions: reference case projections and ICCAC options (consumption-basis, gross emissions)



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; GHG = greenhouse gas; ICCAC = Iowa Climate Change Advisory Council.

Table ES-1a. Annual emissions: reference case projections and impact of ICCAC options (consumption-basis, gross emissions) - 50 % Reduction Scenario by 2050

Consumption Basis - Gross Emissions							
	1990	**2000**	**2005**	**2010**	**2012**	**2015**	**2020**
Projected GHG Emissions	97.3	114.2	119.5	124.4	127.3	131.4	139.1
Reductions from Recent Actions			0.0	0.3	0.7	1.6	3.3
Projected GHG Emissions After Recent Actions*			119.5	124.1	126.6	129.8	135.7
Remaining GHGs After Reduction Scenarios Recommended by ICCAC					118.8	NA	106.3
Total GHG Reductions from ICCAC Policies					19.9	51.8	105.1
Difference Between ICCAC Scenarios and Reductions**					12.1	NA	75.7
Projected Emissions After Quantified ICCAC Reductions					106.7	78.0	30.6

* Reductions from recent actions include the Energy Independence and Security Act of 2007, Title III. GHG reductions from Titles IV and V of this Act have not been quantified because of the uncertainties in how they will be implemented. It is expected that Titles IV and V measures will overlap with EEC policies. Projected annual emissions also include reductions from recent actions.. Existing utility energy efficiency programs are not included in the existing action analysis because they are impounded in the utility load growth forecasts used in the Iowa Inventory and Forecast. ** (Difference = Row 4- row 7)

Table ES-1b. Annual emissions: reference case projections and impact of ICCAC options (consumption-basis, gross emissions)- 90 % Reduction Scenario by 2050

Consumption Basis - Gross Emissions							
	1990	2000	2005	2010	2012	2015	2020
Projected GHG Emissions	97.3	114.2	119.5	124.4	127.3	131.4	139.1
Reductions from Recent Actions			0.0	0.3	0.7	1.6	3.3
Projected GHG Emissions After Recent Actions*			119.5	124.1	126.6	129.8	135.7
Remaining GHGs after Reduction Scenarios Recommended by ICCAC					115.3	NA	93.5
Total GHG Reductions from ICCAC Policies					19.9	51.8	105.1
Difference Between ICCAC Scenarios and Reductions					8.6	NA	62.9
Projected Emissions After Quantified ICCAC Reductions					106.7	78.0	30.6

* Reductions from recent actions include the Energy Independence and Security Act of 2007, Title III. GHG reductions from Titles IV and V of this Act have not been quantified because of the uncertainties in how they will be implemented. It is expected that Titles IV and V measures will overlap with EEC policies. Projected annual emissions also include reductions from recent actions.. Existing utility energy efficiency programs are not included in the existing action analysis because they are impounded in the utility load growth forecasts used in the Iowa Inventory and Forecast. ** (Difference = Row 4- row 7)

Table ES-2. Summary by sector of estimated impacts of implementing all of the ICCAC options (cumulative reductions and costs/savings)

Sector	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2020 (Million $)	Cost-Effective-ness ($/tCO_2e$)
	2012	2020	Total 2009–2020		
Energy Efficiency and Conservation	1.1	8.5	42.8	-$1,057	-$25
Clean and Renewable Energy	5.8	48.0	233.5	$5,921	$25
Transportation and Land Use	1.6	11.1	55.0*	-$2,219	-$59
Agriculture, Forestry, and Waste Management	11.3	37.4	233.0	$2,139	$9.2
Cross-Cutting Issues	Non-quantified, enabling options				
TOTAL (includes all adjustments for overlaps)	**19.9**	**105.1**	**564.3**	**$4,785**	**$8.8**

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

The values in this table do not include the effects of recent actions. Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings associated with the policy options.

Within each sector, values have been adjusted to eliminate double counting for policies or elements of policies that overlap. In addition, values associated with policies or elements of policies within a sector that overlap with policies or elements of policies in another sector have been adjusted to eliminate double counting. Appendix F (for the EEC sectors), Appendix G (for the CRE sectors), Appendix H (for the TLU sectors) and Appendix I (for the AFW sectors) of this report provide documentation of how sector-level emission reductions and costs (or cost savings) were adjusted to eliminate double counting associated with overlaps between policies.

* Deduct total TLU-6 2009-2020 reductions [17.7MMt] from 55.03 total = 37.3, before calculating cost/ton for TLU Options. Total Reductions for calculation of cost-effectiveness: 564.3- 17.7 = 546.6. [$4.785 / 546.6 = $8.8/t

Table ES-3. Energy Efficiency and Conservation Policy Options

No.	Policy Option	CO_2 Reduction 2012	CO_2 Reduction 2020	Total 2009–2020	Net Present Value 2009–2020 (Million $)	Cost/Ton ($/tCO$_2$e)	Level of Support
EEC-1	Consumer Education Programs	*Not quantified*					Unanimous
EEC-2	Demand-Side Management (DSM)/Energy Efficiency Programs for Natural Gas	0.08	1.24	5.43	–$191.77	–$35.29	Super Majority (4 objections)
EEC-3	Financial Mechanisms for Energy Efficiency	1.62	6.11	36.81	–$805.05	–$21.87	Super Majority (1 objection)
EEC-4	Improved Building Codes for Energy Efficiency	0.05	0.40	1.89	–$46.27	–$24.44	Super Majority (5 objections)
EEC-5	Incentive Mechanisms for Achieving Energy Efficiency	0.35	3.29	16.33	–$350.79	–$21.48	Unanimous
EEC-6	Promotion and Incentives for Improved Design and Construction in the Private Sector	0.00	0.12	0.46	–$11.36	–$24.57	Super Majority (1 objection)
EEC-7	Training and Education for Builders and Contractors	*Not quantified*					Unanimous
EEC-8	Focus on Specific Residential Market Segments	0.09	0.98	4.83	–$122.53	–$25.37	Unanimous
EEC-9	Midwestern Governors Association Energy Security and Climate Stewardship Platform	0.13	4.13	17.14	–$375.69	–$21.92	Majority (9 objections)
EEC-10	Energy Management Training/Training of Building Operators	0.10	1.29	5.48	–$129.49	–$23.63	Super Majority (1 objection)
EEC-11	Rate Structures and Technologies To Promote Reductions	0.04	0.21	1.20	–$25.73	–$21.45	Unanimous
EEC-12	Demand-Side Management (DSM)/Energy Efficiency Programs for Electricity	0.39	4.38	20.33	–$444.81	–$21.88	Super Majority (4 objections)
EEC-13	Government Lead by Example: Improved Design, Construction, and Energy Operations in New and Existing State and Local Government Buildings	0.08	0.36	1.97	1.04	0.53	Majority (6 objections)
EEC-14	More Stringent Appliance Efficiency Standards	0.94	2.20	17.33	–$708.15	–$40.85	Super Majority (2 objections)
	Sector Total After Adjusting for Overlaps	**1.1**	**8.6**	**43.2**	**–$1,064.5**	**–$24.7**	
	Reductions From Recent Actions: EISA (2007) and Executive Orders #6 and 41	**0.44**	**1.42**	**9.19**			
	Sector Total Plus Recent Actions	**1.6**	**10.0**	**52.3**			

DSM = demand-side management; EISA = Energy Independence and Security Act of 2007; GHG = greenhouse gas; MMtCO$_2$e = million metric tons of carbon dioxide equivalent; $/tCO$_2$e = dollars per metric ton of carbon dioxide equivalent. Existing utility energy efficiency programs are not included in the recent action analysis because they are impounded in the utility load growth forecasts used in the Iowa Inventory and Forecast.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy options is for reference purposes only; it does not reflect prioritization among these important policy options.

Table ES-3. (continued) Clean and Renewable Energy Policy Options

No.	Policy Option	CO_2 Reduction 2012	CO_2 Reduction 2020	Total 2009–2020	Net Present Value 2009–2020 (Million $)	Cost/ton ($/t$CO_2$e)	Change in Generation Cost in 2020 $/MWh*	Level of Support
CRE-1	Education	*Not Quantified*						Unanimous
CRE-2	Technology Initiatives, Including Renewables	4.7	33.4	192.6	$5,653	$29.4	$25.7	Super Majority (3 Objections)
CRE-3	MGA Cap and Trade, Including Offsets To Promote Renewables	*Not Quantified*						Majority (5 Objections)
CRE-4	Decarbonization Fund	2.2	11.4	74.1	$316	$4.3	$3.1	Super Majority (2 Objections)
CRE-5	Performance Standards (50% Reduction by 2050)	4.9	11.4	95.4	$2,650.6	$27.8	$7.3	Super Majority (3 Objections, 1 Abstention)
CRE-6	Voluntary GHG Commitments	*Not Quantified*						Unanimous
CRE-7	Policies Related to Nuclear Power	0.0	9.7	9.7	$268	$27.6	$4.5	Majority (5 Objections)
CRE-8	Support for Grid-Based Renewable Energy & Development (MGA Target of 20% of retail sales by 2020)	0.0	2.3	4.3	$93.4	$21.8	$1.5	Unanimous
CRE-9	Transmission System Upgrading	*Not Quantified*						Unanimous
CRE-10	R&D for Emerging Technologies and Corresponding Incentives	*Not Quantified*						Unanimous
CRE-11	Distributed Generation/Co-Generation	0.0	0.1	0.5	$14	$29.1	$0.1	Super Majority (1 Objection)
CRE-12	Combined Heat and Power	0.3	2.1	13.6	–$564.3	–$41.4	$0.0	Unanimous
CRE-13	Pricing Strategies To Promote Renewable Energy and/or CHP	1.2	5.6	35	$1,128	$32.1	$4.7	Super Majority (3 Objections)
	Sector Total After Adjusting for Overlaps	**6**	**48**	**233**	**$5,921**	**$25**		
	Reductions From Recent Actions	**0**	**0**	**0**	**0**	**0**		
	Sector Total Plus Recent Actions	**6**	**48**	**233**	**$5,921**	**$25**		

GHG = greenhouse gas; MMtCO_2e = million metric tons of carbon dioxide equivalent; $/t$CO_2$e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy options is for reference purposes only; it does not reflect prioritization among these important policy options.

Table ES-3. (continued) Transportation and Land Use Policy Options

No.	Policy Option	GHG Reductions ($MMtCO_2e$) 2012	2020	Total 2009–2020	Net Present Value 2009–2020 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)	Level of Support
TLU-1	Smart Growth Bundle with Transit	0.076	0.242	1.53	–$377	–$245	Unanimous
TLU-1a	Expand and Improve Transit Infrastructure	0.004	0.026	0.127	$7.2	+$57	Majority (5 objections)
TLU-2	GHG Impacts for State and Local Capital Funding	*Quantified as part of TLU-1 and TLU-1a*					Unanimous
TLU-4	Support Passenger Rail Service in Iowa	N/A	0.008	0.026	$15	+$597	Majority (7 objections)
TLU-5a	Adopt Best Workplaces for Commuters in Iowa	0.02	0.02	0.21	$18	$84	Majority (6 objections)
TLU-5b	Distributed Workplace Models	*Non-quantified, qualitative option*					Unanimous
TLU-6	Light Duty Vehicles Fuel Efficiency Incentives	0.44	3.65	17.70*	NQ	NQ	Supermajority (3 objections)
TLU-7	Fuel Efficient Operations for Light Duty Vehicles	0.11	0.65	3.41	–$306.9	–$90	Unanimous
TLU-8	New Vehicle Standards (Tailpipe GHG and Fuel Economy)	N/A	0.8	4.1	–$246	–$60	Unanimous
TLU-9	Freight Strategies (Truck and Rail)	0.39	0.63	5.9	$30	+$5	Supermajority (1 objection)
TLU-10	Fuel Strategies (20% Low Carbon Fuel Standard)	0.60	5.11	22.03	–$1,359	–$62	Unanimous
	Sector Total After Adjusting for Overlaps and Synergies	**1.64**	**11.14**	**55.03***	**-$2,218.50**	**-$59**	
	Reductions From Recent Actions (Federal CAFE Requirements)	**0.26**	**1.93**	**9.39**	***Not Quantified***		
	Sector Total Plus Recent Actions	**1.9 (8.3)**	**13.07 (48)**	**64.42**	**N/A**	**N/A**	

CAFE = corporate average fuel economy; GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; N/A = not applicable.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy options is for reference purposes only; it does not reflect prioritization among these important policy options.

*Deduct total TLU-6 2009-2020 reductions [17.7MMt] from 55.03 total = 37.3, before calculating cost/ton for TLU Options.

Table ES-3. (continued) Agriculture, Forestry, and Waste Management Policy Options

No.	Policy Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2020 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
		2012	2020	Total 2009–2020			
AFW-1	Nutrient Management						Majority (7 Objections)
	Increase Efficiency of Fertilizer	0.11	0.53	3.0	–$103	–$34	
	Seasonally Flooded Areas	0.002	0.009	0.05	$10	$194	
	Improved Nutrient Distribution	0.02	0.1	0.55	$373	$693	
AFW-2	Wetlands and Drainage	0.01	0.16	0.57	$120	$218	Majority (5 Objections)
AFW-3	Expanded Use of Agriculture and Forestry Biomass Feedstocks for Electricity, Heat, or Steam Production	4.4	20	113	$4,281	$38	Unanimous
AFW-4	Encourage Large-Scale Manure/Methane Management Capture Utilization						Unanimous
	Methane Management Capture Utilization	0.8	3	17	$63	$4	
	Manure Management	0.2	0.7	4.6	–$38	–$8	
AFW-5	Land Management to Promote Sequestration Benefits						Unanimous
	Conservation Tillage	2.9	9	56	–$6	–$0.1	
	Agriculture Land Conversion	0.1	0.4	2.6	$199	$76	
	Conservation Grazing	0.1	0.3	1.7	–$116	–$67	
	Afforestation	0.2	0.6	4.1	$216	$53	
	Unmanaged Grazed Forested Land	0.3	0.8	5.5	$93.7	$17	
	Urban Forestry	0.1	0.4	2.4	–$99	–$41	
AFW-6	Cellulosic Biofuel*	2.0	9.8	49	–$1,410	–$29	Unanimous
AFW-7	Improved On-Farm (or First Point of Purchase) Energy Use and Efficiency						Unanimous
	Renewable Energy	0.02	0.08	0.5	$23	$51	
	Energy Efficiency	0.2	0.9	5.9	–$610	–$104	
AFW-8	Waste Management Strategies	1.5	4.1	26.5	–$220	–$8	Unanimous
AFW-9	Landfill Methane Energy Programs	0.2	0.8	4.8	$4	$0.8	Unanimous
	Sector Total After Adjusting for Overlaps	**11**	**37**	**233**	**$2,139**	**$9**	
	Reductions From Recent Actions	**0.0**	**0.0**	**0.0**	**$0.0**	**$0.0**	
	Sector Total Plus Recent Actions	**11**	**37**	**233**	**$2,139**	**$9**	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

* Note that the costs/savings of this option include a $1.01/gallon federal subsidy for cellulosic ethanol.

The numbering used to denote the above policy options is for reference purposes only; it does not reflect prioritization among these important policy options.

Table ES-3. (continued) Cross-Cutting Issues Policy Options

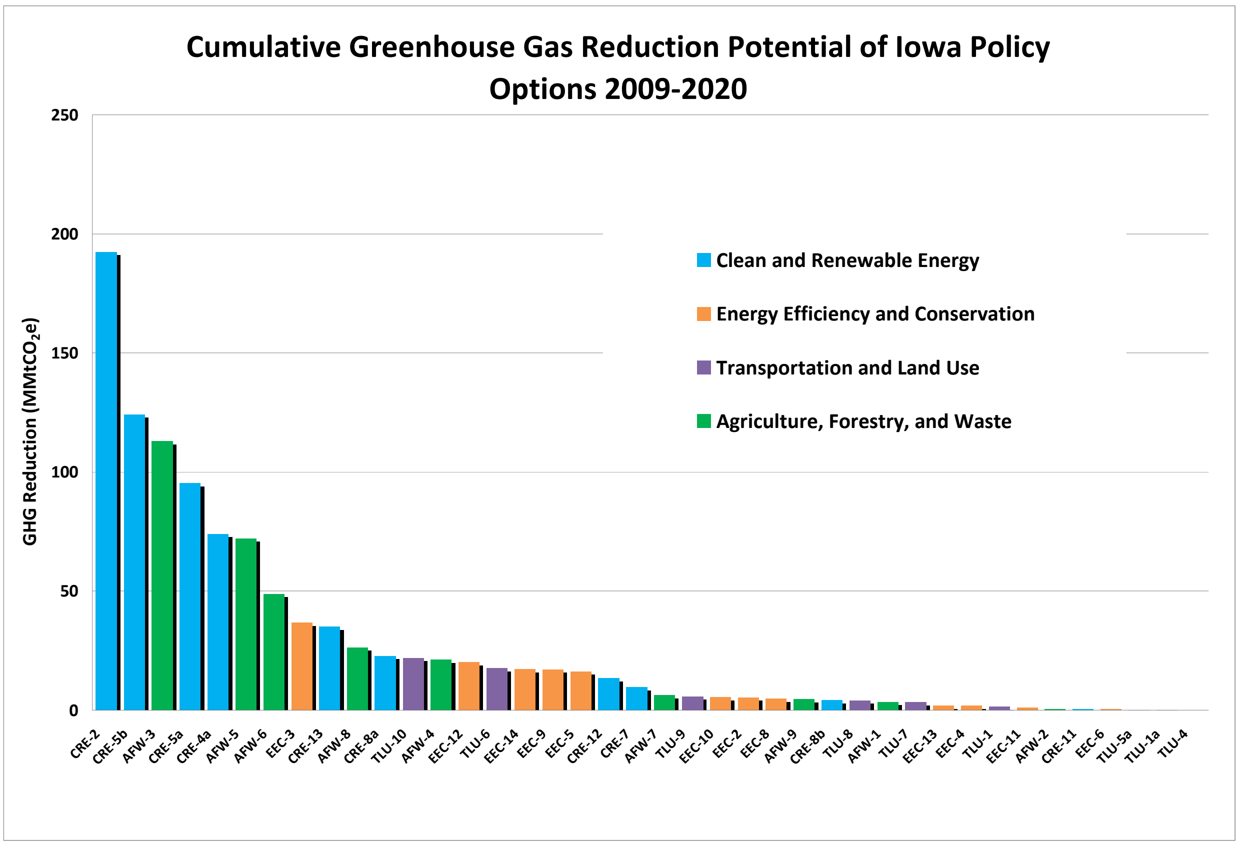
Policy No.	Policy Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2020 (Million $)	Cost-Effective-ness ($/t$CO_2$e)	Status of Option
		2012	2020	Total 2009–2020			
CC-1	GHG Inventories, Forecasting, Reporting, and Registry	*Not Quantified*					Unanimous
CC-2	Statewide GHG Reduction Scenarios	*Not Quantified*					Majority (4 Objections)
CC-3	State and Local Government GHG Emissions (Lead by Example)	*Not Quantified*					Unanimous
CC-4	Public Education and Outreach	*Not Quantified*					Unanimous
CC-5	Tax and Cap Policies—Lead Transferred to the CRE SC	*Not Quantified*					Transferred
CC-6	Seek Funding for Implementation of ICCAC Options	*Not Quantified*					Unanimous
CC-7	Adaptation and Vulnerability	*Not Quantified*					Unanimous
CC-8	Participate in Regional and Multistate GHG Reduction Efforts	*Not Quantified*					Unanimous
CC-9	Encourage the Creation of a Business-Oriented Organization To Facilitate Investment in Climate-Related Business Opportunities and To Share Information and Strategies, Recognize Successes, and Support Aggressive GHG Reduction Goals	*Not Quantified*					Unanimous

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t$CO_2$e = dollars per metric ton of carbon dioxide equivalent.

The numbering used to denote the above policy options is for reference purposes only; it does not reflect prioritization among these important policy options.

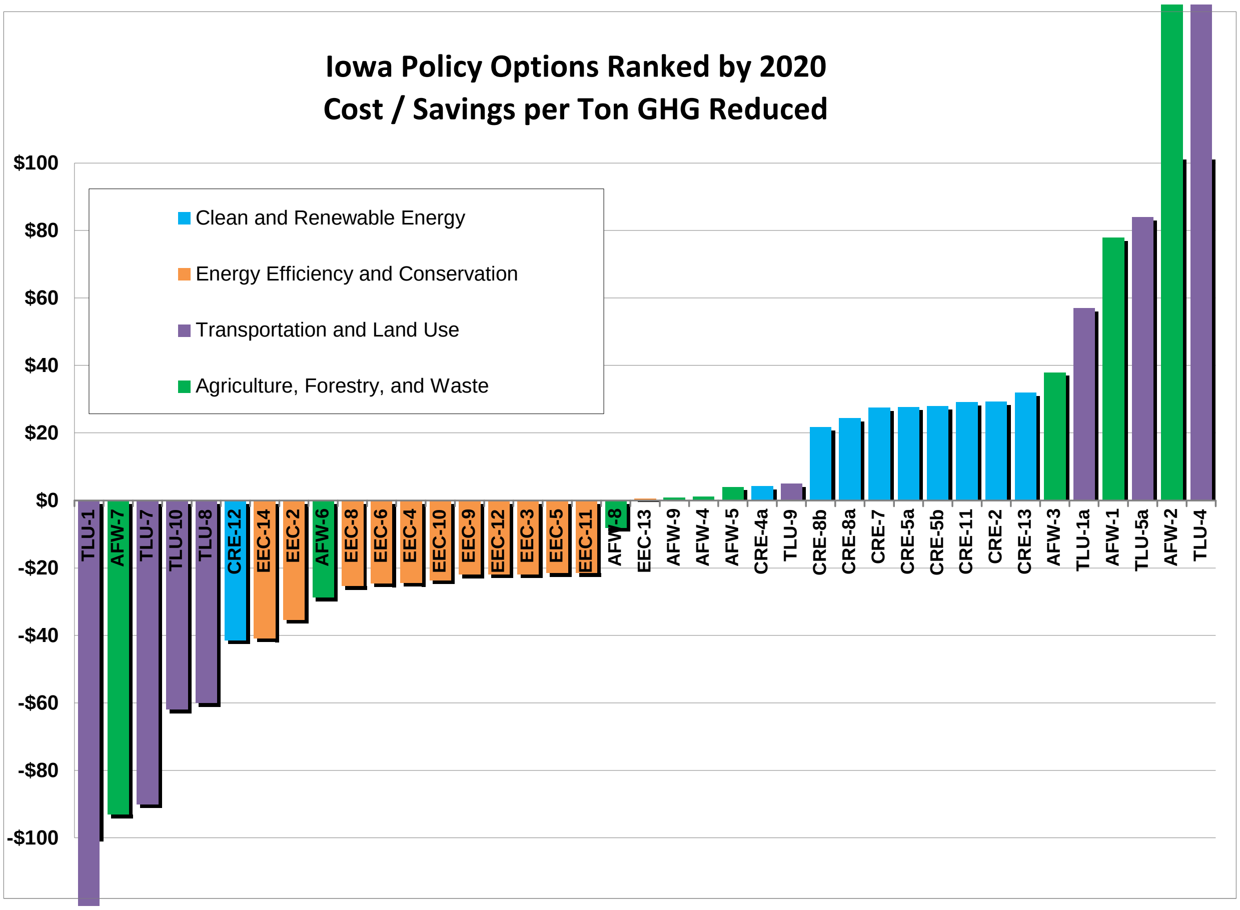
As explained above, the ICCAC considered the estimates of the GHG reductions that could be achieved by 38 of its options derived from 2005 baseline data, and the costs (or cost savings) of 37 of the options. Figure ES-4 presents the estimated tons of GHG emission reductions for each policy option for which estimates were quantified, expressed as a cumulative figure for the period 2009–2020. In addition to the imprecision in GHG reductions achieved by each policy option, there are uncertainties about the exact cost (or cost savings) per ton of reduction achieved. Figure ES-5 presents the estimated dollars-per-ton cost (or cost savings, depicted as a negative number) for each policy option for which cost estimates were quantified, expressed as a cumulative figure for the period 2009–2020. This measure is calculated by dividing the net present value of the cost of the policy option by the cumulative GHG reductions, all for the period 2009–2020.

Figure ES-4. ICCAC policy options ranked by cumulative (2009–2020) GHG reduction potential



GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; AFW = Agriculture, Forestry, and Waste Management; EEC = Energy Efficiency and Conservation,; TLU = Transportation and Land Use; CRE = Clean and Renewable Energy

Figure ES-5. ICCAC policy options ranked by cumulative (2009–2025) net cost/cost savings per ton of GHG removed

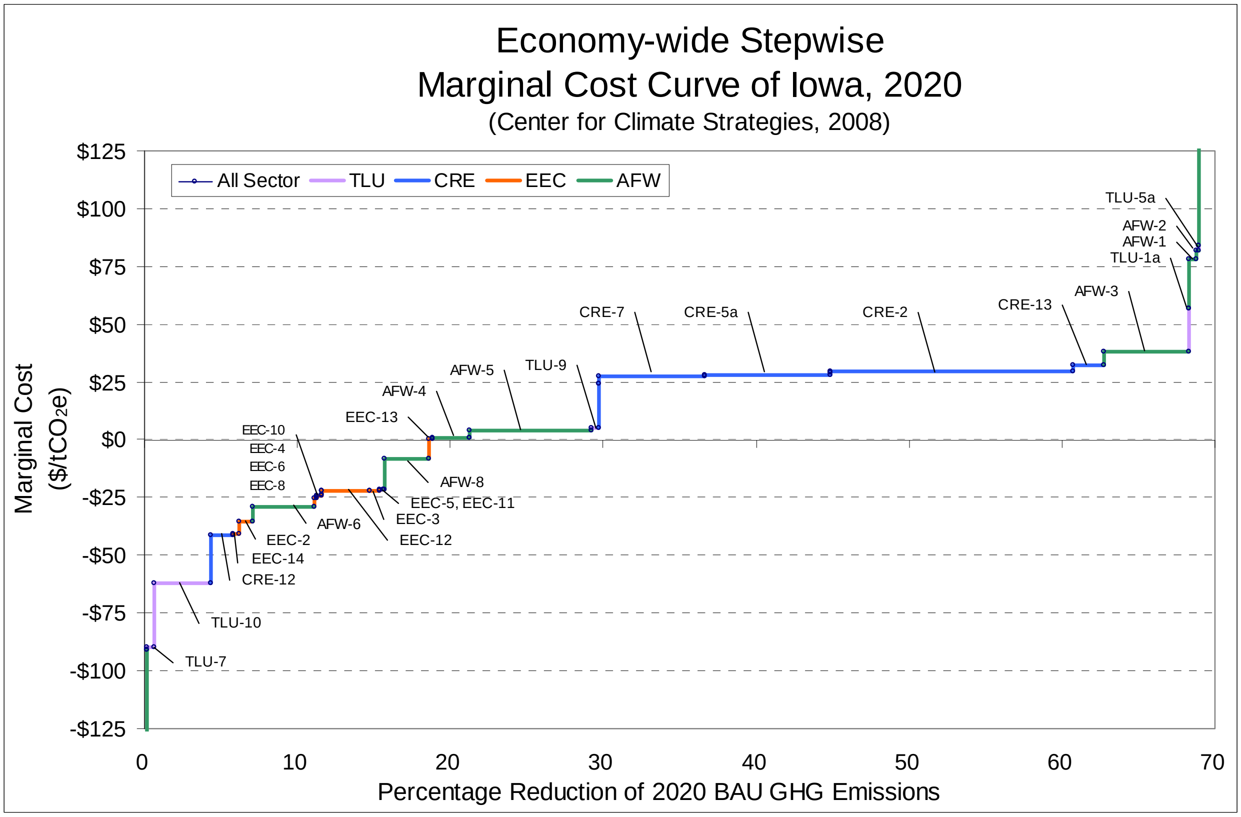


GHG = greenhouse gas; EEC = Energy Efficiency and Conservation; TLU = Transportation and Land Use; CRE = Clean and Renewable Energy; AFW = Agriculture, Forestry, and Waste Management.

Negative values represent net cost savings and positive values represent net costs associated with the policy option.

Figure ES-6 presents a stepwise marginal cost curve for Iowa. The horizontal axis represents the percentage of GHG emissions reduction in 2020 for each option relative to the business as usual (BAU) forecast. The vertical axis represents the marginal cost of mitigation (expressed as the cost-effectiveness of each policy option on a cumulative basis, 2009-2020). In the figure, each horizontal segment represents an individual policy. The width of the segment indicates the GHG emission reduction potential of the option in percentage terms. The height of the segment relative to the x-axis shows the average cost (saving) of reducing one $MMtCO_2e$ of GHG emissions with the application of the option.

Figure ES-6. Stepwise marginal cost curve for Iowa, 2025



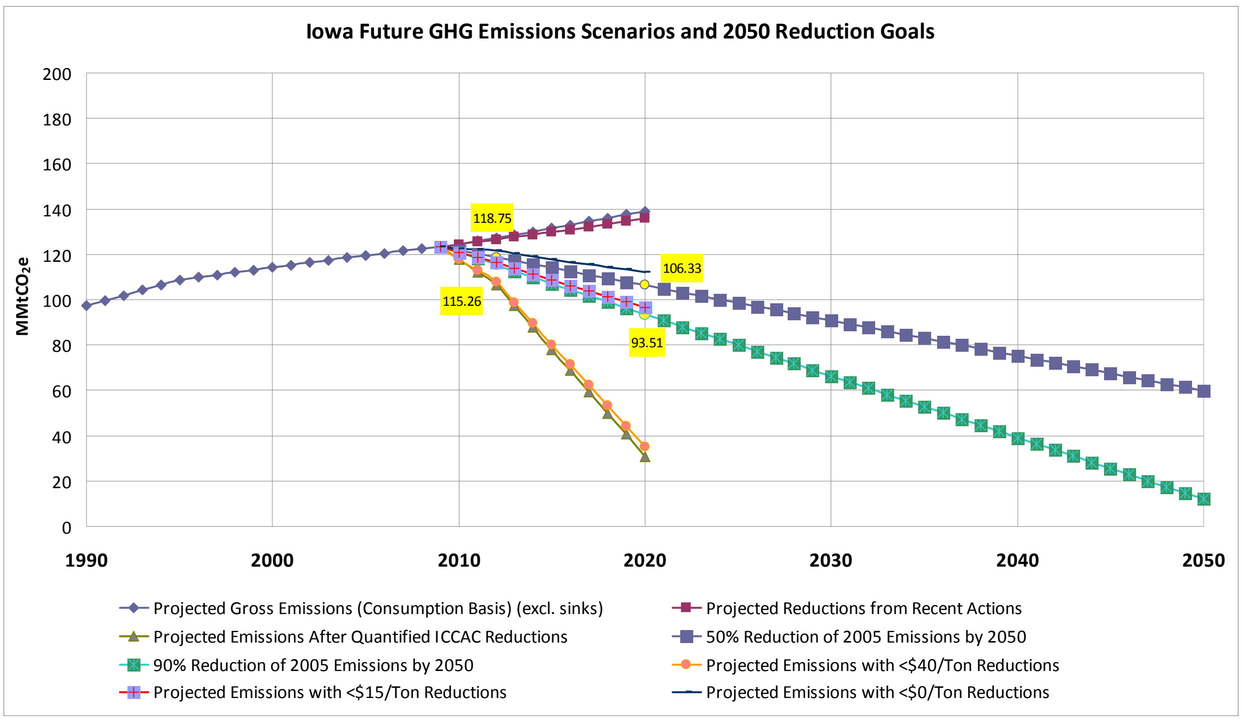
BAU = business as usual; GHG = greenhouse gas; tCO_2e = metric tons of carbon dioxide equivalent; AFW = Agriculture, Forestry, and Waste Management; EEC = Energy Efficiency and Conservation; TLU = Transportation and Land Use; CRE = Clean and Renewable Energy.

Negative values represent net cost savings and positive values represent net costs associated with the policy option.

Note: Results have been adjusted to remove overlaps between policies.

Finally, Figure ES-7 presents a graph with a linear extrapolation out to 2050 for the two ICCAC scenarios; a 50% GHG Reduction scenario [blue line] and a 90% GHG Reduction scenario [green line]. The 2012 and 2020 intersection points on each of these scenario lines were chosen for the short and mid-term scenario proposals. For both scenarios, a simple linear extrapolation was used from Iowa's estimated 2009 emissions to the targets of 50% and 90% reductions in 2050, which allowed delineation of interim targets for each scenario in 2012 and 2020. The assumption of linearity was made because there were plenty of reductions in the approved policy options to achieve the interim targets, and a more extensive analysis was beyond the scope of this report. For comparative purposes the figure also includes three lines indicating the projected emissions with three cost-effectiveness projections: for less than $40/T, $15/T and $0/T with orange, red and blue shades, respectively.

Figure ES-7. Iowa Future GHG Emissions Scenarios and 2050 Reduction Goals



Chapter 1
Background and Overview

Creation of the Iowa Climate Change Advisory Council

Iowa Senate File 485

The Iowa General Assembly enacted Senate File 485 in 2007 and House File 2571 in 2008. This legislation created the Iowa Climate Change Advisory Council (ICCAC) which consists of twenty-three (23) voting members appointed by the Governor, and serve three-year staggered terms. The Council is also comprised of four (4) non-voting, ex-officio members from the General Assembly.

As specified in Iowa Code section 455B.851, "The council shall submit the greenhouse gas emission reduction proposals to the governor and the general assembly by January 1, 2009." The proposals include the following:

- After consideration of a full range of policies and strategies, including the cost-effectiveness of the strategies, the Council shall develop multiple scenarios designed to reduce statewide greenhouse gas emissions, including one scenario that would reduce such emissions by fifty percent and ninety percent by 2050.

- The Council shall also develop short-term, medium-term, and long-term scenarios designed to reduce statewide greenhouse gas emissions and shall consider the cost-effectiveness of the scenarios.
- The Council shall establish 2005 as the baseline year for purposes of calculating reductions in statewide greenhouse gas emissions

ICCAC's Response

In fulfillment of the requirements of this legislation ICCAC held eight meetings over the last fifteen months. Additionally, the Council formed five technical Subcommittees (SCs) to assist the Council in formulating options. These SCs met numerous times between the ICCAC meetings. As a result the Council has prepared this Report which includes the following key outcomes and options:

- The Iowa Greenhouse Gas (GHG) Emissions Inventory and Forecast has been prepared which outlines baseline conditions as of 2005[1] and projected emissions through 2025 if no changes to the business as usual reference case are made. These projections were prepared in close consultation with the Iowa Department of Natural Resources (IDNR) and many Council and Sub-Committee members offered specific recommended improvements during its development. ICCAC recommends that the GHG Emissions Inventory and Forecast be updated annually.

[1] Year 2005 was selected as the base year for the GHG reduction scenarios and cost-effectiveness analysis because emissions inventory data are more complete for year 2005 than for previous years.

- Approval of a comprehensive package of multi-sector policy options to reduce GHG emissions and address related energy and commerce issues in Iowa. ICCAC approved 56 policy options for inclusion in this Final Report. The ICCAC Members present and voting approved 32 of these policy options unanimously, approved 11 more with a super-majority vote (support of 80% or more of the members present and voting), and 13 additional options with a simple majority supporting it. One option failed to gain ICCAC approval. Explanations of objections are in included in Appendices F through J of this Report, which contain detailed accounts of the ICCAC's options.
- Evaluation of the direct costs and direct cost savings of the policy options in Iowa. The ICCAC analyzed quantitatively the direct costs or cost savings of 37 of its 56 policy options. Although the total net cost associated with the 37 policies analyzed is estimated at about $ 4.8 billion between 2009 and 2020, the weighted-average cost-effectiveness of the 37 policies is estimated to be approximately $8.80/tCO$_2$e reduced. Many of the policies are estimated to yield significant cost-saving opportunities for Iowans. Other policies will incur net costs.
- The Council developed two GHG Reduction Scenarios. One scenario was specified by the enabling legislation to achieve a 50% reduction from the baseline year [2005] by 2050. The Council developed a second GHG reduction scenario to achieve a 90% GHG reduction below the 2005 baseline year by 2050. The Council chose 2012 and 2020 as its short-term and mid-term intervals, respectively. For a 50% reduction by 2050 scenario the Council recommends a 1% reduction by 2012 and an 11% reduction by 2020. For the 90% reduction scenario the Council recommends a 3% reduction by 2012 and a 22 % reduction by 2020. The ICCAC based its options on its review of the potential overall emission reduction estimates (as compared to the GHG emissions inventory and forecast) for 38 of 56 policy Options for which emission reductions were quantified, and its review of goals and targets adopted by several other states. Of the 56 policy Options, 38 were analyzed quantitatively to have a cumulative effect of reducing emissions by about 20 million metric tons of carbon dioxide equivalent (MMtCO$_2$e) in 2012 and 105 (MMtCO$_2$e) in 2020. Together, if the 38 quantified policy options and the recent federal and state actions (or their functional equivalent) are successfully implemented, the 2020 emission reduction scenario based on results of analysis of ICCAC proposals conducted through the ICCAC and Subcommittee process is achievable.
- In addition, the ICCAC recommends that the state report biennially to the Governor and the state legislature on the state's progress in reducing GHG emissions under these scenarios.

Recent Actions

GHG Reductions Associated With Recent Federal Actions

The federal Energy Independence and Security Act of 2007 (EISA) was signed into law in December 2007. This law contains several requirements that will reduce GHG emissions as they are implemented over the next few years. During the ICCAC process, sufficient information was identified (e.g., implementation schedules) to estimate GHG emission reductions associated with implementing the Corporate Average Fuel Economy requirements and energy efficiency requirements for new appliances and lighting associated with the EISA's Title IV (Energy Savings in Buildings and Industry) and Title V (Energy Savings in Government and Public

Institutions) requirements in Iowa. The GHG emission reductions projected to be achieved by these actions are shown in Figure 1-1. Table 1-1 provides the numeric estimates underlying Figure 1-1.

Recent State Actions

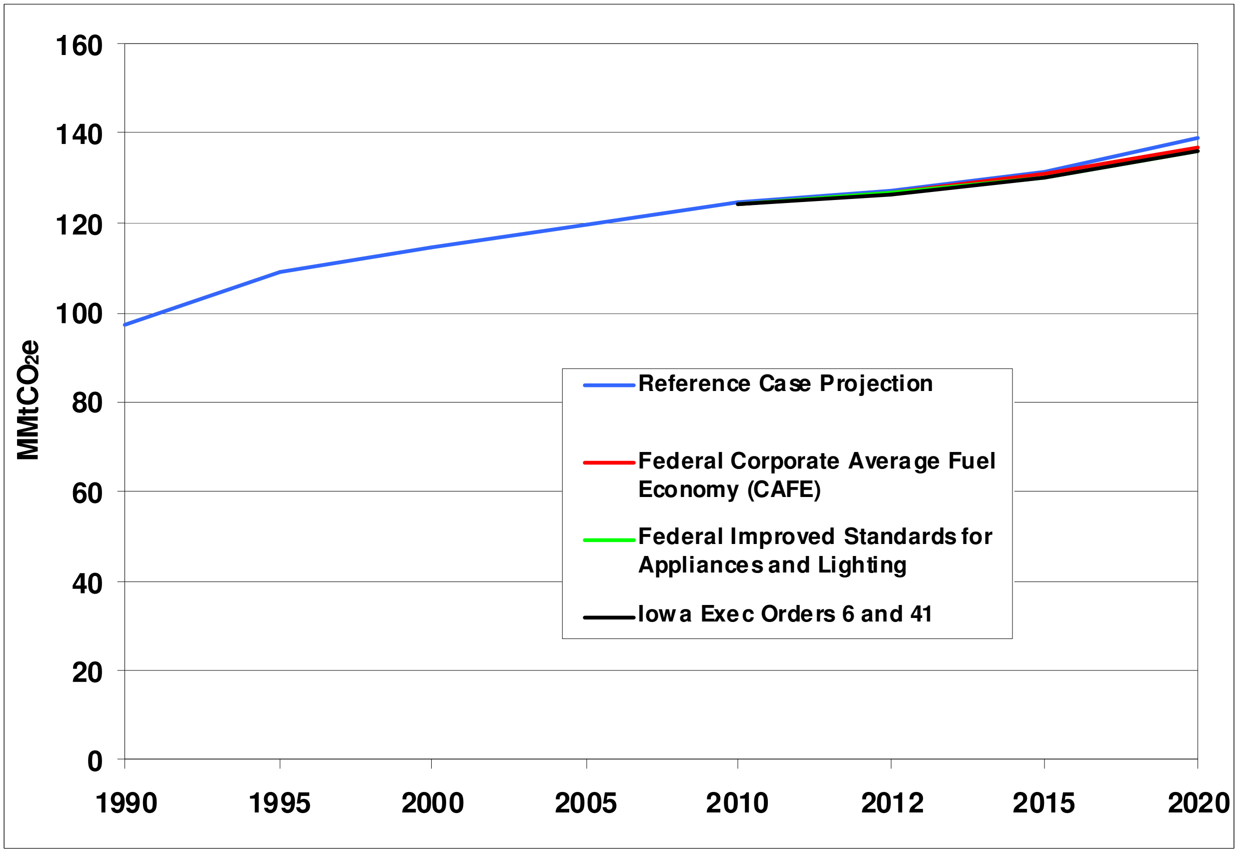
Iowa has recently embarked on statewide energy efficiency programs in response to concerns about energy costs. The state is implementing two energy efficiency initiatives under Executive Orders 6 and 41. Executive Order 6[2] by Governor Culver establishes a Green Government Initiative in Iowa that is targeted at three areas (buildings, materials and biofuels). Several Task Forces have been established to address the specific areas. Executive Order 41[3] by Governor Vilsack requires that all state agencies reduce energy consumption in state buildings. The estimated reductions associated with each of these efforts is also incorporated into Figure 1-1 and Table 1-1.

Together, these federal and state requirements are estimated to reduce gross GHG emissions for all sectors combined in Iowa by about 3.4 $MMtCO_2e$ (a 2.4% reduction) from the business-as-usual emissions in 2020.

[2] State of Iowa, Executive Department. Executive Order Number Six, February 21, 2008 Available at http://publications.iowa.gov

[3] State of Iowa, Executive Department. Executive Order Number Forty-one. April 22, 2005. Available at http://publications.iowa.gov/2619/1/EO_41.pdf

Figure 1-1. Estimated emission reductions associated with the effect of recent federal and state actions in Iowa (consumption-basis, gross emissions)



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Table 1-1. Estimated emission reductions associated with the effect of recent federal and state actions in Iowa (consumption-basis, gross emissions)

Sector / Recent Action	GHG Reductions ($MMtCO_2e$) 2012	GHG Reductions ($MMtCO_2e$) 2020	GHG Emissions ($MMtCO_2e$) Business as Usual 2020	GHG Emissions ($MMtCO_2e$) With Recent Actions 2020
Energy Efficiency and Conservation (EEC)*				
Federal Improved Standards for Appliances and Lighting Requirements	0.23	1.13	29.7	28.6
Iowa Executive Orders 6 and 41	0.21	0.29		28.3
Transportation and Land Use (TLU)				
Federal Corporate Average Fuel Economy (CAFE) Requirements	0.26	1.93	27.2	25.2
Total (EEC + TLU Sectors)	0.70	3.35	56.9	53.5
Total (All Sectors)			139.1	135.7

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.
*EEC in this report specifically addresses residential, commercial and industrial (RCI) fuel use.

The ICCAC Process

The ICCAC began its deliberative process at its second meeting on December 17, 2007 following an organizational meeting via teleconference on October 18, 2007. ICCAC met a total of seven times, with the final decisional meeting held on November 10, 2008, followed by a conference call on December 10, 2008 for review of this report. About 75 additional teleconference meetings of ICCAC's five supporting Subcommittees were also held to identify and analyze various potential policy actions in advance of the ICCAC's November 10, 2008 final decisional meeting.

The five SCs considered information and potential options in the following sectors:

- Energy Efficiency and Conservation (EEC);
- Clean and Renewable Energy (CRE);
- Transportation and Land Use (TLU);
- Agriculture, Forestry, and Waste Management (AFW); and
- Cross-Cutting Issues (CC) (i.e., issues that cut across the above sectors).

The Center for Climate Strategies (CCS) provided facilitation and technical assistance to the ICCAC and each of the SCs, based on a detailed proposal approved by the ICCAC. The SCs consisted of ICCAC members and selected additional members. Members of the public were invited to observe and provide input at all meetings of the ICCAC and SCs. The SCs served as advisers to the ICCAC and helped generate initial options on Iowa-specific policy options to be added to the catalog of existing states actions; priority policy options for analysis; draft proposals on the design characteristics and quantification of the proposed policy options; specifications and assistance for analysis of draft policy options (including best available data sources, methods and assumptions); and other key elements of policy option proposals, including related policies and programs, key uncertainties, co-benefits and costs, feasibility issues, and potential barriers to consensus. Where members of a SC did not fully agree on options to the ICCAC, the summary of their efforts was reported to the ICCAC as a part of its consideration and actions. The ICCAC then made its decisions after reviewing the SCs' proposals, including modifications as deemed appropriate in their judgment.

The ICCAC process employed a model of informed self-determination through a facilitated, stepwise, fact-based, and consensus-building approach. The process was facilitated by CCS, an independent, expert facilitation and technical analysis team. It was based on procedures that CCS has used in a number of other state climate change planning initiatives since 2000, but was adapted specifically for Iowa. The ICCAC process sought but did not mandate consensus, and it explicitly documented the level of ICCAC support for policies and key findings through a voting process established in advance, including barriers to full consensus where they existed on final consideration of proposed actions.

The 56 policy options (out of more than 300 potential options considered) adopted by the ICCAC and presented in this report were developed through a stepwise approach that included: (1) expanding a list existing states actions to include additional Iowa-specific actions; (2) developing a set of "priority for analysis" options for further development; (3) fleshing these proposals out for full analysis by development of "straw proposals" for level of effort, timing and parties involved in implementation; (4) developing and applying a common framework of analysis for options, including sector specific guidance and detailed specifications for options that include data sources, methods and key assumptions; (5) reviewing results of analysis and modifying proposals as needed to address potential barriers to consensus; (6) finalizing design and analysis of options to remove barriers to final agreement; and (7) developing other key elements of policy proposals such as implementation mechanisms, co-benefits, and feasibility considerations. At the final three meetings of the process, policy options with at least majority support (defined as less than half of those present objecting) from ICCAC members present were adopted by the ICCAC and included in this report. The SCs' options to the ICCAC were documented and presented to the ICCAC at each ICCAC meeting. All of the ICCAC and SC meetings were open to the public and all materials for and summaries of the ICCAC and SC meetings were posted on the ICCAC Web site (www.iaclimatechange.us). A detailed description of the deliberative process is included in Appendix B.

Analysis of Policy Options

With CCS providing facilitation and technical analysis, the five SCs submitted options for policies for ICCAC consideration using a "policy option template" conveying the following key information:

- Policy Description
- Policy Design (Goals, Timing, Parties Involved)
- Implementation Mechanisms
- Related Policies/Programs in Place
- Type(s) of GHG Reductions
- Estimated GHG Reductions and Net Costs or Cost Savings
- Key Uncertainties
- Additional Benefits and Costs
- Feasibility Issues
- Status of Group Approval
- Level of Group Support
- Barriers to Consensus

In its deliberations, the ICCAC reviewed, modified, and reached group agreement on various policy options. The final versions for each sector, conforming to the policy option templates, appear in Appendices F through J and constitute the most detailed record of decisions of the ICCAC. Appendix E describes the methods used for quantification of the 38 policy options that were analyzed quantitatively. The quantitative analysis produced estimates of the GHG emission reductions and direct net costs (or cost savings) of implementation of various policies, in terms of both a net present value from 2009 to 2020 and a dollars-per-ton cost (i.e., cost-effectiveness). The key methods are summarized below.

Estimates of GHG Reductions: Using the projection of future GHG emissions (see below) as a starting point, 38 policy options were analyzed by CCS to estimate GHG reductions attributable to each policy in the individual years of 2012 and 2020 and cumulative reductions over the period 2009–2020. The estimates were prepared in accordance with guidance by the appropriate SC and the ICCAC, which later reviewed the estimates and, in some cases, directed that they be revised with respect to such elements as goals, data sources, assumptions, sensitivity analysis, and methodology. Many policies were estimated to affect the quantity or type of fossil fuel combusted; others affected methane or CO_2 sequestered. Among the many assumptions involved in this task was identification of the appropriate GHG accounting framework—namely, the choice between taking a "production-based" approach versus a "consumption-based" approach to various sectors of the economy.[4]

Estimates of Costs/Cost Savings: The analyses of 37 policy options included estimates of the direct cost of those policies, in terms of both net costs or cost savings during 2009–2020 and a dollars-per-ton cost (i.e., cost-effectiveness). Following is a brief summary of the approach used to estimate the costs or cost savings associated with the policy options:

- *Discounted and annualized costs or cost savings*—Standard approaches were taken here. The net present value of costs or cost savings was calculated by applying a real discount rate of 5%. Dollars-per-ton estimates were derived as an annualized cost per ton, dividing the present value cost or savings by the cumulative GHG reduction measured in tons. As was the case with GHG reductions, the period 2009–2025 was analyzed.
- *Cost savings*— Total net costs or savings were estimated through comparison of monetized costs and savings of policy implementation over time, using discounting. These net costs could be positive or negative; negative costs indicated that the policy saved money or produced "cost savings." Many policies were estimated to create net financial cost savings (typically through fuel savings and electricity savings associated with new policy actions).
- *Direct vs. indirect effects*—Estimates of costs and cost savings were based on "direct effects" (i.e., those borne by the entities implementing the policy).[5] Implementing entities could be individuals, companies, and/or government agencies. In contrast, conventional cost-benefit analysis takes the "societal perspective" and tallies every conceivable impact on every entity in society (and quantifies these wherever possible).

Additional Costs and Benefits: The ICCAC options were guided by four decision criteria that included GHG reductions and monetized costs and cost savings of various policies, as well as other potential co-benefits and costs (e.g., social, economic, and environmental) and feasibility considerations. The SCs were asked to examine the latter two in qualitative terms where deemed important and quantify them on a case-by-case basis, as needed, depending on need and where data were readily available.

[4] A production-based approach estimates GHG emissions associated with goods and services produced within the state, and a consumption-based approach estimates GHG emissions associated with goods and services consumed within the state. In some sectors of the economy, these two approaches may not result in significantly different numbers. However, the power sector is notable, in that it is responsible for large quantities of GHG emissions, and states often produce more or less electricity than they consume (with the remainder attributable to power exports or imports).

[5] "Additional benefits and costs" were defined as those borne by entities other than those implementing the policy option. These indirect effects were quantified on a case-by-case basis, depending on magnitude, importance, need, and availability of data.

Implementation Mechanisms: The analysis for each option (see Appendices F through J) of the ICCAC includes guidance on the policy instruments or "mechanisms" that were prescribed or assumed for the policy action. This includes a range of potential mechanisms including, for instance, funding incentives, codes and standards, voluntary and negotiated agreements, market based instruments, information and education, reporting and disclosure, and other instruments. In some cases, the recommended instruments are precise. In other cases, they are more general and envision further work to develop concrete programs and steps to achieve the goals recommended by the ICCAC.

Iowa GHG Emissions Inventory and Reference Case Projections

In April 2008, CCS completed a draft GHG emissions inventory and reference case projection to assist the ICCAC and SCs in understanding past, current, and possible future GHG emissions in Iowa, and thereby inform the policy development process.[6] The ICCAC and SCs reviewed, discussed, and evaluated the draft inventory and projections methodologies, as well as alternative data and approaches for improving the draft inventory and projections. The final report incorporating comments provided by the Subcommittees that were approved by the ICCAC at their September 2008 meeting and incorporated into the final report during October, is available at: http://www.iaclimatechange.us/Inventory_Forecast_Report.cfm . At the 7th ICCAC meeting in November 2008 the Council received the final I-F Report[7] and agreed to file and forward it to the Governor and Legislature.

The inventory and reference case projections included detailed coverage of all economic sectors and GHGs in Iowa, including future emission trends and assessment issues related to energy, the economy, and population growth. It is important to note that the emission estimates reflect the GHG emissions associated with the electricity sources used to meet Iowa's demands, corresponding to a consumption-based approach to emissions accounting. Another way to look at electricity emissions is to consider the GHG emissions produced by electricity generation facilities in the state—a production-based method. The study covers both methods of accounting for emissions, but for consistency, all total results are reported as consumption-based.

As illustrated in Figure 1-2, under the reference case projections, Iowa's gross GHG emissions continue to grow steadily, climbing to about 148 $MMtCO_2e$ by 2025, 52% above 1990 levels. This equates to a 1.1% annual rate of growth from 2005 to 2025. Relative to 2005, the share of emissions associated with electricity consumption and the transportation sector both increase slightly to 32% and 20%, respectively, in 2025. The share of emissions from the industrial processes and fossil fuel industry sectors is projected to increase to 6% and 3%, respectively, by

[6] Center for Climate Strategies. *Draft Iowa Greenhouse Gas Inventory and Reference Case Projections, 1990–2025*. Prepared for the Iowa Climate Change Advisory Council. April, 2008. Available at: http://www.iaclimatechange.us/Inventory_Forecast_Report.cfm

[7] Center for Climate Strategies. *Final Iowa Greenhouse Gas Inventory and Reference Case Projections, 1990–2025*. Prepared for the Iowa Climate Change Advisory Council. October, 2008. Available at: http://www.iaclimatechange.us/Inventory_Forecast_Report.cfm. See pages 13 and 14 of this report for a list of the the revisions that the ICCAC made to the inventory and reference case projections; these revisions are also identified at the end of Chapter 2 of the ICCAC final report.

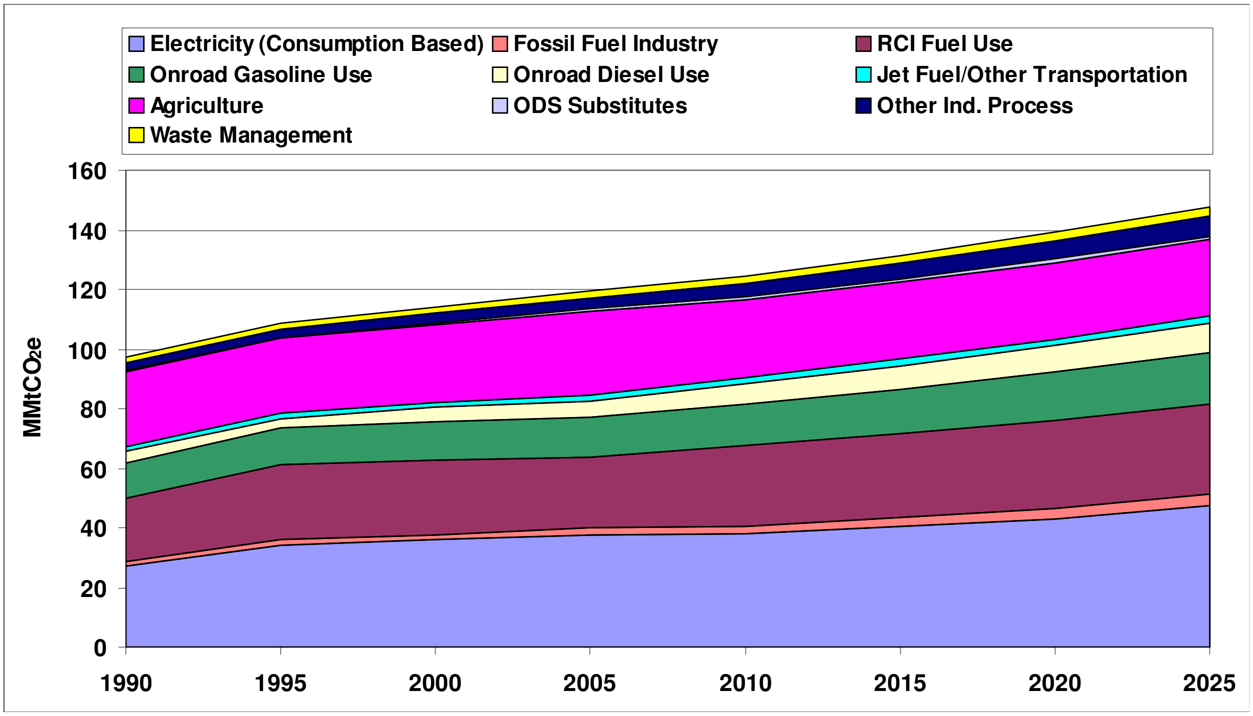
2025. The share of emissions from the residential commercial and industrial and commercial (RCI) fuel use sector and the waste management sector is projected to remain the same at about 20% and 2%, respectively, of Iowa's gross GHG emissions in 2025. The agriculture sector is the only sector in Iowa whose emission share in 2025 is projected to decrease from its emission share in 2005 (from 23% in 2005 to 17% in 2025).

Emissions associated with electricity consumption are projected to be the largest contributor to future GHG emissions growth, followed by emissions associated with the transportation sector. Other sources of emissions growth include the RCI fuel use sector and the increasing use of HFCs and PFCs as substitutes for ozone-depleting substances in refrigeration, air conditioning, and other applications. The agriculture sector is the only sector in which emissions are projected to decrease from 2005 to 2025. Figure 1-3 depicts the 2005 distribution of sources in Iowa compared to the United States (U.S.) .

Estimates of carbon sinks within Iowa's forests, including urban forests and land use changes as well as agricultural soils, have also been included in this report. The current estimates indicate that about 27 $MMtCO_2e$ were stored in Iowa soils, forests and agricultural biomass in 2005. This leads to *net* emissions of 92 $MMtCO_2e$ in Iowa in 2005, an amount equal to 1.4% of total US net GHG emissions.

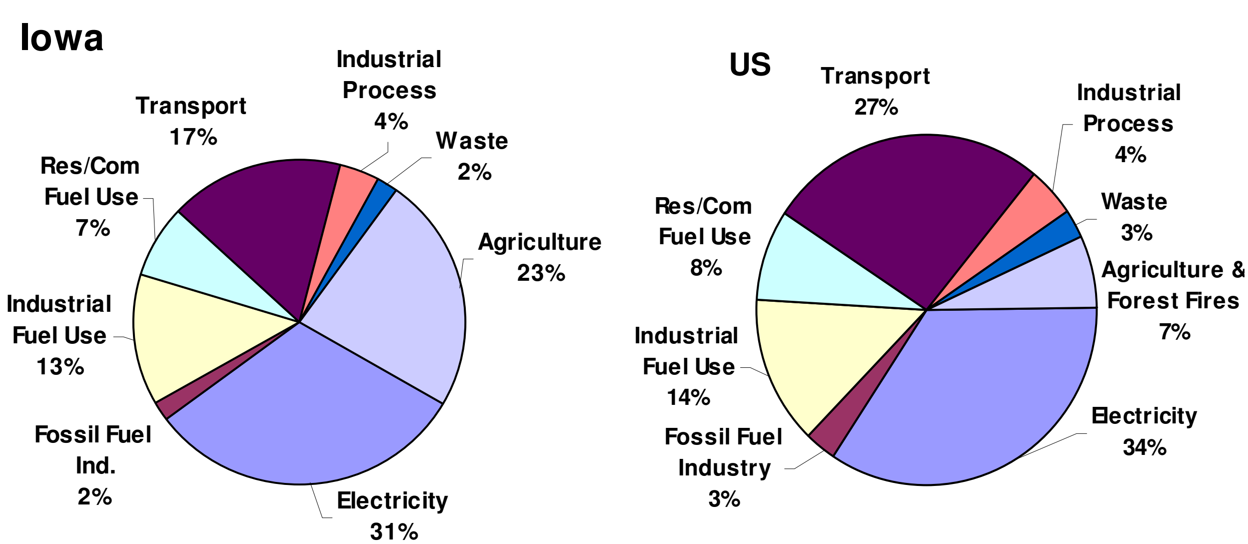
While Iowa's estimated emissions growth rate presents challenges, it also provides major opportunities. Key choices regarding technologies and infrastructure can have a significant impact on emissions growth in Iowa. The ICCAC's options document the opportunities for the state to reduce its GHG emissions, while continuing its strong economic growth by being more energy efficient, using more renewable energy sources, and increasing the use of cleaner transportation modes, technologies, and fuels.

Figure 1-2. Gross GHG emissions by sector, 1990–2025: historical and projected (consumption-based approach) business as usual / base case



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; RCI = direct fuel use in residential, commercial, and industrial sectors; ODS = ozone-depleting substance; Ind. = industrial.

Figure 1-3. Gross GHG emissions by sector, 2005: Iowa and U.S.



ICCAC Policy Options (Beyond Recent Actions)

The ICCAC recommended 56 policy options. The ICCAC Members present and voting approved 32 of these recommended policy options unanimously, approved 11 more with a super-majority vote (support of 80% or more of the members present and voting), and 13 additional options with a simple majority supporting it. One option failed to gain ICCAC approval. Explanations of objections are in included in Appendices F through J of this Report, which contain detailed accounts of the ICCAC's options.

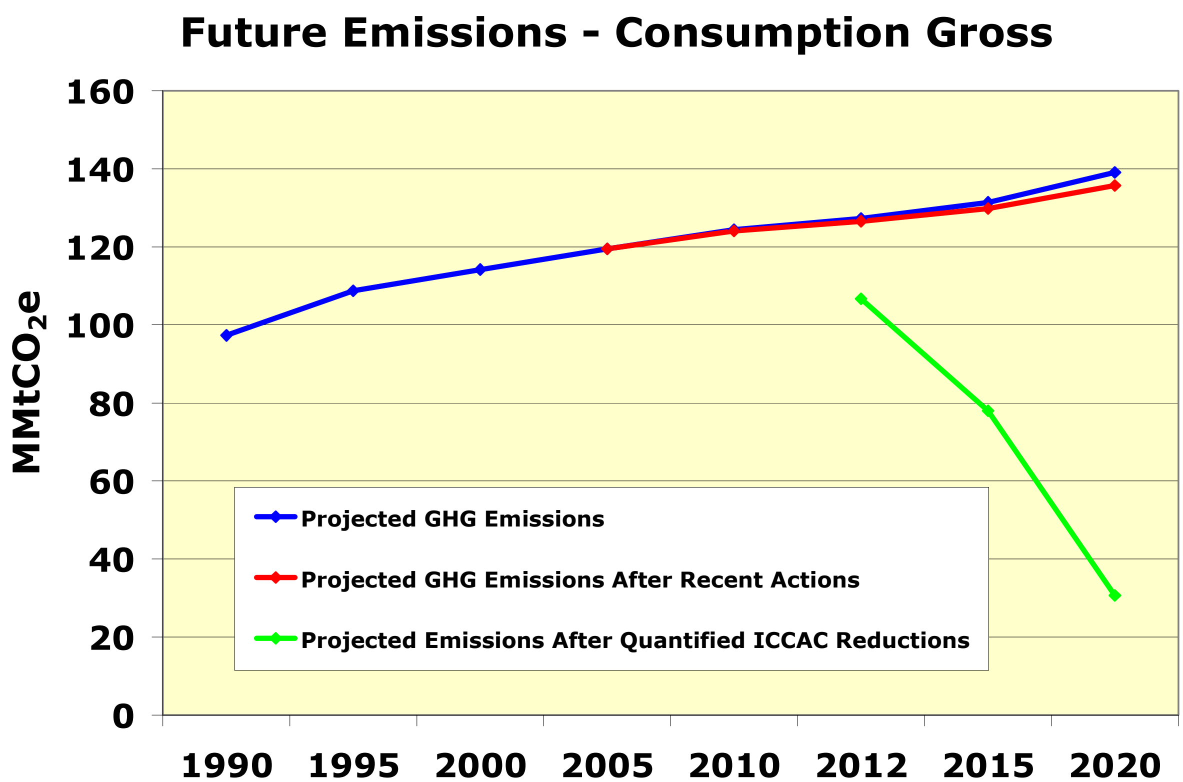
Of the 56 policy options, 38 were analyzed quantitatively to have a cumulative effect of reducing emissions by about 20 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) in 2012 and 105 ($MMtCO_2e$) in 2020.

Figure 1-4 presents a graphical summary of the potential cumulative emission reductions associated with the recent federal actions and the 38 policy options relative to the business-as-usual reference case projections. Table 1-2a provides the numeric estimates underlying Figure 1-4 for the 50% reduction by 2050 scenario and Table 1-2b provides the same estimate for the 90% reduction scenario by 2050. In Figure 1-4:

- The blue line shows actual (for 1990, 1995, 2000, and 2005) and projected (for 2010, 2012, 2015 and 2020) levels of Iowa' gross GHG emissions on a consumption basis. (The consumption-based approach accounts for emissions associated with the generation of electricity in Iowa to meet the state's demand for electricity)
- The red line shows projected emissions associated with recent federal and state actions that were analyzed quantitatively.
- The green line shows projected emissions if all of the ICCAC's 38 options that were analyzed quantitatively with respect to their GHG reduction potential are implemented successfully and the estimated reductions are fully achieved. (Note that other ICCAC options would have the effect of reducing emissions, but those reductions were not analyzed quantitatively, so are not reflected in the green line.)

For the policy options offered by the ICCAC to yield the levels of estimated emission reductions shown in Table 1-3, they must be implemented in a timely, aggressive, and thorough manner. Table 1-4 depicts the final policy options of the Council and their associated GHG reductions and costs/ savings for each sector.

Figure 1-4. Annual GHG emissions: reference case projections and ICCAC options (consumption basis, gross emissions)



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; GHG = greenhouse gas; ICCAC = Iowa Climate Change Advisory Council.

Table 1-2a. Annual emissions: reference case projections and impact of ICCAC options (consumption basis, gross emissions) 50% GHG reduction Scenario by 2050

	Consumption Basis – Gross Emissions						
	1990	2000	2005	2010	2012	2015	2020
Projected GHG emissions	97.3	114.2	119.5	124.4	127.3	131.4	139.1
Reductions from recent actions			0.0	0.3	0.7	1.6	3.3
Projected GHG emissions after recent actions*			119.5	124.1	126.6	129.8	135.7
GHG reduction scenarios recommended by ICCAC					118.8	N/A	106.3
Total GHG reductions from ICCAC policies					19.9	51.8	105.1
Difference between ICCAC scenarios and reductions *					12.1	N/A	75.7
Projected emissions after quantified ICCAC reductions					106.7	78.0	30.6

GHG = greenhouse gas; ICCAC = Iowa Climate Change Advisory Council; N/A = not applicable.

Reductions from recent actions include the Energy Independence and Security Act of 2007, Title III. GHG reductions from Titles IV and V of this Act have not been quantified because of the uncertainties in how they will be implemented. It is expected that Titles IV and V measures will overlap with EEC policies. Projected annual emissions also include reductions from recent actions. Existing utility energy efficiency programs are not included in the existing action analysis because they are impounded in the utility load growth forecasts used in the Iowa Inventory and Forecast. * Difference = Row 4- row 7)

Table 1-2b. Annual emissions: reference case projections and impact of ICCAC Options (consumption basis, gross emissions) 90% GHG reduction Scenario by 2050

	Consumption Basis – Gross Emissions						
	1990	2000	2005	2010	2012	2015	2020
Projected GHG emissions	97.3	114.2	119.5	124.4	127.3	131.4	139.1
Reductions from recent actions			0.0	0.3	0.7	1.6	3.3
Projected GHG emissions after recent actions*			119.5	124.1	126.6	129.8	135.7
GHG reduction scenarios recommended by ICCAC					115.3	N/A	93.5
Total GHG reductions from ICCAC policies					19.9	51.8	105.1
Difference between ICCAC scenarios and reductions *					8.6	N/A	62.9
Projected emissions after quantified ICCAC reductions					106.7	78.0	30.6

GHG = greenhouse gas; ICCAC = Iowa Climate Change Advisory Council; N/A = not applicable.

Reductions from recent actions include the Energy Independence and Security Act of 2007, Title III. GHG reductions from Titles IV and V of this Act have not been quantified because of the uncertainties in how they will be implemented. It is expected that Titles IV and V measures will overlap with EEC policies. Projected annual emissions also include reductions from recent actions. Existing utility energy efficiency programs are not included in the existing action analysis because they are impounded in the utility load growth forecasts used in the Iowa Inventory and Forecast. * Difference = Row 4- row 7)

Table 1-3. Summary by sector of estimated impacts of implementing all of the ICCAC options (cumulative reductions and costs/savings)

Sector	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2020 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)
	2012	2020	Total 2009–2020		
Energy Efficiency and Conservation	1.1	8.5	42.8	–$1,057	–$25
Clean and Renewable Energy	5.8	48.0	233.5	$5,921	$25
Transportation and Land Use	1.6	11.1	55.0*	–$2,219	–$59
Agriculture, Forestry, and Waste Management	11.3	37.4	233.0	$2,139	$9.2
Cross-Cutting Issues	Non-quantified, enabling options				
TOTAL (includes all adjustments for overlaps)	**19.9**	**105.1**	**564.3***	**$4,785**	**$8.8**

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

The values in this table do not include the effects of recent actions. Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings associated with the policy options.

* Deduct total TLU-6 2009-2020 reductions [17.7MMt] from 55.03 total = 37.3, before calculating cost/ton for TLU Options. Total Reductions for calculation of cost-effectiveness: 564.3- 17.7 = 546.6. [$4.785 / 546.6 = $8.8/t

Within each sector, values have been adjusted to eliminate double counting for policies or elements of policies that overlap. In addition, values associated with policies or elements of policies within a sector that overlap with policies or elements of policies in another sector have been adjusted to eliminate double counting. Appendix F (for the EEC sectors), Appendix G (for the CRE sectors), Appendix H (for the TLU sectors), and Appendix I (for the AFW sectors) of this report provide documentation of how sector-level emission reductions and costs (or cost savings) were adjusted to eliminate double counting associated with overlaps between policies.

Table 1-4. Energy Efficiency and Conservation Policy Options

Policy No.	Policy Option	CO_2 Reduction 2012	CO_2 Reduction 2020	Total 2009–2020	Net Present Value 2009–2020 (Million $)	Cost/ Ton ($/t$CO_2$e)	Level of Support
EEC-1	Consumer Education Programs	*Not quantified*					Unanimous
EEC-2	Demand-Side Management (DSM) / Energy Efficiency Programs for Natural Gas	0.08	1.24	5.43	–$191.77	–$35.29	Super-majority (4 Obj.)
EEC-3	Financial Mechanisms for Energy Efficiency	1.62	6.11	36.81	–$805.05	–$21.87	Super-majority (1 Obj.)
EEC-4	Improved Building Codes for Energy Efficiency	0.05	0.40	1.89	–$46.27	–$24.44	Super-majority (5 Obj.)
EEC-5	Incentive Mechanisms for Achieving Energy Efficiency	0.35	3.29	16.33	–$350.79	–$21.48	Unanimous
EEC-6	Promotion and Incentives for Improved Design and Construction in the Private Sector	0.00	0.12	0.46	–$11.36	–$24.57	Super-majority (1 Obj.)
EEC-7	Training and Education for Builders and Contractors	*Not quantified*					Unanimous
EEC-8	Focus on Specific Residential Market Segments	0.09	0.98	4.83	–$122.53	–$25.37	Unanimous
EEC-9	Midwestern Governors Association Energy Security and Climate Stewardship Platform	0.13	4.13	17.14	–$375.69	–$21.92	Majority (9 Obj.)
EEC-10	Energy Management Training/Training of Building Operators	0.10	1.29	5.48	–$129.49	–$23.63	Super-majority (1 Obj.)
EEC-11	Rate Structures and Technologies To Promote Reductions	0.04	0.21	1.20	–$25.73	–$21.45	Unanimous
EEC-12	Demand-Side Management (DSM) / Energy Efficiency Programs for Electricity	0.39	4.38	20.33	–$444.81	–$21.88	Super-majority (4 Obj.)
EEC-13	Government Lead by Example: Improved Design, Construction, and Energy Operations in New and Existing State and Local Government Buildings	0.08	0.36	1.97	1.04	0.53	Majority (6 Obj.)
EEC-14	More Stringent Appliance Efficiency Standards	0.94	2.20	17.33	–$708.15	–$40.85	Super-majority (2 Obj.)
	Sector Total After Adjusting for Overlaps	**1.1**	**8.6**	**43.2**	**–$1,064.5**	**–$24.7**	
	Reductions From Recent Actions: EISA (2007) and Executive Orders #6 and 41	**0.44**	**1.42**	**9.19**			
	Sector Total Plus Recent Actions	**1.6**	**10.0**	**52.3**			

CO_2 = carbon dioxide; $/t$CO_2$e = dollars per metric ton of carbon dioxide equivalent; Obj. = objection(s); EISA = Energy Independence and Security Act of 2007.

Negative values in the Net Present Value and the Cost/Ton (cost-effectiveness) columns represent net cost savings.

The numbering used to denote the above policy options is for reference purposes only; it does not reflect prioritization among these important policy options.

Table 1-4 (continued). Clean and Renewable Energy Policy Options

Policy No.	Policy Option	CO_2 Reduction 2012	CO_2 Reduction 2020	Total 2009–2020	Net Present Value 2009–2020 (Million $)	Cost/ton ($/t$CO_2$e)	Change in Generation Cost in 2020 $/MWh*	Level of Support
CRE-1	Education	*Not quantified*						Unanimous
CRE-2	Technology Initiatives, Including Renewables	4.7	33.4	192.6	$5,653	$29.4	$25.7	Super-majority (3 Obj.)
CRE-3	MGA Cap-and-Trade, Including Offsets To Promote Renewables	*Not quantified*						Majority (5 Obj.)
CRE-4	Decarbonization Fund	2.2	11.4	74.1	$316	$4.3	$3.1	Super-majority (2 Obj.)
CRE-5	Performance Standards (50% Reduction by 2050)	4.9	11.4	95.4	$2,650.6	$27.8	$7.3	Super-majority (3 Obj., 1 Abst.)
CRE-6	Voluntary GHG Commitments	*Not quantified*						Unanimous
CRE-7	Policies Related to Nuclear Power	0.0	9.7	9.7	$268	$27.6	$4.5	Majority (5 Obj.)
CRE-8	Support for Grid-Based Renewable Energy & Development (MGA Target of 20% of retail sales by 2020)	0.0	2.3	4.3	$93.4	$21.8	$1.5	Unanimous
CRE-9	Transmission System Upgrading	*Not quantified*						Unanimous
CRE-10	R&D for Emerging Technologies and Corresponding Incentives	*Not quantified*						Unanimous
CRE-11	Distributed Generation / Co-Generation	0.0	0.1	0.5	$14	$29.1	$0.1	Super-majority (1 Obj.)
CRE-12	Combined Heat and Power	0.3	2.1	13.6	–$564.3	–$41.4	$0.0	Unanimous
CRE-13	Pricing Strategies To Promote Renewable Energy and/or CHP	1.2	5.6	35	$1,128	$32.1	$4.7	Super-majority (3 Obj.)
	Sector Total After Adjusting for Overlaps	**6**	**48**	**233**	**$5,921**	**$25**		
	Reductions From Recent Actions	**0**	**0**	**0**	**$0**	**$0**		
	Sector Total Plus Recent Actions	**6**	**48**	**233**	**$5,921**	**$25**		

CO_2 = carbon dioxide; $/t$CO_2$e = dollars per metric ton of carbon dioxide equivalent; $/MWh = dollars per megawatt-hour; Obj. = objection(s); MGA = Midwestern Governors Association; Abst. = abstention; GHG = greenhouse gas; R&D = research and development; CHP = combined heat and power.

Negative values in the Net Present Value and the Cost/Ton (cost-effectiveness) columns represent net cost savings.

The numbering used to denote the above policy options is for reference purposes only; it does not reflect prioritization among these important policy options.

Table 1-4 (continued). Transportation and Land Use Policy Options

Policy No.	Policy Option	GHG Reductions ($MMtCO_2e$) 2012	2020	Total 2009–2020	Net Present Value 2009–2020 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)	Level of Support
TLU-1	Smart Growth Bundle with Transit	0.076	0.242	1.53	–$377	–$245	Unanimous
TLU-1a	Expand and Improve Transit Infrastructure	0.004	0.026	0.127	$7.2	$57	Majority (5 objections)
TLU-2	GHG Impacts for State and Local Capital Funding	*Quantified as part of TLU-1 and TLU-1a*					Unanimous
TLU-4	Support Passenger Rail Service in Iowa	N/A	0.008	0.026	$15	$597	Majority (7 objections)
TLU-5a	Adopt Best Workplaces for Commuters in Iowa	0.02	0.02	0.21	$18	$84	Majority (6 objections
TLU-5b	Distributed Workplace Models	*Non-quantified, qualitative Option*					Unanimous
TLU-6	Light-Duty Vehicles Fuel Efficiency Incentives	0.44	3.65	17.70	N/Q	N/Q	Super-majority (objections)
TLU-7	Fuel Efficient Operations for Light-Duty Vehicles	0.11	0.65	3.41	–$306.9	–$90	Unanimous
TLU-8	New Vehicle Standards (Tailpipe GHG and Fuel Economy)	N/A	0.8	4.1	–$246	–$60	Unanimous
TLU-9	Freight Strategies (Truck and Rail)	0.39	0.63	5.9	$30	$5	Super-majority (1 obj.)
TLU-10	Fuel Strategies (20% Low Carbon Fuel Standard)	0.60	5.11	22.03	–$1,359	–$62	Unanimous
	Sector Total After Adjusting for Overlaps and Synergies	**1.64**	**11.14**	**55.03***	**–$2,218.50**	**-$59***	
	Reductions From Recent Actions (Federal CAFE Requirements)	**0.26**	**1.93**	**9.39**	***Not Quantified***		
	Sector Total Plus Recent Actions	**1.9 (8.3)**	**13.07 (48)**	**64.42**	**N/A**	**N/A**	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; N/A = not applicable; N/Q = not quantified; LRR = low rolling resistance; BAU = business as usual.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy options is for reference purposes only; it does not reflect prioritization among these important policy options.

* Deduct total TLU-6 2009-2020 reductions [17.7MMt] from 55.03 total = 37.3, before calculating cost/ton for TLU Options.

Chapter 2
Inventory and Projections of GHG Emissions

Introduction

This chapter summarizes Iowa's greenhouse gas (GHG) emissions and sinks (carbon storage) from 1990 to 2025. The Center for Climate Strategies (CCS) prepared a draft of Iowa's GHG emissions inventory and reference case projections for the Iowa Department of Natural Resources (Iowa DNR) as part of the Iowa Climate Change Advisory Council (ICCAC) process. The draft inventory and reference case projections, completed in April 2008, provided the ICCAC with an initial, comprehensive understanding of current and possible future GHG emissions. The draft report was provided to the ICCAC and its Subcommittees (SCs) to assist them in understanding past, current, and possible future GHG emissions in Iowa, and thereby inform the policy option development process. The ICCAC and SCs have reviewed, discussed, and evaluated the draft inventory and methodologies, as well as alternative data and approaches for improving the draft GHG inventory and forecast. The inventory and forecast have since been revised to address the comments provided by the ICCAC.

The information in this chapter reflects the information presented in the final *Iowa Greenhouse Gas Inventory and Reference Case Projections* report (hereafter referred to as the Inventory and Projections report).[1] The final report, incorporating comments provided by the Subcommittees that were approved by the ICCAC at their September 2008 meeting and incorporated into the final report during October, is available at: http://www.iaclimatechange.us/Inventory_Forecast_Report.cfm . At the 7th ICCAC meeting in November 2008 the Council received the final I-F Report and agreed to file and forward it to the Governor and Legislature.

Historical GHG emission estimates (1990 through 2005)[2] were developed using a set of generally accepted principles and guidelines for state GHG emission inventories, relying to the extent possible on Iowa-specific data and inputs. The reference case projections (2006–2025) are based on a compilation of various existing projections of electricity generation, fuel use, and other GHG-emitting activities, along with a set of simple, transparent assumptions described in the final Inventory and Projections report.

The Inventory and Projections report covers the six types of gases included in the U.S. GHG inventory: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Emissions of these GHGs are presented using a common metric, CO_2 equivalence (CO_2e), which indicates the relative

[1] Center for Climate Strategies. *Final Iowa Greenhouse Gas Inventory and Reference Case Projections: 1990–2025*. Prepared for the Iowa Climate Change Advisory Council. October 2008.

[2] The last year of available historical data for each sector varies between 2000 and 2005.

contribution of each gas, per unit mass, to global average radiative forcing on a global warming potential-weighted basis.[3]

It is important to note that the emission estimates reflect the GHG emissions associated with the electricity sources used to meet Iowa's demands, corresponding to a consumption-based approach to emissions accounting. Another way to look at electricity emissions is to consider the GHG emissions produced by electricity generation facilities in the state—a production-based method. The study covers both methods of accounting for emissions, but for consistency, all total results are reported as consumption-based.

Iowa GHG Emissions: Sources and Trends

Table 2-1 provides a summary of GHG emissions estimated for Iowa by sector for 1990, 2000, 2005, 2010, 2020, and 2025. As shown in this table, Iowa is estimated to be a net source of GHG emissions (positive, or gross, emissions). Iowa's forests serve as sinks of GHG emissions (removal of emissions, or negative emissions). Iowa's net emissions are derived by subtracting the CO_2 equivalent emissions in sinks from the gross GHG emission totals. The following sections discuss GHG emission sources and sinks, trends, projections, and uncertainties.

Historical Emissions

Overview

In 2005, on a gross emissions consumption basis (i.e., excluding carbon sinks), activities in Iowa accounted for approximately 120 million metric tons (MMt) of CO_2e emissions, an amount equal to 1.7% of total U.S. gross GHG emissions. On a net emissions basis (i.e., including carbon sinks), activities in Iowa accounted for approximately 92 MMtCO_2e of emissions in 2005, an amount equal to 1.4% of total U.S. net GHG emissions.[4] Iowa's GHG emissions are rising faster than those of the nation as a whole. From 1990 to 2005, Iowa's gross GHG emissions increased by 23%, while national gross emissions rose by 16%.[5] Table 2-1, below, presents Iowa's historical and reference case GHG emissions by sector for

[3] Changes in the atmospheric concentrations of GHGs can alter the balance of energy transfers between the atmosphere, space, land, and the oceans. A gauge of these changes is called radiative forcing, which is a simple measure of changes in the energy available to the Earth–atmosphere system. Holding everything else constant, increases in GHG concentrations in the atmosphere will produce positive radiative forcing (i.e., a net increase in the absorption of energy by the Earth). See: Boucher, O., et al. "Radiative Forcing of Climate Change." Chapter 6 in *Climate Change 2001: The Scientific Basis*. Contribution of Working Group 1 of the Intergovernmental Panel on Climate Change Cambridge University Press. Cambridge, United Kingdom. Available at: http://www.grida.no/climate/ipcc_tar/wg1/212.htm.

[4] The national emissions used for these comparisons are based on 2005 emissions from U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006*, April 15, 2008, EPA430-R-08-005. Available at: http://www.epa.gov/climatechange/emissions/usinventoryreport.html.

[5] During this period, population grew by 6% in Iowa and by 19% nationally. However, Iowa's economy grew at a faster rate on a per capita basis (up 51% vs. 33% nationally).

Table 2-1. Iowa historical and reference case GHG emissions, by sector*

Million Metric Tons CO_2e	1990	2000	2005	2010	2020	2025
Energy (Consumption Based)	**67.0**	**82.1**	**84.6**	**90.5**	**103.3**	**111.0**
Electricity Use (Consumption)	**27.4**	**35.8**	**37.6**	**38.0**	**43.1**	**47.5**
Electricity Production (in-state)	26.7	36.7	36.3	41.8	41.8	41.8
Coal	*26.5*	*36.3*	*34.9*	*40.4*	*40.4*	*40.4*
Natural Gas	*0.17*	*0.24*	*1.15*	*1.15*	*1.15*	*1.15*
Oil	*0.05*	*0.10*	*0.15*	*0.15*	*0.15*	*0.15*
MSW/Landfill Gas	*0.01*	*0.02*	*0.06*	*0.06*	*0.06*	*0.06*
Imported (Exported) Electricity	0.68	-0.87	1.33	-3.74	1.38	5.78
Residential/Commercial/Industrial (RCI) Fuel Use	**21.3**	**25.3**	**24.1**	**27.0**	**29.7**	**30.2**
Coal	5.53	6.42	6.22	6.45	6.82	6.83
Natural Gas	10.9	11.6	11.0	13.9	15.8	16.3
Petroleum	4.70	7.25	6.78	6.51	6.93	6.86
Wood (CH_4 and N_2O)	0.13	0.08	0.08	0.17	0.19	0.20
Transportation	**16.9**	**19.1**	**20.7**	**22.8**	**27.2**	**29.4**
On-road Gasoline	11.4	12.8	13.0	13.9	16.2	17.2
On-road Diesel	3.96	4.66	5.69	6.76	8.80	9.94
Rail	0.31	0.26	0.56	0.56	0.56	0.56
Marine Vessels, Natural Gas, LPG, Other	0.81	1.07	1.04	1.07	1.22	1.29
Jet Fuel and Aviation Gasoline	0.39	0.34	0.45	0.48	0.45	0.42
Fossil Fuel Industry	**1.49**	**1.81**	**2.25**	**2.61**	**3.32**	**3.78**
Natural Gas Industry	1.48	1.81	2.25	2.61	3.32	3.78
Coal Mining	0.01	0.00	0.00	0.00	0.00	0.00
Industrial Processes	**2.74**	**3.82**	**4.59**	**5.35**	**7.04**	**8.14**
Cement Manufacture (CO_2)	1.18	1.28	1.28	1.35	1.48	1.56
Lime Manufacture (CO_2)	0.06	0.06	0.09	0.11	0.14	0.17
Limestone and Dolomite Use (CO_2)	0.20	0.21	0.18	0.17	0.15	0.15
Soda Ash (CO_2)	0.03	0.03	0.03	0.02	0.02	0.02
Iron & Steel (CO_2)	0.03	0.10	0.12	0.16	0.27	0.36
Ammonia and Urea (CO_2)	0.64	0.56	0.49	0.47	0.44	0.43
Nitric Acid Production (N_2O)	0.30	0.57	1.01	1.05	1.14	1.19
ODS Substitutes (HFC, PFC)	0.00	0.83	1.23	1.87	3.25	4.15
Electric Power T&D (SF_6)	0.29	0.17	0.15	0.14	0.13	0.13
Waste Management	**2.18**	**2.27**	**2.40**	**2.57**	**2.95**	**3.16**
Waste Combustion	0.07	0.07	0.06	0.06	0.05	0.05
Landfills	1.65	1.68	1.82	1.97	2.30	2.48
Wastewater Management	0.46	0.53	0.52	0.54	0.60	0.62
Agriculture	**25.4**	**26.0**	**27.9**	**26.0**	**25.8**	**25.6**
Enteric Fermentation	5.04	4.39	4.26	3.81	3.27	2.98
Manure Management	4.49	6.02	6.64	6.55	6.86	7.01
Agricultural Soils	15.7	15.5	16.8	15.5	15.4	15.3
Agricultural Burning	0.13	0.16	0.19	0.2	0.24	0.26
Gross Emissions (Consumption Basis)	**97.3**	**114.2**	**119.5**	**124.4**	**139.1**	**147.9**

Million Metric Tons CO_2e	1990	2000	2005	2010	2020	2025
Increase relative to 1990		*17%*	*23%*	*28%*	*43%*	*52%*
Emissions Sinks	**-21.8**	**-19.9**	**-27.3**	**-27.3**	**-27.3**	**-27.3**
Forestry and Land Use	**-10.5**	**-8.53**	**-15.9**	**-15.9**	**-15.9**	**-15.9**
Forested Landscape	-7.88	-7.88	-15.3	-15.3	-15.3	-15.3
Urban Forestry and Land Use	-2.59	-0.65	-0.63	-0.63	-0.63	-0.63
Agricultural Soils (Cultivation Practices)	**-11.4**	**-11.4**	**-11.4**	**-11.4**	**-11.4**	**-11.4**
Net Emissions (Consumption Basis) (including forestry and land use sinks)	**75.4**	**94.3**	**92.2**	**97.1**	**111.8**	**120.6**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; CH_4 = methane; N_2O = nitrous oxide; MSW = municipal solid waste; LPG = liquefied petroleum gas; ODS = ozone-depleting substance; HFC = hydrofluorocarbon; PFC = perfluorocarbon; SF_6 = sulfur hexafluoride; T&D = transmission and distribution.

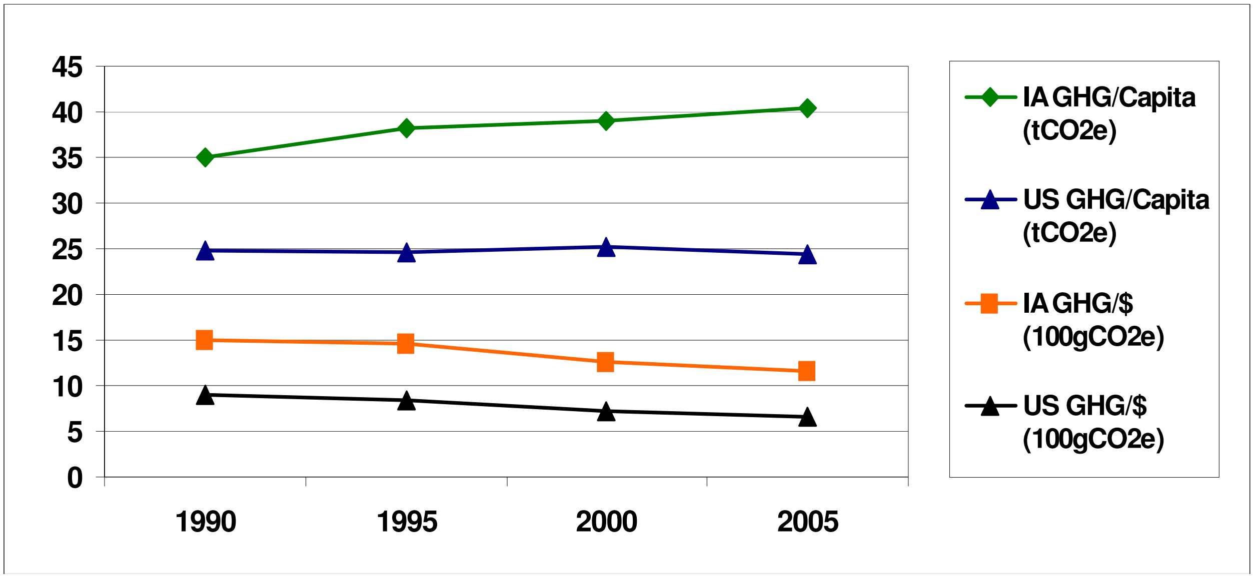
* Totals may not equal exact sum of subtotals shown in this table due to independent rounding.

In Iowa, gross CO_2e emissions on a per capita basis were about 40 metric tons (t) of gross CO_2e in 2005, higher than the national per capita emissions of about 24 tCO_2e in 2005. Figure 2-1 illustrates the state's emissions per capita and per unit of economic output. It also shows that while per-capita emissions have increased from 1990 to 2005 in Iowa, per capita emissions for the nation as a whole remained fairly flat from 1990 to 2005. The higher per capita emission rates in Iowa are due in part to emissions in the agricultural industry (agricultural industry emissions are much higher than the national average) and a lower population density (due to a larger rural area) in Iowa relative to the US as a whole.[6] In both Iowa and the nation as a whole, economic growth exceeded emissions growth throughout the 1990–2005 period. From 1990 to 2005, emissions per unit of gross product dropped by 26% nationally, and by 24% in Iowa.[7]

[6] Based on information from the US Census Bureau (http://quickfacts.census.gov/qfd/states/19000.html), Iowa has 55,869 square miles, which is 1.6% of the nation's 3,537,438 square miles. In 2005, Iowa had a population density of 53.3 persons per square mile, as compared with 84.7 persons per square mile for the US.

[7] Based on real gross domestic product (millions of chained 2000 dollars) that excludes the effects of inflation. U.S. Department of Commerce, Bureau of Economic Analysis. "Gross Domestic Product by State." Available at: http://www.bea.gov/regional/gsp/.

Figure 2-1. Iowa and U.S. gross GHG emissions, per-capita and per-unit gross product

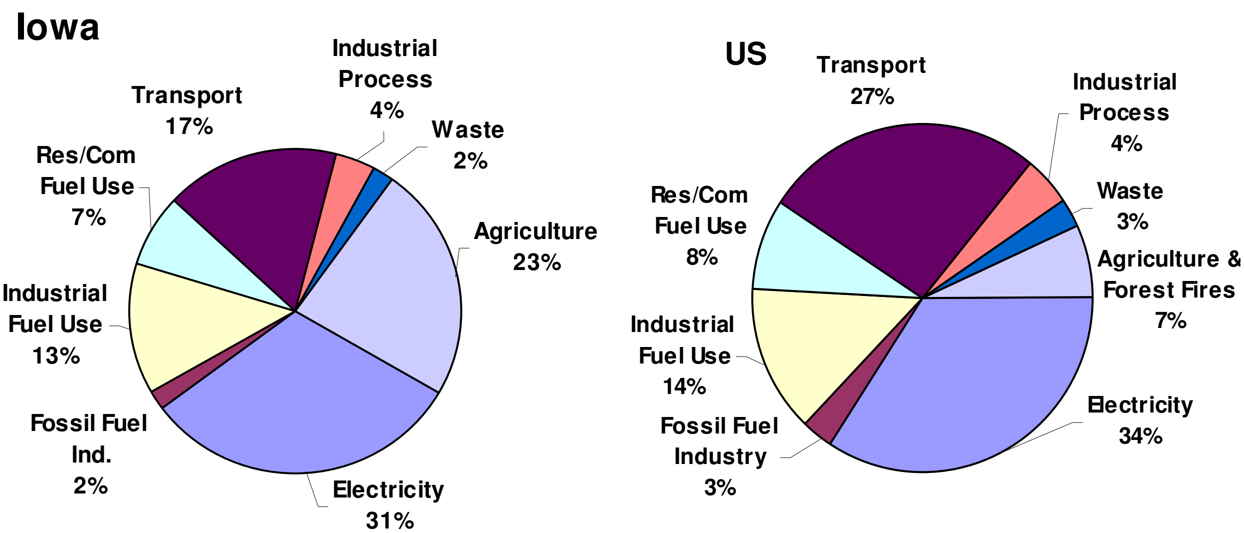


GHG = greenhouse gas; tCO_2e = metric tons of carbon dioxide equivalent.; g = grams.

Figure 2-2 compares gross GHG emissions estimated for Iowa to emissions for the U.S. for 2005. The principal sources of Iowa's GHG emissions in 2005 are electricity consumption (31% of Iowa's gross GHG emissions); agriculture (23% of Iowa's gross GHG emissions); residential, commercial, and industrial (RCI) fuel use (20% of Iowa's gross GHG emissions); and transportation (17% of Iowa's gross GHG emissions). Figure 2-2 also shows that the industrial processes sector in Iowa accounted for 4% of gross GHG emissions in 2005. These emissions are rising due to the increasing use of HFCs and PFCs as substitutes for ozone-depleting chlorofluorocarbons.[8] Other industrial process emissions include CO_2 released by cement and lime manufacturing; CO_2 released during soda ash, limestone, and dolomite use; CO_2 released during ammonia, urea, and iron and steel production; N_2O released during nitric acid production; and SF_6 released from transformers used in electricity transmission and distribution systems. Also, landfills and wastewater management facilities produce CH_4 and N_2O emissions that accounted for 2% of total gross GHG emissions in Iowa in 2005. Similarly, emissions associated with the production, processing, transmission, and distribution of fossil fuels accounted for 2% of the gross GHG emissions in 2005.

[8] Chlorofluorocarbons are also potent GHGs; however, they are not included in GHG estimates because of concerns related to implementation of the Montreal Protocol on Substances That Affect the Ozone Layer. See Appendix I in the Final Inventory and Projections report for Iowa (http://www.iaclimatechange.us/Inventory_Forecast_Report.cfm).

Figure 2-2. Gross GHG emissions by sector, 2005: Iowa and U.S.



Notes: Res/Com = Residential and commercial fuel use sectors. Emissions for the residential, commercial, and industrial fuel use sectors are associated with the direct use of fuels (natural gas, petroleum, coal, and wood) to provide space heating, water heating, process heating, cooking, and other energy end-uses. The commercial sector accounts for emissions associated with the direct use of fuels by, for example, hospitals, schools, government buildings (local, county, and state) and other commercial establishments. The industrial processes sector accounts for emissions associated with manufacturing and excludes emissions included in the industrial fuel use sector. The transportation sector accounts for emissions associated with fuel consumption by all on-road and non-highway vehicles. Non-highway vehicles include jet aircraft, gasoline-fueled piston aircraft, railway locomotives, boats, and ships. Emissions from non-highway agricultural and construction equipment are included in the industrial sector. Emissions associated with forest wildfires and rangeland burning were not calculated for Iowa due to a lack of data on acreage burned.

Electricity = Electricity generation sector emissions on a consumption basis, including emissions associated with electricity imported from outside of Iowa and excluding emissions associated with electricity exported from Iowa to other states.

Forestry emissions refer to the net CO_2 flux[9] from forested lands in Iowa, which account for about 8% of the state's land area.[10] Iowa's forests are estimated to be net sinks of CO_2 emissions in the state, reducing net GHG emissions by 16 $MMtCO_2e$ in 2005. In addition, estimates of net carbon fluxes from agricultural soil cultivation practices are estimated to be net sinks of CO_2 emissions in Iowa, reducing net GHG emissions by 11 $MMtCO_2e$ in 2005. However, the

[9] "Flux" refers to both emissions of CO_2 to the atmosphere and removal (sinks) of CO_2 from the atmosphere.

[10] Total forested acreage in Iowa is 2.8 million acres. Total forested area and forest type percentages provided by P. Tauke, DNR to M. Stein, DNR on March 21, 2008. The total land area in Iowa is 35.8 million acres (http://www.50states.com/iowa.htm).

Inventory and Projections report does not consider above-ground carbon sequestration in agriculture because it is not considered to be sequestered.[11]

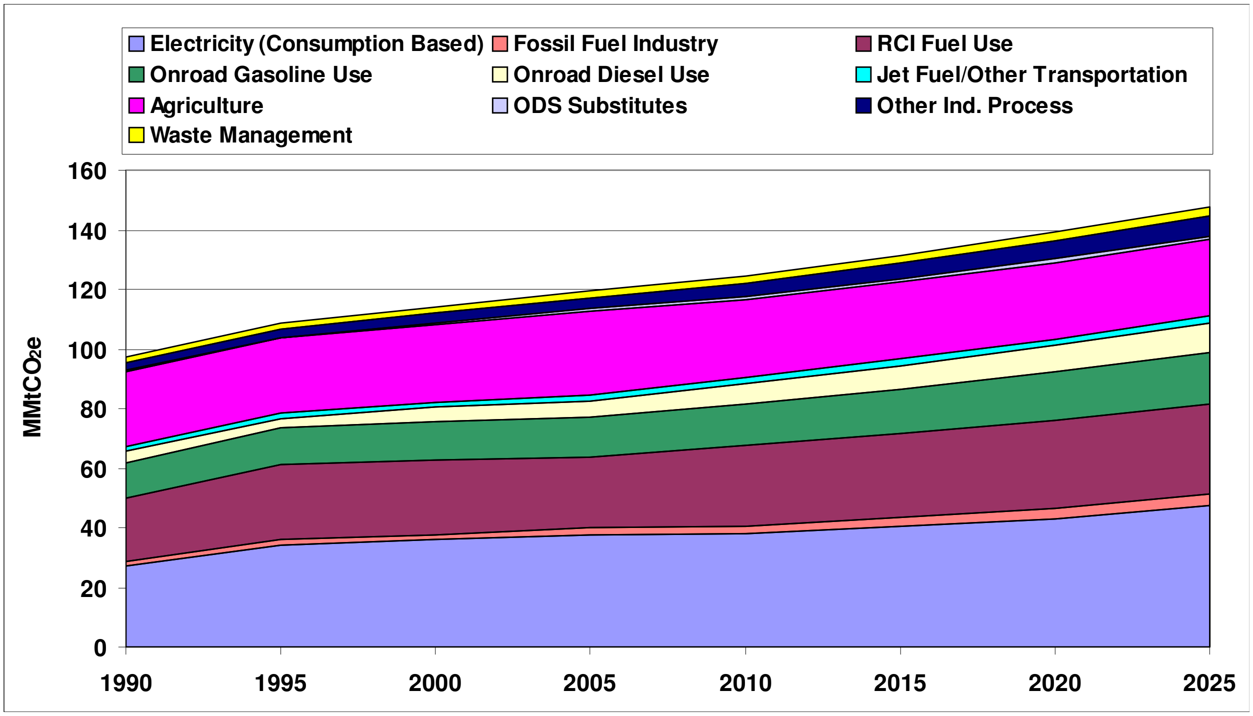
Reference Case Projections

Relying on a variety of sources for projections, as noted in the Inventory and Projections report, a simple reference case projection of GHG emissions through 2025 was developed. As illustrated in Figure 2-3 and shown numerically in Table 2-1, under the reference case projections, Iowa's gross GHG emissions continue to grow steadily, climbing to about 148 $MMtCO_2e$ by 2025, 52% above 1990 levels. This equates to a 1.1% annual rate of growth from 2005 to 2025. Relative to 2005, the share of emissions associated with electricity consumption and the transportation sector both increase slightly to 32% and 20%, respectively, in 2025. The share of emissions from the industrial processes and fossil fuel industry sectors is projected to increase to 6% and 3%, respectively, by 2025. The share of emissions from the RCI fuel use sector and the waste management sector is projected to remain the same at about 20% and 2%, respectively, of Iowa's gross GHG emissions in 2025. The agriculture sector is the only sector in Iowa whose emission share in 2025 is projected to decrease from its emission share in 2005 (from 23% in 2005 to 17% in 2025).

Emissions associated with electricity consumption are projected to be the largest contributor to future GHG emissions growth, followed by emissions associated with the transportation sector, as shown in Figure 2-4. Other sources of emissions growth include the RCI fuel use sector and the increasing use of HFCs and PFCs as substitutes for ozone-depleting substances in refrigeration, air conditioning, and other applications. The agriculture sector is the only sector in which emissions are projected to decrease from 2005 to 2025. Table 2-2 summarizes the growth rates that drive the growth in the Iowa reference case projections, as well as the sources of these data.

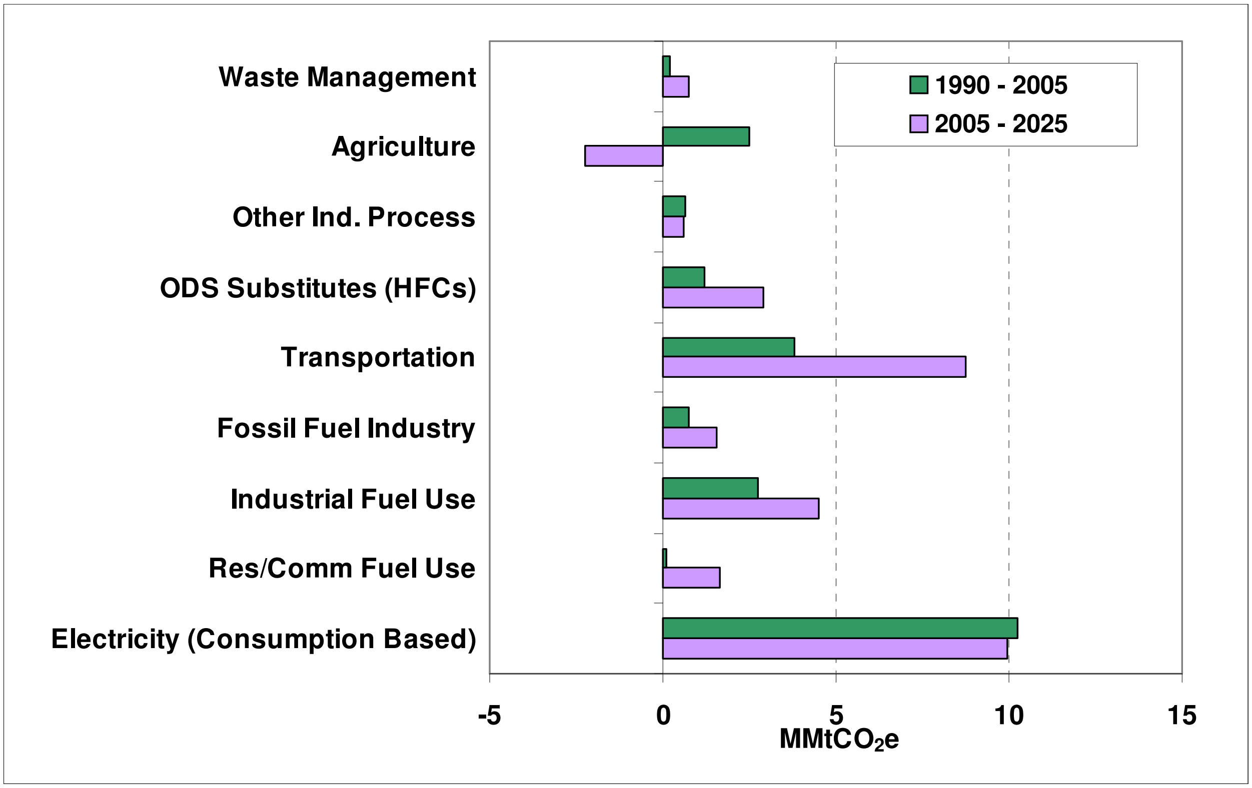
[11] Above-ground carbon re-enters the natural carbon cycle and is lost to the atmosphere through respiration or decomposition either directly or indirectly (e.g., used as energy as animal feed or by humans) over relatively short periods of time (months to years). Carbon sequestration in agriculture is below ground in the form of soil carbon (i.e., the result of the photosynthesis process), where carbon can be stored over long periods of time (potentially indefinitely). The U.S. Environmental Protection Agency (EPA) Web sites http://www.epa.gov/sequestration/ccyle.html and http://www.epa.gov/sequestration/local_scale.html have some useful information. For additional information on the potential for sequestration in agriculture, see EPA's *Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture* (http://www.epa.gov/sequestration/pdf/greenhousegas2005.pdf).

Figure 2-3. Iowa gross GHG emissions by sector, 1990–2025: historical and projected



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; RCI = direct fuel use in residential, commercial, and industrial sectors; ODS = ozone-depleting substance; Ind. = industrial.

Figure 2-4. Sector contributions to gross emissions growth in Iowa, 1990–2025: reference case projections



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; ODS = ozone-depleting substance; HFCs = hydrofluoro-carbons; Res/Comm = direct fuel use in the residential and commercial sectors (see Fig. 2-2 note for full definition.)

Table 2-2. Key annual growth rates for Iowa, historical and projected

	1990–2005	2005–2025	Sources
Population	0.42%	0.06%	Decennial Population and Population Estimates for Iowa: 1900 – 2007 - http://data.iowadatacenter.org/datatables/State/stpopest19002007.xls ”Iowa Census Data Tables: Projections,” State Data Center of Iowa, http://data.iowadatacenter.org/browse/projections.html
Electricity Sales -Total Sales[a] -IA Sales[b]	 2.50% 2.40%	 1.90% 1.50%	For 1990-2005, annual growth rate in total electricity sales for all sectors combined in Iowa calculated from EIA State Electricity Profiles (Table 8) http://www.eia.doe.gov/cneaf/electricity/st_profiles/iowa.html and sales by Iowa generators calculated by subtracting T&D losses from net generations collected from EIA Annual Electric Utility Data - 906/920 database. For 2005-2025, annual growth rates are based on data that Iowa utilities provided for Iowa load growth forecast for 2007 through 2025.
Vehicle Miles Traveled	2.10%	1.80%	Iowa historical VMT data (1994-2006) provided by, Iowa Department of Transportation. Future data were estimated based on historical trends.

[a] Represents annual growth in total sales of electricity by generators inside or outside of Iowa to RCI sectors located within Iowa.
[b] Represents annual growth in total sales of electricity by generators in Iowa to RCI sectors located within Iowa.

A Closer Look at the Four Major Sources: Electricity Consumption; Agriculture; Residential, Commercial, Industrial (RCI) Fuel Consumption; and Transportation

Electricity Consumption Sector

As shown in Figure 2-2, electricity use in 2005 accounted for 31% of Iowa's gross GHG emissions (about 38 $MMtCO_2e$), which was slightly lower the national share of emissions from electricity generation (34%). On a per-capita basis, Iowa's GHG emissions from electricity consumption are higher than the national average (in 2005, 12.7 tCO_2e per capita in Iowa, versus 8.1 tCO_2e per capita nationally). Electricity generated by plants located in Iowa comes primarily from coal (71% in 2005), while virtually all of the rest comes from nuclear (17% in 2005), wind and hydroelectric (6% in 2005), and natural gas (5% in 2005).

In 2005, emissions associated with Iowa's electricity consumption (38 $MMtCO_2e$) were about 1.3 $MMtCO_2e$ higher than those associated with electricity production (36.3 $MMtCO_2e$). The higher level for consumption-based emissions reflects GHG emissions associated with net imports of electricity from other states to meet Iowa's electricity demand.[12] In some historical and forecast years, Iowa is an electricity importing state. In other years, Iowa is an electricity exporting state—when its total gross generation by the in-state power plants exceeds the annual demand for electricity in the state. The reference case projection assumes that production-based emissions (associated with electricity generated in-state) will increase by about 5 $MMtCO_2e$ between 2005 and 2025, and consumption-based emissions (associated with electricity consumed in-state) will increase by about 10 $MMtCO_2e$.

While estimates are provided for emissions from both electricity production and consumption, unless otherwise indicated, tables, figures, and totals in this report reflect electricity consumption emissions. The consumption-based approach can better reflect the emissions (and emission reductions) associated with activities occurring in the state, particularly with respect to electricity use (and efficiency improvements), and is particularly useful for decision making. Under this approach, emissions associated with electricity exported to other states would need to be covered in those states' inventories in order to avoid double counting or exclusions. The reference case forecast for Iowa assumes significant wind generation resources are added and also excludes to base-load coal plants that are currently at various stages of the permitting and approval process. The CCS methodology allows new fossil-based generation to be included in the reference case only when the plants have received all necessary permits which has not occurred for the two coal plants proposed in Iowa.

Agricultural Sector

The agricultural sector accounts for 23% of the gross GHG emissions in Iowa in 2005. This is significantly higher than the national average for agricultural emissions in that year (7%). However, this is not at all surprising considering the importance of the agricultural sector to the economy in Iowa.

[12] Estimating the emissions associated with electricity use requires an understanding of the electricity sources (both in-state and out-of-state) used by utilities to meet consumer demand. The current estimate reflects some very simple assumptions, as described in Appendix A of the Inventory and Projections report.

These emissions primarily come from agricultural soils, manure management, and enteric fermentation. Agricultural soils can produce GHG emissions from nitrogen fertilizers and manure as well as from decomposition of crop residues. Manure management can result in CH_4 emissions as a result of manure breaking down. Enteric fermentation is the result of normal digestive processes of livestock; it creates CH_4 emissions. All of these processes can result in emissions of N_2O. Emissions from the agricultural sector are projected to decrease by 8% between 2005 and 2025. This decrease is expected to come primarily from the agricultural soils-livestock and enteric fermentation categories.

Residential, Commercial, and Industrial Fuel Use Sectors

In 2005, combustion of oil, natural gas, coal, and wood in the RCI sectors contributed about 20% (about 24 $MMtCO_2e$) of Iowa's gross GHG emissions, slightly lower than the RCI sector contribution for the nation (22%). Activities in the RCI[13] sectors produce GHG emissions when fuels are combusted to provide space heating, process heating, and energy for other applications.

The residential sector's share of total RCI emissions from direct fuel use was 20% (4.8 $MMtCO_2e$) in 2005, the commercial sector accounted for 15% (3.6 $MMtCO_2e$), and the industrial sector's share of total RCI emissions from direct fuel use was 65% (15.7 $MMtCO_2e$). Overall, emissions for the RCI sectors (excluding those associated with electricity consumption) are expected to increase by 25% between 2005 and 2025. Emissions from the commercial sector are projected to increase by 48% from 2005 to 2025. The industrial sector is predicted to have a 29% increase. In contrast, emissions from the residential sector are expected to decrease slightly (1%) between 2005 and 2025.

Transportation Sector

As shown in Figure 2-2, the transportation sector accounted for about 17% of Iowa's gross GHG emissions in 2005 (about 21 $MMtCO_2e$), which was significantly lower than the national average share of emissions from transportation fuel consumption (27%). The GHG emissions associated with Iowa's transportation sector increased by 3.8 $MMtCO_2e$ between 1990 and 2005.

From 1990 through 2005, Iowa's GHG emissions from transportation fuel use have risen steadily at an average rate of about 1.4% annually. In 2005, onroad gasoline vehicles accounted for about 63% of transportation GHG emissions. Onroad diesel vehicles accounted for another 28% of emissions. Air and marine travel, rail, and other sources (natural gas- and liquefied petroleum gas- (LPG-) fueled-vehicles used in transport applications) accounted for the remaining 9% of transportation emissions. GHG emissions from onroad gasoline use increased 14% between 1990 and 2005. Meanwhile, GHG emissions from onroad diesel use rose 44% during that period, suggesting rapid growth in freight movement within or across the State.

Emissions from on-road gasoline vehicles are projected to increase by 1.4% annually from 2005 to 2025, and emissions from on-road diesel vehicles are projected to increase by 2.8% annually from 2005 to 2025. Total transportation emissions are expected to reach 29 $MMtCO_2e$ by 2025, at a 1.6% annual rate of growth from 2005.

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[13] The industrial sector also includes emissions associated with agricultural energy use.

ICCAC Revisions

The ICCAC made the following revisions to the inventory and reference case projections, which explain the differences between the final Inventory and Projections report and the draft initial assessment completed during April 2008:[14]

Energy Supply:

- The inventory now includes MidAmerican Energy Company's 25% ownership of the 1,700 megawatt (MW) Quad Cities Station nuclear plant in Illinois. This equates to about 3,350 gigawatt-hours (GWh) at 90% capacity. In both the inventory and reference case projections, this generation has been treated as an in-state resource because of its ownership status.
- A revised load growth forecast for Iowa provided by the Iowa utilities has been used.
- The AEO 2007 growth forecast data for MAPP region generation in the draft I&F was updated with data from AEO 2008.
- In the initial analysis, Energy Information Administration (EIA) forecast data of the Mid-Continent Area Power Pool (MAPP) region was used to project the electricity generation growth by fuel type in Iowa. In this report, added/retired electricity generation capacities provided by the Iowa utilities was used to project the electricity generation by fuel type in Iowa for the forecast years.
- Added the 790 MW Walter Scott, Jr. supercritical coal plant that came online in 2007;
- Added the 1284.3 MW new wind capacities of MidAmerican between 2005-2009;
- Included the minority, Iowa share of the uprate for the Duane Arnold Energy Center that is scheduled to be completed in 2009, resulting in approximately a 10 MW capacity increase;
- Added the 200 MW Alliant Franklin County (Whispering Willow) wind farm (will be on the line by 2010);
- Added the 2010 Corn Belt 71 MW wind capacity; and
- Included 100 MW of new wind capacity each year from 2014 to 2020, in response to the Clean and Renewable Energy (CRE) SC's request to extrapolate the 2008-2013 wind installation (average of 100 MW per year) to the future.

In addition to the reference case, two sensitivity cases were analyzed for electricity supply. Sensitivity Analysis Case 1 added the following new capacities, in addition to those new capacities added in the reference case:

- The 649 MW Marshalltown coal plant;
- The 10% biomass co-firing requirement;
- The retirement of the Lansing units;
- Fuel switching in the Dubuque Generating Station Units from coal to natural gas; and
- Alliant 200 MW new wind capacity by 2013.

Sensitivity Analysis Case 2 added the following new capacity, in addition to those new capacities added in the reference case and those added in Sensitivity Analysis Case 1:

- The 750 MW Elk Run plant.

[14] In addition, a minor change was made to the transportation sector reference case projection emissions. This was done to correct the growth rate for marine gasoline fuel consumption to reflect the historical marine gas consumption trend, leading to a decrease of 0.03 $MMtCO_2e$ in the marine emissions.

Agriculture:

- The estimation of soil carbon flux due to cultivation practices has been revised using a year 2000 estimate of the soil carbon sequestration in Iowa. This comes from a publication by William Stigliani, which references a 2001 study of soil carbon in Iowa. This replaced the United States Department of Agriculture (USDA) 1997 soil carbon estimates used for the initial analysis.

Key Uncertainties

Some data gaps exist in this inventory, and particularly in the reference case projections. Key tasks for future refinement of this inventory and forecast include review and revision of key drivers, such as the electricity demand, agricultural activities, RCI fuel use, and transportation growth rates that will be major determinants of Iowa's future GHG emissions (see Table 2-2 and Figure 2-4). These growth rates are driven by uncertain economic, demographic and land use trends (including growth patterns and transportation system impacts), all of which deserve closer review and discussion.

Chapter 3
Energy Efficiency and Conservation

Overview of Greenhouse Gas Emissions

Activities in the residential, commercial, and industrial (RCI) sectors produce greenhouse gas (GHG) emissions when fuels are combusted to provide space heating, process heating, and other applications. In 2005, combustion of oil, natural gas, coal, and wood in the RCI sectors contributed about 26% (about 24 million metric tons of carbon dioxide equivalent [$MMtCO_2e$]) of Iowa's gross GHG emissions. In 2005, this sector was the second largest source of GHG emissions in the state, following the electricity supply sector (37 $MMTCO_2e$).[1] In addition, industrial process (nonfuel use) emissions are forecasted to nearly double by 2020, primarily due to the increasing use of hydrofluorocarbons as substitutes for ozone-depleting chlorofluorocarbons. Together, industrial process emissions, including cement production and chemical manufacturing, will account for an additional 5.6% of Iowa's gross GHG emissions (8.14 $MMtCO_2e$).

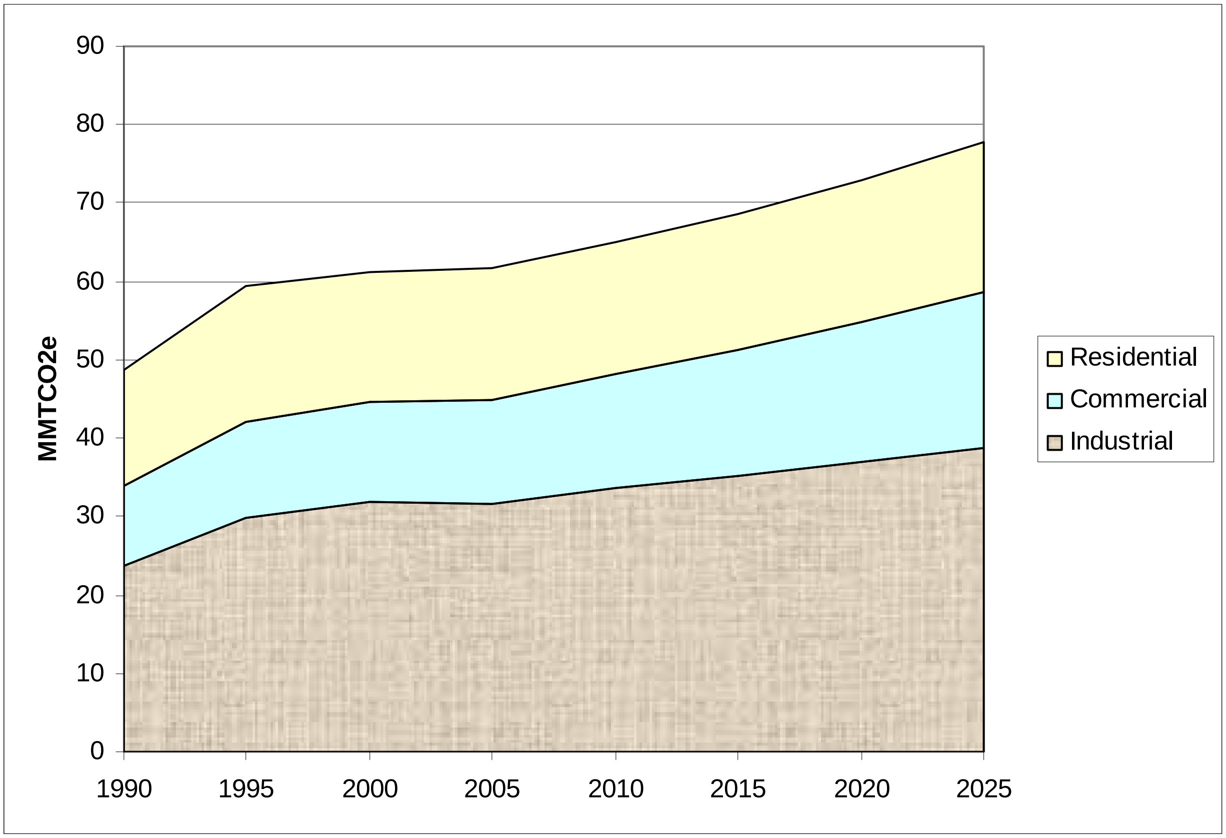
Considering only the direct emissions that occur within buildings and industries, however, ignores the fact that nearly all electricity sold in the state is consumed as the result of RCI activities. If the emissions from all three subsectors of RCI are included (i.e., direct fuel use, emissions associated electricity consumption, and industrial processes), they total about 70% of the state's gross GHG emissions in 2005. Therefore, the state's future GHG emissions will depend heavily on future trends in the consumption of electricity and other fuels in these sectors.

Figure 3-1 shows the growth in GHG emissions by sector through 2025, including electricity use. For the 15-year period from 2005 to 2020, GHG emissions are expected to grow the fastest in the electricity sector, which is forecasted to grow at a 1.0% annual rate. GHG emissions in the residential sector are expected to grow at 0.6%, the commercial sector at 2.2%, and the industrial sector at slightly more than 1% a year.

Much of the growth in GHG emissions over the period can be attributed an average 1.9% annual growth in electricity demand over the 2005–2020 period for the RCI sectors. However, electricity-related GHG emissions are projected to grow by only 1.0% per year, due to the addition of significant wind generation resources in the reference case.

[1] Emissions associated with the electricity supply sector (discussed in Chapter 4) have been allocated to each of the RCI sectors for comparison of those emissions to the emissions associated with direct fuel consumption. Note that this comparison is provided for information purposes, and that emissions estimated for the electricity supply sector are not double counted in the total emissions for the state.

Figure 3-1. Historical and projected residential, commercial, and industrial greenhouse gas emissions by sector in Iowa: 1990–2025*

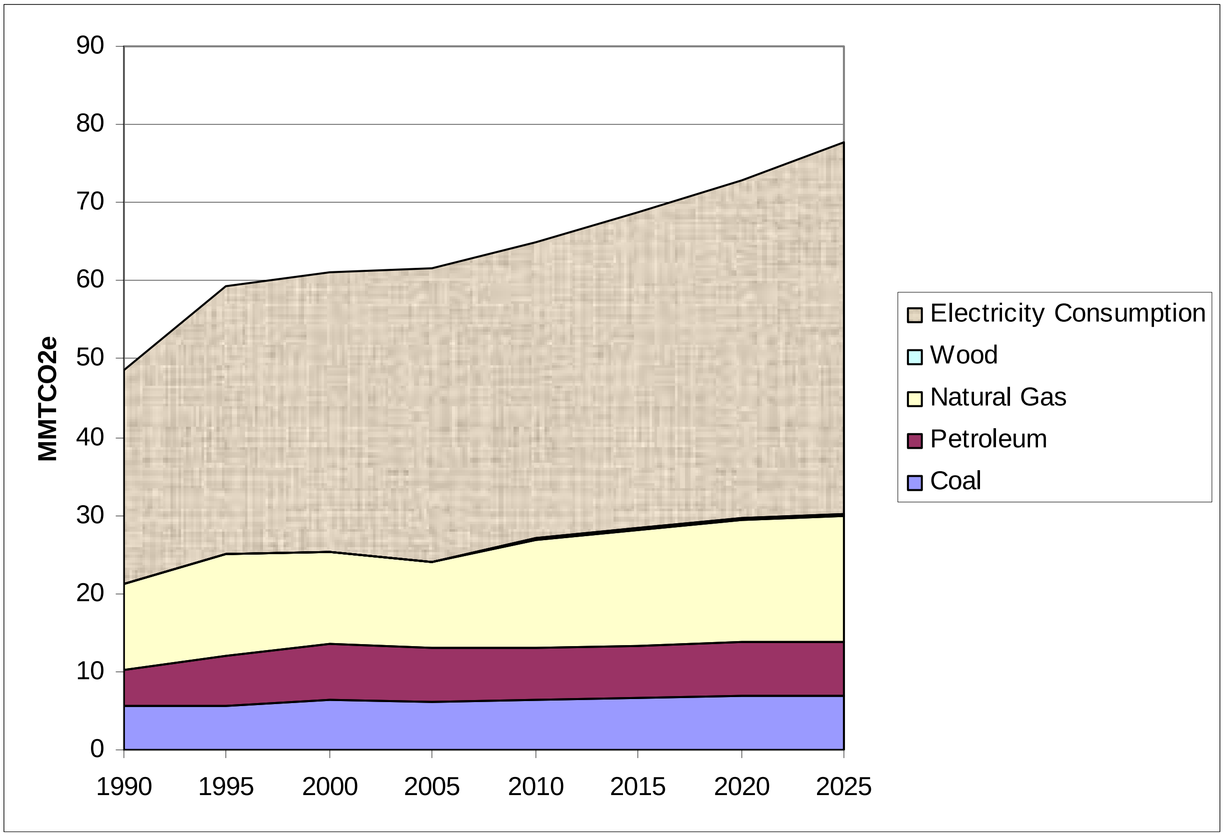


$MMtCO_2e$ = million metric tons of carbon dioxide equivalent

* Emissions associated with the direct use of natural gas, petroleum, coal, and wood and the consumption of electricity. Sources: Tables 3a, 4a, and 5a of Final Iowa Greenhouse Gas Inventory and Reference Case Projections 1990–2025. Available at: http://www.iaclimatechange.us/ewebeditpro/items/O90F20404.pdf.

Figure 3-2 shows the growth in GHG emissions by fuel type through 2025. For the 15-year period 2005–2020, emissions in the sector are dominated by electricity supply, which rise by 15% from 37 $MMtCO_2e$ in 2005 to 43 $MMtCO_2e$ in 2020. Direct emissions from coal are forecasted to increase slightly at a rate of 0.6% per year (not including coal use for electricity generation). Emissions from natural gas explode, rising 2.9% per year. The emissions data from natural gas mask large differences in the growth of the use of this fuel. Residential natural gas consumption is expected to stay nearly constant from 2005 to 2020, while commercial and industrial gas use is expected to increase by 3.3% and 4.6% per year, respectively.

Figure 3-2. Historical and projected residential, commercial, and industrial GHG emissions by type of fuel in Iowa, 1990–2025*



MMtCO$_2$e - million metric tons of carbon dioxide equivalent

* Emissions associated with the direct use of natural gas, petroleum, coal, and wood and the consumption of electricity. Wood-related GHG emissions are too small to be distinguished. Source: Tables 3a, 4a, and 5a of Final Iowa Greenhouse Gas Inventory and Reference Case Projections 1990-2025. Available at: http://www.iaclimatechange.us/ewebeditpro/items/O90F20404.pdf.

Key Challenges and Opportunities

The principal means to reduce RCI emissions include improving energy efficiency, substituting electricity and natural gas with lower-emission energy resources (such as biomass and wind), and implementing various strategies to decrease the emissions associated with electricity production (see Chapter 4, Clean and Renewable Energy [CRE]). The state's aggressive pursuit of energy efficiency in recent years gives stakeholders valuable experience with policymatic efforts to reduce emissions through programs and initiatives to improve the efficiency of buildings, appliances, and industrial practices. While the gas and electricity sectors in Iowa have been securing energy efficiency supplies that are the cheapest source of new resources, recent reports indicate that there is still untapped "low-hanging fruit" remaining in the form of low-cost energy efficiency opportunities in the RCI sectors. Programmatic efforts to harvest these resources are likely to create significant green collar jobs scoping, implementing, and evaluating energy efficiency projects.

Electric utilities in Iowa are required by law to offer cost-effective energy efficiency programs (Iowa Code §§ 476.6(14)). Also, Iowa investor owned utilities (IOUs) have a long history of conducting demand-side management (DSM) programs, under statutes adopted in 1990 and modified in 1996. Municipal and rural electric cooperatives have a more mixed history offering energy efficiency programs. The Iowa Utilities Board is reviewing IOU plans on the effects of goals equivalent to saving an additional 1.5% of retail electric sales in Iowa annually. Currently, IOUs achieve new (incremental) savings equivalent to 0.8% of electricity and natural gas sales.

The Iowa Climate Change Advisory Council (ICCAC) —through the work of its Energy Efficiency and Conservation (EEC) Subcommittee—has identified significant opportunities for reducing GHG emissions growth attributable to the RCI sectors in Iowa. These include expanding or launching energy efficiency programs for electricity, natural gas, and other direct-use fuels; regularly updating building codes; expanding the use of combined heat and power applications; and requiring state and local governments to implement beyond-code building practices. The ICCAC has also identified significant opportunities to reduce GHG emissions through policies addressing electricity production, such as tapping into the state's large biomass and wind potential (detailed in Chapter 4).

Overview of Policy s and Estimated Impacts

The ICCAC presents, with varying levels of support, a set of 14 policies for the RCI sectors that offer significant, cost-effective GHG emissions reductions within the state. These options and results are summarized in Table 3.1. The GHG emission reductions and costs per ton of GHG reductions for 14 of these policies were quantified. The quantified policy options could lead to emission savings from reference case projections of:

- 8.5 $MMtCO_2e$ per year by 2020, and a cumulative savings of 43 $MMtCO_2e$ from 2009 to 2020, and
- Net cost savings of over $1.0 billion through 2020 on a net present value basis.[2] The weighted-average costs of these policies are a net savings of nearly $25/$MMtCO_2e$.

Because most energy use occurs in buildings, the recommended policies center on improving energy efficiency in buildings. There is overlap among the policies as to the types of activities and equipment they cover, but the text following Table 3-1 provides general guidance on how the policies complement each other.

Energy Efficiency and Conservation (EEC) policy option EEC-1 increases the human capital component of energy efficiency by providing education and training for energy users across the state. Similarly, EEC-7 trains builders and developers in the use of energy efficiency technologies and building practices. EEC-2 and EEC-12 are the most general recommended policies that deploy DSM natural gas measures and energy efficiency across all types of energy use: space conditioning, windows, appliances, and water heating and other end uses and technologies. Efficiency improvements occur through improvements in building shells (EEC-4,

[2] The net cost savings, shown in constant 2005 dollars, are based on fuel expenditures; operations, maintenance, and administrative costs; and amortized, incremental equipment costs. All net present value analyses here use a 5% real discount rate.

EEC-6, EEC-13) or enhancing the efficiency of energy-consuming equipment within the buildings (EEC-14, EEC-12).

Table 3-1. Summary List of ICCAC Options

No.	Policy Option	CO_2 Reduction 2012	CO_2 Reduction 2020	Total 2009–2020	Net Present Value 2009–2020 (Million $)	Cost/Ton ($/t$CO_2$e)	Level of Support
EEC-1	Consumer Education Programs	*Not quantified*					Unanimous
EEC-2	Demand-Side Management (DSM)/Energy Efficiency Programs for Natural Gas	0.08	1.24	5.43	–$191.77	–$35.29	Super Majority (4 objections)
EEC-3	Financial Mechanisms for Energy Efficiency	1.62	6.11	36.81	–$805.05	–$21.87	Super Majority (1 objection)
EEC-4	Improved Building Codes for Energy Efficiency	0.05	0.40	1.89	–$46.27	–$24.44	Super Majority (5 objections)
EEC-5	Incentive Mechanisms for Achieving Energy Efficiency	0.35	3.29	16.33	–$350.79	–$21.48	Unanimous
EEC-6	Promotion of and Incentives for Improved Design and Construction in the Private Sector	0.00	0.12	0.46	–$11.36	–$24.57	Super Majority (1 objection)
EEC-7	Training and Education for Builders and Contractors	*Not quantified*					Unanimous
EEC-8	Focus on Specific Residential Market Segments	0.09	0.98	4.83	–$122.53	–$25.37	Unanimous
EEC-9	Midwestern Governors Association Energy Security and Climate Stewardship Platform	0.13	4.13	17.14	–$375.69	–$21.92	Majority (9 objections)
EEC-10	Energy Management Training/Training of Building Operators	0.10	1.29	5.48	–$129.49	–$23.63	Super Majority (1 objection)
EEC-11	Rate Structures and Technologies To Promote Reductions	0.04	0.21	1.20	–$25.73	–$21.45	Unanimous
EEC-12	Demand-Side Management (DSM)/Energy Efficiency Programs for Electricity	0.39	4.38	20.33	–$444.81	–$21.88	Super Majority (4 objections)
EEC-13	Government Lead by Example: Improved Design, Construction, and Energy Operations in New and Existing State and Local Government Buildings	0.08	0.36	1.97	1.04	0.53	Majority (6 objections)
EEC-14	More Stringent Appliance Efficiency Standards	0.94	2.20	17.33	–$708.15	–$40.85	Super Majority (2 objections)
	Sector Total After Adjusting for Overlaps	**1.1**	**8.6**	**43.2**	**–$1,064.5**	**–$24.7**	
	Reductions From Recent Actions: EISA (2007) and Executive Orders #6 and 41	**0.44**	**1.42**	**9.19**			
	Sector Total Plus Recent Actions	**1.6**	**10.0**	**52.3**			

CO_2 = carbon dioxide; DSM = demand-side management; NPV = net present value; $/t$CO_2$e = dollars per metric ton of carbon dioxide equivalent; EISA = Energy Independence and Security Act (2007).

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy options is for reference purposes only; it does not reflect prioritization among these important policy options.

The policy options also differ among the customer classes they target. EEC-13 requires government to lead the rest of the state by example by requiring that new construction and retrofits of existing building stock meet high-performance building requirements. EEC-8 targets low-income residential customers and tenants who typically have less efficient capital equipment and appliances, but are typically hard to reach for utility energy efficiency programs.[3]

There are varying degrees of overlap between policy options which are discussed in more detail in Appendix F. Government high-performance building standards (EEC-13) typically have little overlap with utility efficiency programs because government efficiency improvements are usually implemented via executive orders and procurement standards that might not capture utility incentives.Peak-demand reductions through smart metering (EEC-11) does not overlap with other programs that might reduce peak demand through efficient air conditioners under EEC-12. However, there is overlap in the expected emission reductions and costs among some of the policies within the RCI sectors, as well as between policies in the RCI and energy supply (ES) sectors.

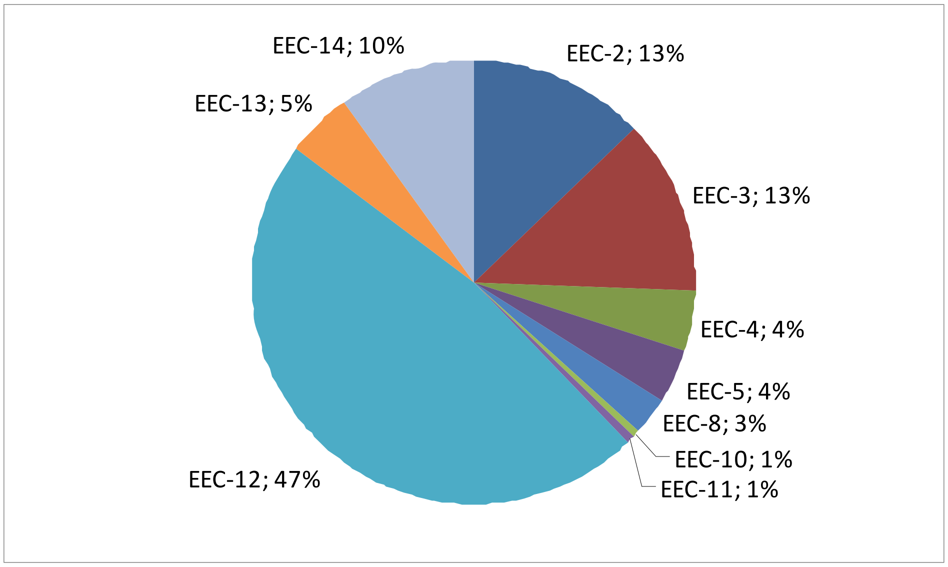
For example, EEC-9, the Midwestern Governors Association energy efficiency target, mirrors the reductions targeted under EEC-2 and EEC-12, so its reductions are eliminated from the adjusted totals. Also, EEC-8 provides energy efficiency investments for low-income residential customers. Well-designed utility and nonutility energy efficiency/DSM programs will target these populations, but not at the level identified under this policy option; therefore, EEC-8 is assumed to overlap with EEC-2 and EEC-12. Also, incentives to purchase ENERGY STAR appliances under EEC-14 are expected to overlap with utility and nonutility incentive programs under EEC-2 and EEC-12.

There is also a potential interaction between the RCI and ES sector policies concerning the clean energy portfolio components in policy option CRE-8 (Midwestern Governors Association renewable portfolio standard [RPS]). Under EEC-12, electricity demand in 2020 is reduced by almost 5,000 gigawatt-hours (GWh) versus the reference case. CRE-8b assumes a 20% RPS by 2020, which is 4% more renewable energy sources (as a percentage of retail sales) than is forecasted under the reference case. Therefore, the implementation of EEC-12 would require 200 GWh fewer of renewable resources to meet the RPS target. Using the renewable energy cost assumptions for CRE-8b, the reduced spending on renewables that cost more than reference case generation in 2020 would result in savings of $0.3 million in that year.

Figure 3-3 shows the cumulative emission reductions from the policy options that have been quantified and produce reductions net of overlaps for the entire planning period for 2009–2020.

[3] See WGA. (2005). Figure III-1. Comparison of the Market Penetration of Energy Efficiency Measures in Owner-Occupied and Rental Housing in California. P. 19.

Figure 3-3. Aggregate (Cumulative) GHG emission reductions, 2009-2020*



*These are the reductions from the Energy Efficiency and Conservation (EEC) policy options, *net of overlaps between options*. Each option number is followed by a semicolon and the percent of total reductions that it represents.

The policy options for the EEC sectors are affected by both state and federal policies that incentivize or mandate more efficient use of energy. The federal Energy Independence and Security Act (EISA) of 2007 was signed into law in December 2007. This law contains several requirements that will reduce GHG emissions as they are implemented over the next few years. During the ICCAC process, sufficient information was identified (e.g., implementation schedules) to estimate GHG emission reductions associated with implementing energy efficiency requirements for new appliances and lighting in Iowa under Title III of the EISA.

The net effect of these reductions was estimated at 1,300 GWh of electricity and 1,300 billion British thermal units of natural gas savings in Iowa by 2020. The associated GHG reductions for these savings are projected to be 1.1 MMtCO_2e for 2020 using the EEC carbon dioxide (CO_2) methodology. Note, however, that GHG emission reductions associated with the EISA Title IV (Energy Savings in Buildings and Industry) and Title V (Energy Savings in Government and Public Institutions) requirements have not been quantified because of the uncertainties about how they will be implemented. It is expected that these requirements will overlap with some of the RCI policy options, especially EEC-4 and EEC-13.

As mentioned in the text below, Iowa utilities have been pursuing energy efficiency programs for some time. These investments are not quantified in the analysis because EEC subcommittee members indicated that the energy impacts from these efficiency programs are already incorporated into the utility load growth forecasts which were used for the reference case inventory and forecast (eg they are already in the baseline). The assumed incremental (new) statewide energy efficiency investments are equal to 0.82% of retail natural gas sales, and 0.69% of electricity sales over the planning period. These investments are deducted from each of the relevant energy efficiency targets in the individual policy options. For example, energy efficiency target in EEC-12 (culminating at 2% of retail sales) is reduced by 0.69% to an incremental 1.31% of new investments by 2020. This approach avoids double counting reductions from existing programs in the policy options. Assuming incremental energy efficiency investments from existing actions in Iowa remained unchanged from 2006 levels, Iowa's cumulative electric energy efficiency deployment would be approximately 15% of sales in 2020. For natural gas, Iowa's cumulative natural gas energy efficiency deployment would be approximately 19% of sales in 2020. When using the levelized cost estimate assumptions developed for the EEC sector, total utility and participant spending on energy efficiency/DSM from existing actions in the reference case is estimated at $270 million in 2020.

The Iowa Utilities Board is reviewing investor-owned utility plans to increase incremental electricity and natural gas investments to 1.5% of natural gas and electricity sales. These plans have not been approved and are therefore not included in the quantitative analyses. However, these targets are similar to those of options EEC-2 and EEC-12 for natural gas and electricity with the primary difference that the two ICCAC options escalate to investments equal to 2% of sales later in the planning period.

Iowa's Executive Orders #41 (Governor Vilsack)[4] and #6 (Governor Culver)[5] to reduce energy use in state buildings will also have an impact on future GHG emissions. The avoided electricity and natural gas GHG emissions are estimated at about 0.30 $MMtCO_2e$ in 2020. The policy options described briefly below, and in more detail in Appendix F, not only result in significant emission reductions and costs savings, but also offer a host of additional benefits as well. These benefits include savings to consumers and businesses on energy bills, which can have macroeconomic benefits; reduction in spending on energy by low-income households; reduced peak demand, electricity system capital and operating costs, risk of power shortages, energy price increases, and price volatility; improved public health as a result of reduced pollutant and particulate emissions by power plants; reduced dependence on imported fuel sources; and green collar employment expansion and economic development.

For these policies recommended by the ICCAC to yield the levels of savings described here, they must be implemented in a timely and thorough manner. This means, for example, not only putting the policies themselves in place, but also attending to the development of "supporting policies" that are needed to help make the recommended policies effective. While the adoption of the recommended policies can result in considerable benefits to Iowa's environment and consumers, careful, comprehensive, and detailed planning and implementation, as well as consistent support, of these policies will be required if these benefits are to be achieved.

[4] State of Iowa, Executive Department. *Executive Order Number Forty-One*. Available at: http://publications.iowa.gov/2619/1/EO_41.pdf.

[5] State of Iowa, Executive Department. *Executive Order Number Six*. February 2008. Available at: http://publications.iowa.gov/6275/1/06-080221%5B1%5D.pdf.

Energy Efficiency and Conservation
Policy Descriptions

EEC-1 Consumer Education Programs

With a unanimous vote, the ICCAC presents a broad climate change and GHG reduction education program. The ultimate effectiveness of emission reduction activities in many cases depends on providing information and education to consumers regarding the energy and GHG emission implications of their choices. Public education and outreach, through such implementing organizations such as the Iowa Energy Center, is vital to fostering a broad awareness of climate change issues and effects (including co-benefits, such as clean air and public health) among the state's citizens. Such awareness is necessary to engage citizens in actions to reduce GHG emissions in their personal and professional lives. This option focuses on public education and outreach to stimulate decisions that yield energy efficiency savings. Consumer education is an integral component of most existing DSM programs offered by investor-owned and consumer-owned utilities. The goal of the program is to achieve a 5% reduction in residential energy consumption by 2020 implemented by the Iowa Office of Energy Independence, community colleges, secondary schools, building professional trade groups, and utilities.

EEC-2. Demand-Side Management (DSM)/Energy Efficiency Programs for Natural Gas

By a super majority vote, the ICCAC presents the option that Iowa increase the efficiency of natural gas use in the state through a goal of deploying new energy efficiency and DSM natural gas measures equal to 1.5% of retail sales by 2015 and 2.0% by 2017. This policy involves implementing new or expanding existing energy efficiency programs for all sectors, including the RCI sectors. Iowa's IOUs are currently conserving 0.8% of sales with new energy efficiency and DSM measures and have plans to double this to 1.5% by 2015. This measure then expands those plans to 2.0% in 2017.

EEC-3. Financial Mechanisms for Energy Efficiency

By a super majority vote, the ICCAC presents an option for modernizing the financial mechanisms that could increase energy efficiency provided by relevant utilities and nonutilities. Incentives for a variety of energy consumers can improve energy performance of buildings, equipment, and residences. Some of the utilities active in Iowa have offered such financing mechanisms in other states and for specific market segments in Iowa. At least one Iowa utility has a pilot program for a no-interest revolving loan fund. The goal of the option is to reduce consumption of electricity, natural gas, and heating fuels across all end-user categories by 2% of retail sales annually. End users include public-sector, industrial, commercial, multifamily residential, and residential users. Note that the GHG reductions and costs of or benefits from natural gas and heating fuels are not quantified in the summary table for this option.

EEC-4. Improved Building Codes for Energy Efficiency

By a super majority vote, the ICCAC presents the option of setting a goal for reducing building energy consumption, to be achieved by increasing standards for the minimum performance of new and substantially renovated commercial and residential buildings through the adoption and enforcement of building codes. Building codes would be made more stringent via incorporation of aspects of advanced/next generation building designs and construction standards, such as sustainable design and green building standards. Building codes should promote further reduction of GHG emissions through adoption of sustainable design or green building standards. Buildings are significant consumers of energy and other resources. Adoption and enforcement of building energy and related codes can be an effective way to eliminate the least efficient energy approaches in new or renovated buildings. The goal of this option is to reduce energy consumption per square foot of floor space at newly constructed and renovated buildings by 15% by 2012 and 50% by 2025. The new codes become effective initially in 2010, and the final goal is achieved by 2025.

This policy also included undertaking a comprehensive review of existing state and local building codes in Iowa to determine where increased energy efficiency can be achieved. This review will be undertaken by the new Commission on Energy Efficiency Standards and Practices, established by legislation enacted this year. Second, the policy aims for increasing the stringency of the Iowa Energy Code and developing a training and certification program for code officials, builders, and contractors on energy efficiency and related sustainable design standards, and in code enforcement.

EEC-5. Incentives for Energy Efficiency

By a unanimous vote, the ICCAC presesnts the option of changing the incentive structures in Iowa to deploy energy efficiency. The goal of this policy is to reduce consumption by 15% of retail sales by 2020. Energy efficiency plans in Iowa address both electric and natural gas use through a variety of programs. New incentive approaches are of three types:

Potential Type 1 Incentives to IOUs

- Decouple IOU revenues from sales of electricity or natural gas.
- Allow IOUs to rate-base their energy efficiency expenditures and earn returns on these investments.
- Allow IOUs to recover revenues that decrease due to DSM, net of utility system cost savings.
- Allow IOUs to implement a revenue normalization mechanism to recognize the impacts of declining per-customer sales due to DSM and other causes, while also recognizing additional sales due to customer growth.
- Allow IOUs to offer all DSM programs as shared-savings or Pay-As-You-Go loan programs, with the interest or earnings on these loans retained as earnings by the IOUs.
- Offer the IOUs some form of monetary reward based on amounts of capacity and energy saved, recoverable from customers as part of DSM costs.

- Evaluate alternative rate regulation structures to better align utility interests with energy efficiency goals. For example, MidAmerican's revenue sharing mechanism incorporates an element of reward for energy efficiency because energy efficiency contributes to the utility's ability to sell electricity in the wholesale market and generate additional revenues that are, pursuant to the revenue sharing arrangement, allocated between the utility and its customers. Thus, the utility and its customers are rewarded for energy efficiency.
- Allow IOUs to "own" all or part of the "carbon credit" impact of capacity and energy saved by DSM programs, and to retain as earnings any funds received from sale of credits based on these savings, above a certain level.
- Require IOUs to document performance, and penalize IOUs that do not meet specific goals by certain dates, to the extent that there is inadequacy in the current Iowa statutes and rules requiring program documentation, and allow the IUB to conduct prudence reviews and impose penalties.

Potential Type 2 Incentives to Utility Customers

- Rate discounts or payments to participants in load management programs, for savings of peak load electric kilowatt (kW).
- Time-of-use rates to electric customers, which offer lower rates off peak and much higher rates during peak electric use periods.
- Free energy audits and simple on-site energy efficiency measures installed during audits.
- Advanced energy efficiency evaluation and design services, typically for nonresidential customers.
- Assistance to residential homebuilders in the form of training, inspection of homes, cash payments for meeting standards, and certification/recognition of highly efficiency homes.
- Rebates and loans to customers for purchasing energy-efficient appliances and equipment.
- Customer education and training on energy-efficient appliances and measures (insulation, infiltration, building weatherization measures, HVAC sizing and maintenance, etc.).

Type 3 Incentives, to Other Energy Efficiency Stakeholders

Another solution to the assumption that Iowa IOUs will not improve their DSM performance very much beyond current levels of energy and capacity savings is to transfer the administration of energy efficiency programs to an independent, third-party administrator. The administrator would be subject to a performance-based compensation structure, including incentives for superior performance.

Another means of overcoming the utilities' disincentive to aggressively promote DSM programs and achieve energy efficiency results is to replace the current system of utility-administered incentives with a system that provides incentives directly to retailers of energy-efficient products and services, energy-efficient product lenders, and building contractors/designers. Some utilities currently offer these stakeholders incentives to promote energy-efficient products, including training, free publicity, and per-item restocking payments to dealers and sales people for promotion of energy-efficient appliances and equipment. Similarly, incentives could be paid directly to marketing firms to advertise and educate consumers about energy-efficient products and energy efficiency services.

EEC-6. Promotion of and Incentives for Improved Design and Construction in the Private Sector

By a super majority vote, the ICCAC presents this option, which provides incentives and targets to induce the owners and developers of new and reused (major retrofitted) residential and commercial buildings to improve the buildings' efficiency for using energy and other resources, along with provisions for raising targets periodically and providing resources to building industry professionals to help achieve the desired building performance. This policy can include elements to encourage the improvement and review of energy use goals over time, and to encourage flexibility in contracting arrangements to encourage integrated energy- and resource-efficient design and construction. The goal of the policy is to reduce energy consumption by the equivalent of 10% of retail electric sales and natural gas in residential and commercial buildings beginning January 1, 2010.

EEC-7. Training and Education for Builders and Contractors

By a unanimous vote, the ICCAC presents the option of an education and outreach policy for building professionals and code enforcement officials to encourage incorporation of energy efficiency and GHG emission reduction measures into construction. These programs can train designers, architects, builders, contractors, and code officials on a variety of relevant energy efficiency issues, such as building shell design, insulation, and proper heating and air conditioning sizing and installation, and can be supported by licensing requirements for design and building trade professionals that address knowledge of techniques for reducing energy use and sustainable design. The policy is to be in place by 2010.

EEC-8. Technology Improvements in Targeted Markets

By a unanimous vote, the ICCAC presents an option incorporating energy efficiency programs, funds, or goals (such as improved weatherization and appliances/HVAC) that focus on specific market segments at rental properties and low-income residential units. Low-income customers typically have less energy-efficient equipment due to informational barriers and a lack of access to capital. Also, there is a split incentive in rental markets where the tenant pays the energy bills, so the owner has no incentive to install energy-efficient technologies. Specific approaches that the policy could take include:

- Expand Iowa’s Weatherization Assistance Program to make the homes of low-income Iowans more energy efficient.
- Develop minimum efficiency goals for rental properties, such as use of compact fluorescent light bulbs and energy-efficient appliances. Evaluate each unit with the departure of current tenants via a pre-rental inspection program before a new tenant takes possession.

- Provide financial mechanisms to assist with the retrofitting of rental properties with energy-efficient appliances, insulation, and high-efficiency furnaces.
- Establish a shared savings or zero-interest loan program to make energy-efficient appliances affordable for everyone.
- Design policies that allow paying for energy-efficient appliances over time on residential utility bills.

Targeting specific market segments can also be an effective component of a regional market transformation alliance.

EEC-9. Midwestern Governors Association Energy Security and Climate Stewardship Platform

By a majority vote, the ICCAC presents the option that Iowa participate in the development and implementation of the Midwestern Governors Association Energy Security and Climate Stewardship Platform, signed in November 2007 by Governor Culver.[6] This policy is designed to address the energy efficiency goal of meeting at least 2% of the region's annual retail sales of natural gas and electricity through energy efficiency programs by 2015 and annually thereafter. This policy option will require all of Iowa's utilities—investor owned, municipal, and cooperatives—to save at least 2% of their annual retail sales of natural gas and electricity through energy efficiency programs by 2015.

EEC-10. Energy Management Training/Building Operators

By a super majority vote, the ICCAC presents as an option the training of building energy managers and operators. In many facilities, utility bills can be significantly decreased through more efficient equipment and building operation. Administrative and technical training can inform and encourage energy managers, school officials, building operators, and others responsible for facility energy efficiency to utilize methods for minimizing unnecessary energy waste. This policy would increase education and demonstrate the benefits of energy-efficient building operation through government "leading by example" of energy service contracting. The goal of the policy is to require energy managers and facility operators in all sectors to obtain certification for successful completion of the training program starting in 2010.

EEC-11. Rate Structures and Technologies To Promote Reductions

Passed by a unanimous vote, this policy option affects various elements of utility rate design that are geared toward reducing GHG emissions, often with other benefits as well, such as reducing peak power demand. The overall goal is to present rate structures so as to better reflect the actual economic and environmental costs of producing and delivering electricity, as those costs vary by time of day, by day of the week, by season of the year, and from year to year. In this way, rates

[6] Midwestern Governors Association. 2007. *Energy Security and Climate Stewardship Platform for the Midwest.* Midwestern Energy Security & Climate Stewardship Summit. Available at: http://www.wisgov.state.wi.us/docview.asp?docid=12495.

provide consumers with information reflecting the impacts of their consumption choices. The goal of the policy is to reduce electricity consumption through pricing by 2% of retail sales, with compliance beginning on January 1, 2010. Options for implementation include seasonal rates, time-of-day rates, critical peak pricing, and real-time pricing of electricity.

EEC-12. Demand-Side Management (DSM)/ Energy Efficiency Programs for Electricity

By a super majority vote, the ICCAC presents as and option a DSM/energy efficiency policy to invest in energy efficiency equal to 1.0% of retail electricity sales per year by 2013, 1.5% per year by 2015, and 2.0% per year by 2017. DSM/energy efficiency is a policy approach that requires actions that influence both the quantity and the patterns of energy consumed by end users. This policy option focuses on DSM/energy efficiency programs run by electric utilities, and may be designed to work in tandem with other recommended strategies that can also encourage efficiency gains. The DSM obligations and goals apply to all electric utilities in Iowa. IOUs are starting at 0.8% of retail sales; municipal utilities and rural electric cooperatives start at varying levels.

EEC-13. Government Lead by Example: Improved Design, Construction, and Energy Operations in New and Existing State and Local Government Buildings

By a majority vote, the ICCAC presents an option that the state of Iowa and municipal and county governments and school districts provide leadership in energy efficiency by adopting policies that improve the energy efficiency of new and renovated public buildings, and the equipment and appliances used therein. This policy option provides targets to improve the efficiency of energy use in new and existing state and local government buildings that are much higher than code standards. The goals for the policy are as follows:

- Require that all new construction and major renovations of government-owned buildings, including schools and publicly owned hospitals, meet sustainable design standards.
- Starting in 2008, all new state buildings and major renovations will be designed to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 50% of the regional average for that building type.
- All state and local governments will require the procurement of energy-efficient equipment, including lighting, office equipment, and other appliances, such as ENERGY STAR. (This goal element is quantified under EEC-14.)
- The fossil fuel reduction standard for all new buildings will be increased to:
    - 60% in 2010
    - 70% in 2015
    - 80% in 2020
    - 90% in 2025
    - All state buildings will be carbon neutral in 2030 (zero net energy, using no fossil fuel GHG-emitting energy to operate).

Implementing parties include state and local governments, the Capitol Planning organization, all three Regents institutions, Iowa Association of Counties, League of Cities, Iowa Association of School Boards, Iowa State Education Association, School Administrators of Iowa, private contractors, and the Iowa State Building & Construction Trades Council.

EEC-14. More Stringent Appliance Efficiency Standards

By a supermajority vote, the ICCAC presents an option increasing the efficiency of appliances in the state. Appliance standards reduce the market cost of energy efficiency improvements by incorporating technological advances into base appliance models, thereby creating economies of scale. Appliance efficiency standards can be implemented at the state level for appliances not covered by federal standards, or standards can be jointly developed by multiple states. The goal of the policy is to achieve 5% reduction in energy consumption from residential, commercial, and industrial consumers via:

- 80% minimum efficiency standards by 2010 for appliances not covered by federal standards;
- 100% market penetration of ENERGY STAR appliances in purchase transactions in which state funds are involved (state purchasing contracts, state grants or loans, etc.) by 2012; and
- A doubling of market penetration of ENERGY STAR appliances in purchases made in the residential, commercial, and industrial sectors, where applicable, up to 100% by 2017.

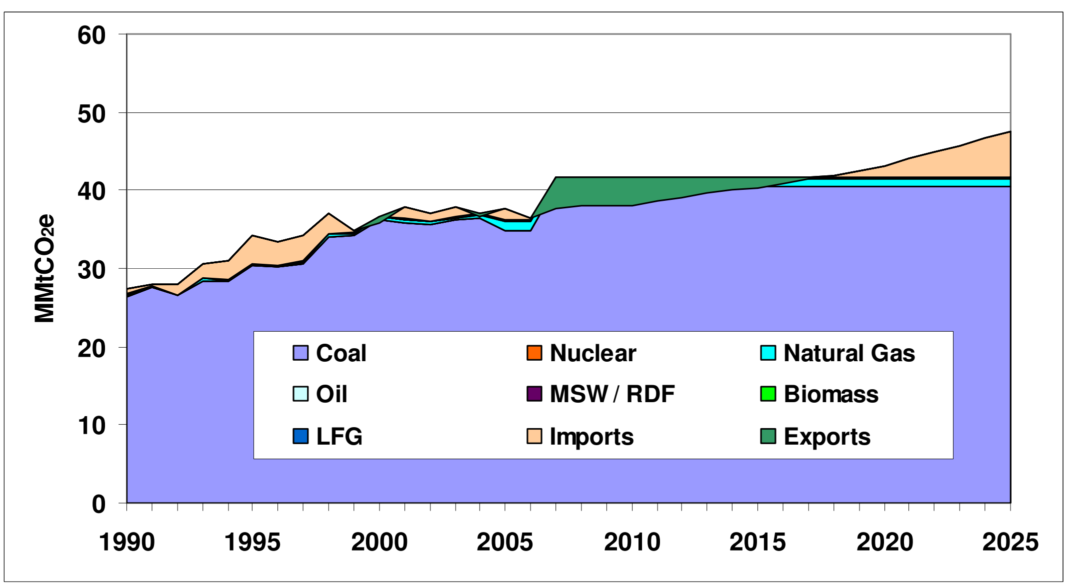
Chapter 4
Clean and Renewable Energy

Overview of Greenhouse Gas Emissions

The energy supply (ES) sector is by far the largest contributor to Iowa's greenhouse gas (GHG) emissions. The 2005 emissions associated with Iowa electricity consumption are estimated at 37.6 million metric tons of carbon dioxide equivalent ($MMtCO_2e$), which is nearly double the next-largest sector of residential, commercial, and industrial (RCI) fuel use. Iowa's GHG emissions from the ES sector are due to the state's reliance on coal as a source of electricity generation. Emissions from the sector are expected to grow by approximately 10 $MMtCO_2e$ through 2025 as demand for electricity increases. This represents approximately 35% of the projected increase in statewide GHG emissions over the period. Iowa Climate Change Advisory Council (ICCAC) stakeholders in the Clean and Renewable Energy (CRE) Subcommittee submitted electricity load growth forecasts that average 1.9% over the 2005–2025 period. However, GHG emissions grow by only 1% per year due to increases in electricity generation from wind resources.

Iowa is expected to be a large importer of electricity in the later years of planning period under the reference case. Figure 4-1 shows the breakdown of GHG emissions on a consumption basis through 2025 by fuel type. Sectoral emissions on a production accounting basis are lower in 2025 than in the reference case (41.8 $MMtCO_2e$), due to the imported power that is excluded from this inventory method. However, under the two sensitivity cases forecasted, energy production 2025 emissions are estimated at 45.44 $MMtCO_2e$ for the Sutherland scenario, and 50.09 $MMtCO_2e$ for the Elk Run scenario (not shown).

Figure 4-1. Historical and projected GHG emissions from Iowa power plants: 1990–2025



Source: Figure A5. Final Iowa Greenhouse Gas Inventory and Reference Case Projections 1990_2025. http://www.iaclimatechange.us/Inventory_Forecast_Report.cfm.

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; LFG = landfill gas; MSW = municipal solid waste; RDF = refuse-derived fuel.

Key Challenges and Opportunities

There are significant opportunities to reduce GHG emissions growth associated with energy production and supply in Iowa, such as promoting distributed renewable generation, combined heat and power applications, investing in technology research and development (R&D) in the state, and diminishing the carbon intensity of electrical generation through greater use of renewable energy and nuclear power. There are also significant opportunities to reduce GHG emissions through policies addressing electricity consumption, and these can often provide cost savings as well as GHG mitigation benefits. In Chapter 3, Energy Efficiency and Conservation (EEC), interested readers can find the 14 policy options that the ICCAC has presented for the residential, commercial, and industrial sectors to improve the efficiency of electricity consumption.

The ICCAC is presenting several policies to increase the efficiency of electricity generation within the ES sector. These include expanding combined heat and power (CHP) production for commercial, industrial, and biofuels processors (CRE-12) and distributed generation (CRE-11), which includes some small CHP applications.

Iowa has some of the largest renewable energy resource supplies in the country in the form of wind and biomass energy. The ICCAC presents options for promoting the development of these resources through a number of policies designed to address the various barriers to realizing the potential for renewable resources. Implementation of renewable resources can be encouraged through feed-in tariffs; direct financial support for biomass and other resources; renewable electricity targets; and performance standards that reduce the CO_2 intensity of generation resources over time. Smaller, distributed resources can be specifically targeted through actions to reduce financial, permitting, and interconnection barriers. Technology R&D can encourage market acceptance of a variety of technologies by lowering the cost or improving the performance of renewable generation, and by encouraging collaboration between R&D, government, academic, and commercial sectors. R&D activities also produce employment and economic development benefits in the state.

Overview of Policy Options and Estimated Impacts

The ICCAC presents a set of 13 policies for the ES sector that offer the potential for significant GHG emission reductions in Iowa. Eight of these have been quantified to estimate the potential for avoided GHG emissions. Figure 4-2 shows the percentage of potential GHG reductions from five CRE policy options with reductions that don't overlap with other options. If implemented together, the quantified policy options could lead to:

- Emission reductions of 48 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) per year by 2020, and 233 $MMtCO_2e$ cumulative savings from 2008 through 2020.
- Net costs of almost $6.0 billion through 2020 on a net present value basis.[1] The weighted-average cost of these policies is approximately $25/$MMtCO_2e$.

[1] The net cost savings, shown in constant 2005 dollars, are based on fuel expenditures; operations, maintenance, and administrative costs; and amortized, incremental equipment costs. All net present value analyses here use a 5% real discount rate.

- The rate impacts of the policy options vary depending on the scale of the policy. A few of the options have negligible or modest potential impacts on ratepayers. Others, like CRE-2, which incentivizes the development of the majority of the estimated renewable electricity supplies in the state, could raise generation costs by up to $26 per megawatt hour (MWh). However, given that 50% of retail electricity sales could come from renewables sources under this policy, it is likely that the electricity generated by this type of policy would be sold to parties outside the state which could instead be a source of revenue to Iowa.

Six of these policies were approved unanimously by the ICCAC, five with a super majority, and two with majority support. Table 4-1 shows the GHG reductions, costs, and levels of support for the 13 policy options.

One of the options increases the human capital component of energy production and consumption by enhancing education about the effects of climate change and giving workers the skills necessary for a green-collar economy. Many of the options focus on economic incentives to make clean sources of electricity competitive with more carbon intensive sources (CRE-2, CRE-8, CRE-11, CRE-12, CRE-13). Other options require producers to deploy more climate-friendly generation resources (CRE-5). One option levies a fee based on the carbon content of generation in order to fund energy efficiency and renewable sources of energy (CRE-4). The most complex option (CRE-3) links Iowa's GHG reductions efforts with the cap and trade program being developed by the Midwestern Governors Association (MGA). Getting clean electricity to the end user is a challenge, given the status of existing transmission and distribution (T&D) assets and that renewable resources are often sited far from demand centers. This is an issue even for the wind resources that are assumed to be built in the reference case for the Iowa Inventory and Forecast. CRE-9 incentivizes upgrading of the T&D system in order to get clean energy to the market. Two of the options incentivize the production of electricity at the point of the end user (CRE-11, CRE-12).

The totals reported at the bottom of Table 4-1 take into account overlaps in the expected emissions reductions and costs among some of the policies within the ES sector, as well as between policies in the ES, RCI, and agricultural, forestry, and waste management (AFW) sectors. Care was taken in the determination of benefits from each of the sectors to ensure that the combined calculated impact of the policies would not double count benefits that overlap.

CRE-2 (Renewable Technologies Initiative)—This option encompasses the estimated supply curve for renewable electricity through 2020. It is likely that the electricity generated by the new renewable energy sources that are developed pursuant to CRE-2 will be purchased by the large power producers that are required to comply with the clean energy targets of CRE-5. Therefore, the reductions of CRE-5 are subtracted from CRE-2.

CRE-8 (Renewables Targets)—The renewables targets under this option are similar, but less aggressive than what is forecasted to occur under CRE-5. Similar generation mixes are expected under either approach. The reductions from this option are eliminated through the overlap analysis.

CRE-13 (Pricing Strategies)—This option promotes the use of net metering and feed-in tariffs to deploy clean energy technologies at the point of customer use. For renewables, there is very little overlap with other CRE policy options because the other options promote the deployment of large-scale renewable energy projects, like wind farms and co-firing biomass in pulverized coal boilers, while this option sites small-scale renewables. However, the CHP element of this option could overlap with CRE-12 (Combined Heat and Power) for industrial or commercial customers who might site microturbines or other CHP technologies at the point of use. For this reason, the electricity generation and associated carbon dioxide (CO_2) reductions from this option are reduced by 50%.

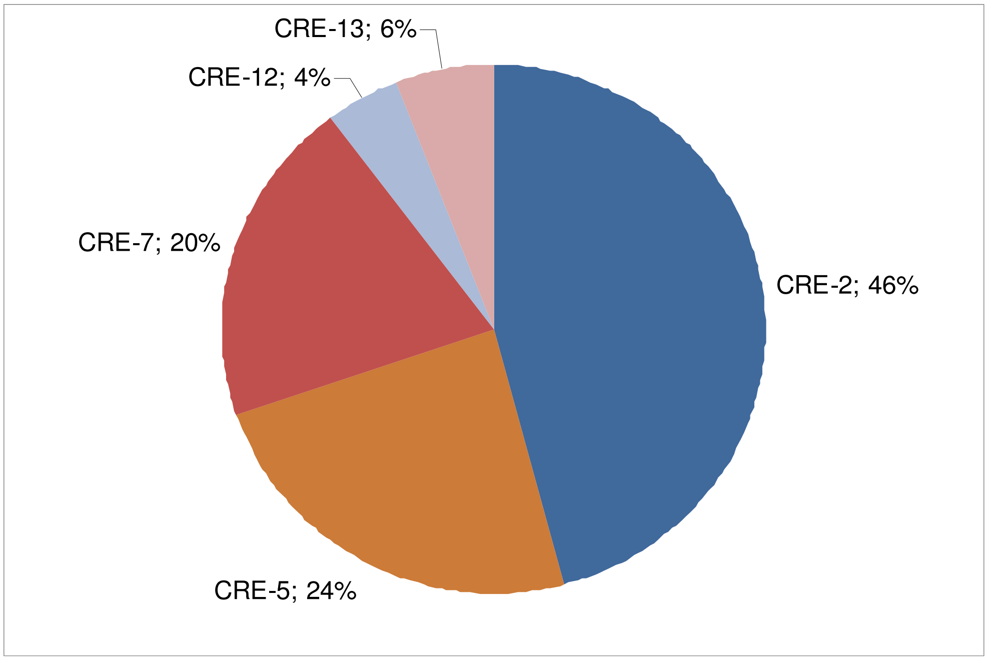
CRE policy options also overlap with other sectors. CRE-4 (Decarbonization Fund) levies a fee based on the greenhouse gas emissions from electric generation to transition to a new, non-emitting and low emitting sources of electricity by funding specified activities such as low income weatherization, energy efficiency, research and development and renewable sources of energy . The renewables and energy efficiency deployment from this option are assumed to overlap with other CRE and EEC options.

CRE-2 also overlaps with policy options AFW-3 and AFW-9. The reductions from the AFW sectors are assumed to completely overlap with CRE-2, and are subsumed under the CRE option.

The electricity energy efficiency investments from the suite of EEC policy options reduce electricity demand and thus make it possible to meet renewable energy mandates more cost-effectively. For example, under EEC-12, electricity demand in 2020 is reduced by almost 5,000 gigawatt-hours (GWh) versus the reference case. CRE-8b assumes a 20% renewables target by 2020, which is 4% more renewable energy sources (as a percentage of retail sales) than is forecasted under the reference case. Therefore, the implementation of EEC-12 would require 200 GWh fewer of renewable resources to meet the renewables target. Using the renewable energy cost assumptions for CRE-8b, the reduced spending on renewables that cost more than reference case generation in 2020 would result in savings of $0.3 million in that year.

Finally, an additional feedback is that certain CRE policies will have the effect of reducing the GHG emissions associated with energy production, so that EEC policies that target electricity use will have a reduced impact on overall emissions. However, this impact is small and has not been reflected in the analysis beyond the avoided CO_2 methodology that assumes in the later years of the program that 21% new renewables are avoided by implementing the EEC options. (The CRE methodology does not include avoided renewables, because doing so would contradict the goals of the CRE options.) See Annex A in the CRE Appendix for a discussion of the avoided CO_2 methodology.

Figure 4-2. Percentage of avoided greenhouse gas emissions by CRE policy: 2008–2020



* These are the reductions from the policy options, *net of overlaps between options*.

Table 4-1. Summary list of policy options

No.	Policy Options	GHG Reductions ($MMtCO_2e$) 2012	2020	Total 2009–2020	Net Present Value 2009–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Change in Generation Cost in 2020 $/MWh*	Level of Support
CRE-1	Education	*Not quantified*						Unanimous
CRE-2	Technology Initiatives, Including Renewables	4.7	33.4	192.6	$5,653	$29.4	$25.7	Super Majority (3 objections)
CRE-3	MGA Cap and Trade, Including Offsets To Promote Renewables	*Not quantified*						Majority (5 objections)
CRE-4	Decarbonization Fund	2.2	11.4	74.1	$316	$4.3	$3.1	Super Majority (2 objections)
CRE-5	Performance Standards (50% Reduction by 2050)	4.9	11.4	95.4	$2,650.6	$27.8	$7.3	Super Majority (3 objections, 1 abstention)
CRE-6	Voluntary GHG Commitments	*Not Quantified*						Unanimous
CRE-7	Policies Related to Nuclear Power	0.0	9.7	9.7	$268	$27.6	$4.5	Majority (5 objections)
CRE-8	Support for Grid-Based Renewable Energy & Development (MGA Target of 20% of retail sales by 2020)	0.0	2.3	4.3	$93.4	$21.8	$1.5	Unanimous
CRE-9	Transmission System Upgrading	*Not quantified*						Unanimous
CRE-10	R&D for Emerging Technologies and Corresponding Incentives	*Not quantified*						Unanimous
CRE-11	Distributed Generation/Co-Generation	0.0	0.1	0.5	$14	$29.1	$0.1	Super Majority (1 objection)
CRE-12	Combined Heat and Power	0.3	2.1	13.6	–$564.3	–$41.4	$0.0	Unanimous
CRE-13	Pricing Strategies To Promote Renewable Energy and/or CHP	1.2	5.6	35	$1,128	$32.1	$4.7	Super Majority (3 objections)
	Sector Total After Adjusting for Overlaps	**6**	**48**	**233**	**$5,921**	**$25**		
	Reductions From Recent Actions	**0.0**	**0.0**	**0.0**	**$0.0**	**$0.0**		
	Sector Total Plus Recent Actions	**6**	**48**	**233**	**$5,921**	**$25**		

CO_2 = carbon dioxide; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; $/MWh = dollars per megawatt-hour; MGA = Midwestern Governors Association; GHG = greenhouse gas; per year; R&D = research and development; CHP = combined heat and power.

* Represents the change in the cost of generation in $/MWh in the Policy case from the No-Policy case to meet Iowa's electricity demand or for exports. This is one measure of the possible rate impacts to customers from the policies.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy options is for reference purposes only; it does not reflect prioritization among these important policy options.

The options offered here present a balanced portfolio of policies to significantly reduce GHG emissions associated with electricity supply in Iowa. Iowa's considerable natural endowments of wind and biomass resources, coupled with its low population density, positions Iowa as a leader in the region and the nation to deploy clean energy. The state can benefit from developing and selling these resources to trading partners who don't have Iowa's resources or have moved more slowly. For Iowa to capture these economic advantages, the suite of policy options offered here needs to be authorized and implemented in a timely, consistent, and thorough manner.

Clean and Renewable Energy Policy Descriptions

CRE-1. Education

By unanimous approval, the ICCAC presents a policy option directed at education and outreach for the purposes of nurturing public consciousness of climate change issues, as well as providing technical skills training for employment in positions that directly support GHG emission reduction activities. Broad awareness engages citizens of all ages to take direct action to reduce GHG emissions through personal and public means. It also builds grass-root support for government, industrial, and civil society actions with regard to GHG emission reduction programs, policies, or goals. Technical instruction and training of citizens will provide the number of skilled employees needed to fill critical jobs in the new and growing industries that will provide emission reductions and clean energy.

Beginning in the 2010 academic year, the goals of this policy option focus on developing, implementing, and executing a statewide climate change control awareness education and job-training program that: provides a platform that, along with imparting knowledge; encourages a bias for action on the part of all Iowans; provides a specified environmental education curriculum to primary, secondary, and post-secondary audiences within the state; provides continuous public exposure through a variety of communications channels to educate and enhance the awareness of Iowans about environmental issues; provides technical job training in support of the growing need by Iowa's renewable energy industries for skilled workers; and develops statewide environmental literacy. The policy is implemented by elementary and secondary school districts, municipal governments, the three Regents state universities, Iowa community colleges, and community partners/associations.

CRE-2. Technology Initiatives, Including Renewables

By a majority approval, the ICCAC presents a policy option that deals with the implementation of CRE technologies that are currently commercially available. Iowa can undertake initiatives focused on developing, promoting, and/or implementing one or more specific technologies that show promise for reducing GHG emissions. This policy would support providing state government and other private and public parties with resources and incentives for analysis, targeted R&D, market development, and adoption of GHG-reducing technologies that are not covered by other CRE policies.

CRE-2 has specific goals for annual increases of renewable electric production in Iowa subject to maximum feasible supply constraints: landfill gas-to-energy projects—9,000 megawatt-hours (MWh), municipal waste—65,500 MWh, wind energy—2.6 million MWh, biomass cofiring of agricultural residues—3,600 MWh, biomass from energy crops—760,000 MWh, and repowering hydropower facilities—112,000 MWh.

CRE-3. Midwest Governors Cap and Trade, Including Offsets To Promote Renewables

By a majority vote, the ICCAC presents a policy option for Iowa's participation in the Midwest Governors Cap and Trade program. A cap-and-trade system is a constructed market-based compliance mechanism in which GHG emissions are limited to a specified amount (i.e., the cap), and entities subject to the cap can buy and sell (i.e., trade) emission allowances. In theory, a properly designed cap-and-trade system of sufficient market size can lower the cost of compliance of meeting the emissions cap to all entities involved. This is possible because participants with a lower cost of compliance can reduce emissions below their allocation and sell their additional allowances to a participant with a cost of compliance that is otherwise higher than the market allowance price. The goals of this policy are assumed to be those adopted by the MGA cap-and-trade program. The ICCAC should revisit what action to take on this option once the MGA cap levels and model rule have been developed. The policy would start in concert with other MGA actions. The larger the scope of a cap-and-trade program, the more likely the odds of lowering the cost of compliance for all participants. Thus, a federal cap-and-trade program is recommended as the first choice. A regional cap-and-trade program, such as the MGA Accord, is the second-best choice and is also the minimum size recommended for a cap-and-trade program. A state-level program is not likely to be a cost-effective option; therefore, it is not recommended.

CRE-4. Decarbonization Fund

By a super majority vote, the ICCAC presents a policy option for the adoption of a fee on each ton of CO_2 emissions produced by the electricity supply sector to transition to a new, non-emitting and low-emitting sources of electricity. The most important policy aspect of a decarbonization fee is that the revenue generation potential of even a small fee, feeding into a targeted decarbonization fund, can be significant. Given this, the monies derived from a decarbonization fee can provide a strong incentive toward GHG emission reductions. Thus, the most effective decarbonization fee design would include both the front-end variables (i.e., the covered GHGs, the amount levied per ton of emissions) and the back-end variables (i.e., where revenue is housed, how revenue is utilized). To help mitigate the potential impacts on the economy, the decarbonization fee should be phased in and capped at a reasonable rate, allowing for long-term planning by consumers. Therefore, as a starting point for the analysis, it is recommended that the decarbonization fee for electric generation begin at \$1/metric ton (t) of CO_2 in 2010, and increase by \$1/year until a cap of \$10/tCO_2 is obtained in 2019. The funding in 2019 is estimated at \$320 million. This funding could only be used for energy efficiency, renewable energy development, R&D, and low-income weatherization assistance programs and initiatives.

CRE-5. Performance Standards

By a supermajority vote, the ICCAC presents a policy option for generation performance standard (GPS) to be applied to the electricity supply sector. A GPS is an emissions rate hurdle that must be met for compliance by sources supplying electricity to consumers in Iowa. A GPS can be applied to new generation or can include the system-wide emissions rate of an entity's generating fleet. The ICCAC presents two GPS targets for policymakers to choose from: either 5(a) which is the less aggressive option targeting a 50% reduction in CO_2 intensity per MWh from 2005 emission levels by 2050, or the more aggressive 5(b) option targeting a 90% reduction goal from 2005 emissions levels by 2050.

CRE-6. Voluntary GHG Standards

By a unanimous vote, the ICCAC presents a policy option for adopting standards to recognize voluntary GHG reductions by entities in the state. The standard provides an incentive for companies that are voluntarily addressing global climate change through proactive and innovative measures, including setting targets for GHG emission reductions, implementing innovative energy supply and demand solutions, improving waste management practices, participating in emissions trading, and investing in carbon sequestration opportunities and research. The goals for an Iowa voluntary GHG program include: encouraging Iowa businesses and citizens to voluntarily begin reducing GHG emissions immediately, without waiting for mandatory Iowa or national GHG reduction program measures; obtaining voluntary commitments from each of Iowa's investor-owned utilities to reduce GHG emissions by at least 6% below the baseline year 2005 emissions by 2010; and obtaining similar commitments from 25% of Iowa's GHG-emitting private businesses. Also, the voluntary standards should provide rate-regulated utilities assurance of cost recovery for voluntary GHG reduction measures that are previewed and approved as prudent and reasonable by the Iowa Utilities Board.

CRE-7. Policies Related to Nuclear Power

By a majority vote, the ICCAC presents a policy option that, if deemed necessary, would build one new 1200-megawatt nuclear power plant in Iowa by January 1, 2020. It is currently estimated that it would take approximately 10–12 years to design, permit, and construct a new nuclear power plant. Therefore, steps should be taken today if Iowa chooses to employ nuclear power as part of a balanced and diversified energy portfolio that achieves Iowa's long-term carbon emission reduction goals. The focus of this particular option is to determine the economic feasibility of nuclear power in a carbon-constrained environment, and to define specific state legislative and regulatory actions to facilitate licensing, financing, and construction of a new nuclear power plant in Iowa. There are considerable uncertainties about the cost characteristics of new nuclear power. The latest numbers for nuclear power, based on an average of data prepared by Progress Energy Florida and Florida Power and Light, estimate the total levelized unit cost of nuclear power is $100/MWh ($2006 dollars) generated.[2] This is nearly double the $52/MWh used in the quantification for CRE-7 in Iowa.

[2] Assumes a useful life (and life for calculation of annualized capital costs) of 40 years, a capacity factor of 91%, an average installed capital cost of $7,091/kW, $79/kW-yr fixed O&M costs, $3.1/MWh variable O&M costs, $15/MWh fuel costs, and a 8.5%/yr weighted-average cost of capital. See: http://www.flclimatechange.us/ewebeditpro/items/O12F19875.pdf.

CRE-8. Support for Grid-Based Renewable Energy and Development

By a unanimous vote, the ICCAC presents a policy option for financial incentives to encourage investment in renewable energy resources by businesses and individuals who sell power commercially. The policies help overcome financial barriers and increase incentives for renewable energy development. Institutional barriers—such as low market prices, the inability of the market to assign values to the public benefits of renewables and the social costs of fossil fuel technologies, high transaction costs relative to smaller project sizes, and high financing costs because of lender unfamiliarity and perceived risk—can be overcome through a suite of financial and regulatory incentives for renewable energy development. These policies and incentives can include direct subsidies for buying or selling renewable generation equipment, tax credits or exemptions for buying or selling renewable generation equipment, government-sponsored or -facilitated loan programs for buying renewable generation equipment, tax credits, or direct subsidies for each kilowatt-hour (kWh) generated or sold from renewable generation facilities.

This option includes two different pathways for promoting renewable energy development. CRE-8a (More aggressive case) increases grid-based renewable electric production in Iowa by 400,000 MWh (400 GWh) of generation in the first year and growing by 1% of retail MWh sales each year thereafter. This policy adds an average of 521 GWh of new renewable resources per year over 2012–2020, and results in incremental renewables generation equal to 3.7% of retail sales by 2015, and 8.2% of retail sales by 2020. Including assumed reference case renewables deployment, CRE-8a results in approximately 24.2% of renewables as a percentage of retail sales by 2020, and 32.2% by 2030. CRE-8b (Less aggressive case) reflects the MGA renewable energy goal, which is a goal for the Midwest region equivalent to 10% of retail MWh sales by 2015, 20% by 2020, and 30% by 2030. CRE-8b results in new renewables generation equal to 4% of retail sales by 2020, and additional increments equal to 1% of retail sales each year thereafter. Including assumed reference case renewables deployment, CRE-8b results in the MGA target of 20% of renewables as a percentage of retail sales by 2020, and 30% by 2030.

CRE-9. Transmission System Upgrading

By a unanimous vote, the ICCAC presents a policy option to upgrade Iowa's transmission system. The policy's goals are to research how implementing modern grid technologies would enable a more efficient and intelligent transmission system; identify specific legislative and regulatory actions that would be needed to support long-term, cost-effective alternatives that increase transmission system capabilities; and commission a study that would identify areas in Iowa's transmission system where upgrading and/or expanding transmission would enable the state's wind resources to be developed for Iowa users and for potential exports to other states.

CRE-10. Research and Development (R&D) for Emerging Technologies and Corresponding Incentives

By a unanimous vote, the ICCAC presents a policy option for supporting R&D of emerging technologies to develop demonstration projects and eventual commercialization of reasonable-cost generation technologies with low or zero GHG emissions. Technology areas often cited as requiring such reasonable-cost developments are CO_2 capture and storage (e.g., in deep saline aquifers or coal seams) for fossil fuel facilities, and large-scale baseload renewable energy or technologies that can transform intermittent renewables into baseload generation (e.g., batteries, compressed air storage). A small fee per kWh of electricity could generate significant funding for R&D and commercialization. By 2010, the policy would begin to implement the R&D funding mechanisms.

CRE-11. Distributed Generation/Co-Generation

By a super majority vote, the ICCAC presents a policy option focusing on encouraging investment in small-scale distributed generation (DG) through incentives or subsidies and the prevention of barriers for both utility and consumer investment, with a goal of deploying 7500 MWh per year of new distributed renewable generation by 2010 and continuing each year thereafter. DG can be encouraged by ensuring access to the grid under uniform technical and contractual terms for interconnection that are based on best practices, so that owners know in advance the requirements for parallel interconnection and manufacturers can design standard packages to meet technical requirements. Changes that generally facilitate the integration of customer-owned DG with the grid could encourage the adoption of specific renewable energy and high-efficiency technologies, including solar photovoltaic systems, fuel cells, and microturbines. Uniform requirements for emissions, land use, and building codes should be established that are based on the technology of electricity generation, so that manufacturers can design suitable units and owners of distributed generators are not restricted in their siting and operating decisions relative to other new sources of generation.

CRE-12. Combined Heat and Power (CHP)

By a unanimous vote, the ICCAC presents a policy option to promote CHP technology, which recovers waste heat from energy production for productive use. The key to implementing CHP systems is to provide adequate incentives for the development of infrastructure to capture and utilize the waste heat. Such incentives could come in many forms, such as recruiting suitable end users to the area, tax credits, grants, zoning, and offset credits for avoided emissions. Studies indicate substantial opportunities for electricity generation at commercial and industrial facilities in the state. In addition, Iowa's leadership as a biofuels producer is a significant source of CHP electricity, where the waste heat from electricity generation can be used to refine biofuel feedstocks.

CRE-13. Pricing Strategies To Promote Renewable Energy and/or CHP

By a super majority vote, the ICCAC offers this policy option focusing on creating pricing and metering strategies that can encourage consumers to implement CHP, renewable energy, and overall reductions in GHG emissions. Pricing strategies, such as feed-in tariffs, provide minimum utility purchase rates for DG. Net metering is a policy that allows owners of DG (generating units on the customer side of the meter, often limited to some maximum kW level) to generate excess electricity and effectively sell it back to the utility by "turning the meter backward." Implementation of pricing strategies, such as feed-in tariffs, must be considered in light of existing rules, such as the Federal Energy Regulatory Commission's avoided cost standard. The goal of this option is to achieve a 10% shift to renewable energy sources, as a percentage of retail sales, through implementation of various pricing strategies. The policy begins with a 1% shift achieved in 2010, and continues with linear growth through 2019.

Chapter 5
Transportation and Land Use Sectors

Overview of Greenhouse Gas Emissions

The transportation sector, which includes light- and heavy-duty (on-road) vehicles, aircraft, rail engines, and marine engines, is one of the largest contributors of gross greenhouse gas (GHG) emissions in Iowa. This sector accounted for 17% of Iowa's gross GHG emissions in 2005, which was slightly under the national average of 27%. However, by 2025, the share of emissions associated with the transportation sector is anticipated to increase slightly to 20%.

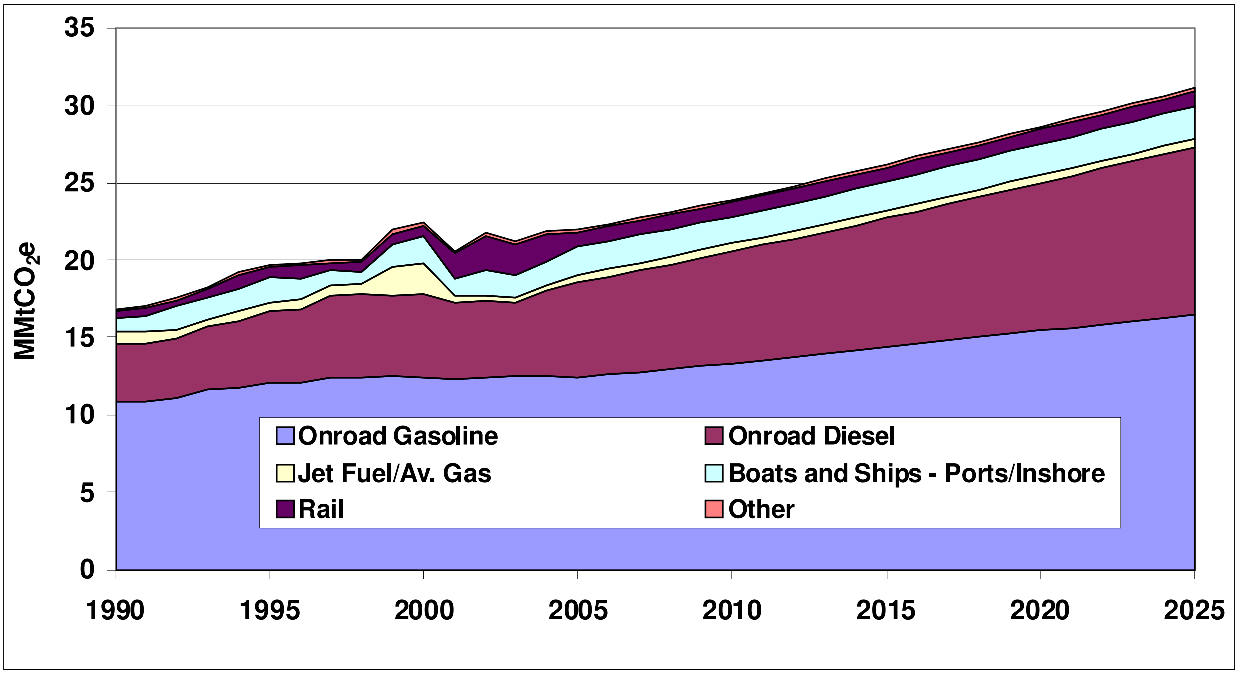
From 1990 to 2005, Iowa's GHG emissions from transportation fuel use have risen steadily at an average rate of about 1.4% annually. The GHG emissions associated with Iowa's transportation sector also rose accordingly, increasing by 3.8 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) emissions during the same time period from about 17 $MMtCO_2e$ to nearly 21 $MMtCO_2e$. If left unabated, this number is expected to increase by nearly 30%, to 29.4 $MMtCO_2e$ by 2025.

Carbon dioxide (CO_2) accounts for about 98% of transportation GHG emissions, with most of the remaining GHG emissions coming from nitrous oxide (N_2O) emissions from gasoline engines. Emissions released from on-road gasoline consumption account for approximately 57% of the transportation sector's GHG emissions. This has historically been the largest share of transportation GHG emissions, and this trend is forecast to continue.

Figure 5-1 shows historic and projected transportation GHG emissions by fuel and source. As a result of Iowa's population and economic growth and an increase in total vehicle miles traveled (VMT), GHG emissions from on-road gasoline consumption increased by about 14% between 1990 and 2005 and accounted for 63% of the total transportation emissions in 2005. Meanwhile, GHG emissions from on-road diesel fuel consumption rose by 44% during that period, accounting for 28% of GHG emissions from the transportation sector in 2005, suggesting an even more rapid growth in freight movement within or across the state.

In the absence of significant increases in vehicle fuel economy, a significant reduction in VMT, or technological breakthroughs in low-carbon fuels, on-road gasoline and diesel emissions are expected to continue to grow. GHG emissions from on-road gasoline consumption are projected to increase by about 33%, and GHG emissions from on-road diesel consumption are expected to increase by 75% between 2005 and 2025. The consumption of these fuels will significantly contribute to the projected 42% increase in overall GHG emission levels for the entire state of Iowa over 2005 levels by 2025.

Figure 5-1. Transportation GHG emissions by fuel source, 1990–2020



$MMtCO_2e$ - million metric tons of carbon dioxide equivalent; av. gas = aviation gas.

Key Challenges and Opportunities

Iowa has substantial opportunities to reduce transportation emissions. The principal means to reduce emissions from transportation and land use (TLU) are:

- Improving vehicle fuel efficiency,
- Substituting gasoline and diesel with lower-emission fuels, and
- Reducing total VMT.

In Iowa and in the nation as a whole, vehicle fuel efficiency has improved little since the late 1980s, yet many studies have documented the potential for substantial increases in efficiency, while maintaining vehicle size and performance. Automobile manufacturers typically oppose dramatic increases in fuel economy. Key points of contention include the cost to manufacturers and cost to consumers. Even with the adoption of the new federal corporate average fuel economy (CAFE) requirements, there may still be opportunities for further increases in fuel efficiency while maintaining vehicle size and performance.

The use of fuels with lower per-mile GHG emissions is growing in Iowa, and larger market penetration is possible. Conventional gasoline- and diesel-fueled vehicles can use low-level blends of biofuels. Alternative-technology vehicles can also use higher-level blends of biofuels, as well as other types of alternative fuels, such as natural gas and hydrogen. The type of fuel used is a crucial determinant of impact on emissions, as some alternative fuels have relatively little GHG benefit. Currently, the most prevalent biofuel in Iowa is corn-based ethanol, which has a GHG benefit of 15.9% from a life-cycle perspective.[1] Key determinants of impact will be the development and deployment of fuel types. At present, fuel distribution infrastructure is a constraining factor.

Reducing VMT is crucial to mitigating GHG emissions from transportation. Developing smarter land-use and transportation development patterns that reduce trip length and support transit, ride sharing, biking, and walking can contribute substantially to this goal. A variety of pricing polices and incentive packages can also help to reduce VMT. Developing better planning methods and regulations, and increasing funding of multiple modes of transportation will be key components in achieving these goals.

Overview of Policy Options and Estimated Impacts

The Iowa Climate Change Advisory Council (ICCAC) selected a set of 11 policies for the TLU sector that offer the potential for major economic benefits and emission savings. Implementing these policy options could lead to emission reductions of:

- 11.14 $MMtCO_2e$ per year by 2020, and
- 55.03 $MMtCO_2e$ cumulative from 2009 through 2020.

The weighted-average cost effectiveness of the selected policies is about -\$59/tCO_2e. This average value includes policies that have both much lower and much higher likely costs per ton. One option, the cost of which particularly skews the numbers, is TLU-4, "Support Passenger Rail Service in Iowa." This policy option has an identified cost per ton of \$597/tCO_2e which is largely driven by high up-front capital costs associated with the development of new rail lines. It should be noted that by 2024 the cumulative ridership benefits are anticipated to outstrip these costs and this policy option will have a negative cost per ton beyond 2024.

The estimated impacts of the individual policy options are shown in Table 5-1. The ICCAC policy options are described briefly here and in more detail in Appendix H of this report. The options not only result in significant emission reductions, but offer a host of additional benefits as well. These benefits include reduced local air pollution; more livable, healthier communities; and economic development and job growth from the development of transit and rail, smart growth developments, and in-state biofuel production. To yield the levels of savings described here, these policies need to be implemented in a timely, aggressive, and thorough manner.

Some policy options focus on reducing VMT by further developing other modes of transportation, such as transit (TLU-1a) and passenger rail (TLU-4). Other VMT reduction strategies include implementing programs to eliminate or make commuting more efficient by improving pedestrian, bicycling, and carpooling options or placing work centers within established communities (TLU-5a, TLU-5b). Further rail development and implementing new freight strategies can also significantly reduce VMT associated with freight transportation (TLU-9). Another way to reduce VMT is to develop denser, mixed-use communities where the need

[1] Biofuels analysis was based on information from the Argonne National Laboratory's GREET model, version 1.8, which indicates a life-cycle emission reduction of 15.9% for E85 corn ethanol. See Appendix H for more details on assumed reduction factors for various types of biofuels.

for long commutes becomes significantly reduced and transit can be easily implemented (TLU-1). All of the above mentioned policy options help to reduce GHG emissions by moving people and freight more efficiently and providing other options for people and freight to reach their destinations.

Qualitative policies (policy options that are nonquantifiable) are an important component of the combined policies, but because they are not quantified, these options are not reflected in the GHG emission reductions or costs. These options focus on establishing a reliable source of capital funding for transportation related GHG reduction policies (TLU-2) and developing a distributed workplace model where smaller work centers are located in communities, thereby reducing VMT (TLU-5b). While the implementation of these options may contribute to significant GHG emission reductions, the immediate impact of these policies individually is not quantifiable.

Further developing the efficiency of vehicles can also have a major impact on reducing GHG emissions. TLU-6 focuses on providing incentives such as feebates, tax credits for low GHG vehicles, and operating incentives for low GHG vehicles to promote the purchase and operation of more efficient vehicles. Increased utilization of these low GHG emission vehicles can significantly impact overall GHG emissions associated with light-duty vehicle VMT. Working in concert with TLU-6, TLU-8 promotes the development of fuel efficient vehicles by promoting increased fuel economy standards through the adoption of a State Clear Car Program. TLU-7 aims at increasing vehicle efficiency by impacting consumer choice through educating consumers about vehicle maintenance and operation techniques and encouraging the use of fuel efficient tires.

Iowa can achieve greater alternative fuel use while simultaneously reducing GHG emissions by putting in place a low-carbon fuel standard (TLU-10). Such a policy option ensures that fuel sold in Iowa would meet, on average, a declining standard for GHG emissions measured in CO2 equivalent per unit of fuel energy.

Table 5-1. Summary list of TLU policy options

No.	Policy Options	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2020 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)	Level of Support
		2012	2020	Total 2009–2020			
TLU-1	Smart Growth Bundle with Transit	0.076	0.242	1.53	-$377	-$245	Unanimous
TLU-1a	Expand and Improve Transit Infrastructure	0.004	0.026	0.127	$7.2	+$57	Supermajority
TLU-2	GHG Impacts for State and Local Capital Funding	*Quantified as part of TLU-1 and TLU-1a*					Unanimous
TLU-4	Support Passenger Rail Service in Iowa	N/A	0.008	0.026	$15	+$597	Majority
TLU-5a	Adopt Best Workplaces for Commuters in Iowa	0.02	0.02	0.21	$18	$84	Supermajority
TLU-5b	Distributed Workplace Models	*Non-quantified, qualitative option*					Unanimous
TLU-6	Light Duty Vehicles Fuel Efficiency Incentives	0.44	3.65	17.70	NQ	NQ	Supermajority
TLU-7	Fuel Efficient Operations for	0.11	0.65	3.41	-$306.9	-$90	Unanimous

No.	Policy Options	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2020 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
		2012	2020	Total 2009–2020			
	Light Duty Vehicles						
TLU-8	New Vehicle Standards (Tailpipe GHG and Fuel Economy)	N/A	0.8	4.1	-$246	-$60	Unanimous
TLU-9	Freight Strategies (Truck and Rail)	0.39	0.63	5.9	$30	+$5	Supermajority
TLU-10	Fuel Strategies (20% Low Carbon Fuel Standard)	0.60	5.11	22.03	-$1,359	-$62	Unanimous
	Sector Total After Adjusting for Overlaps and Synergies	**1.64**	**11.14**	**55.03***	**-$2,218.50**	**-$59**	
	Reductions From Recent Actions (Federal CAFE Requirements)	**0.26**	**1.93**	**9.39**	***Not Quantified***		
	Sector Total Plus Recent Actions	**1.9 (8.3)**	**13.07 (48)**	**64.42**	**N/A**	**N/A**	

CAFE = corporate average fuel economy; GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; N/A = not applicable

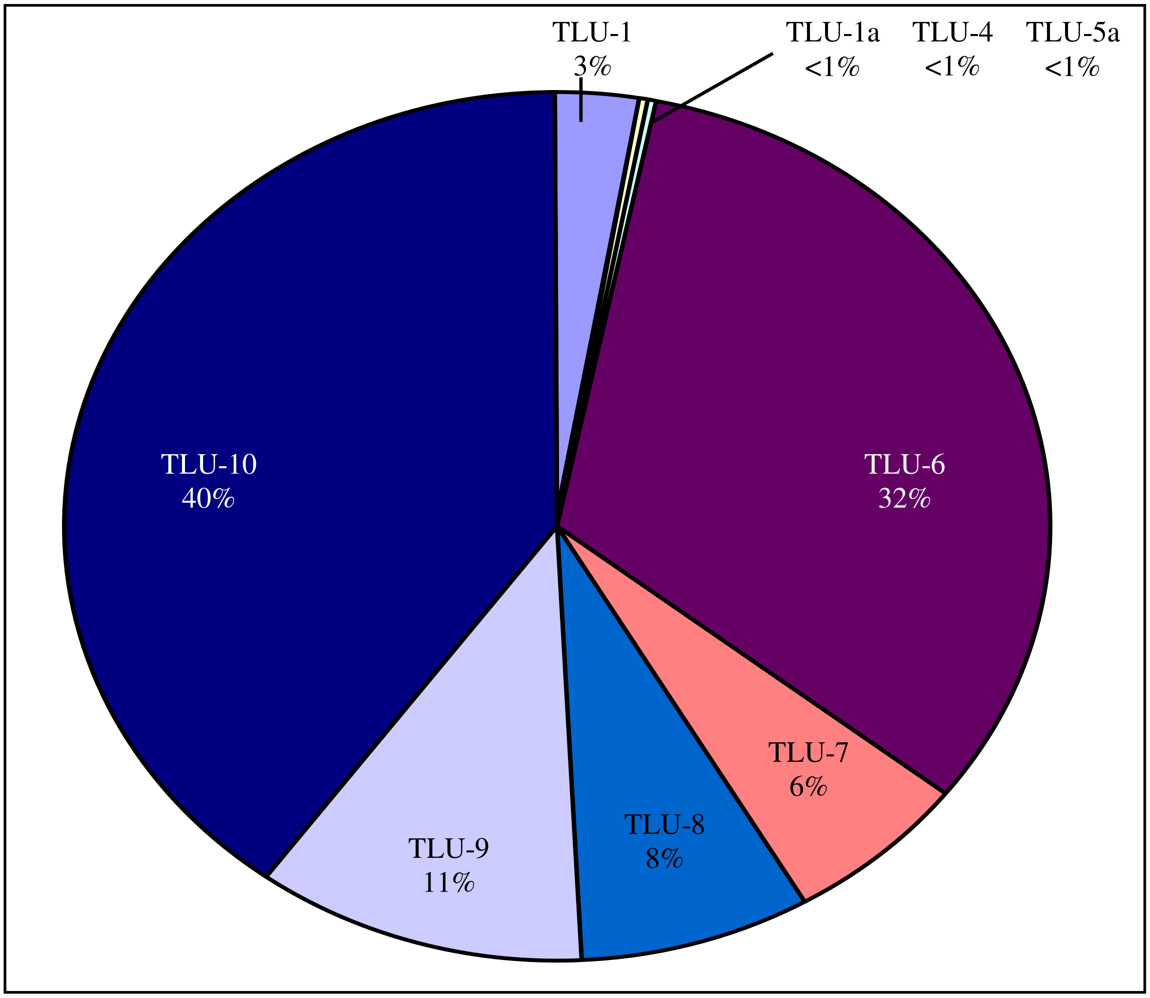
Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy options is for reference purposes only; it does not reflect prioritization among these important policy options.

Deduct total TLU-6 2009-2020 reductions [17.7MMt] from 55.03 total = 37.3, before calculating cost/ton for TLU Options.

Figure 5-2 shows the breakdown of the projected impacts of the TLU policies selected for further development, taken together, in terms of avoided GHG emissions. For the TLU policies developed by the ICCAC to yield the levels of savings described here, the policies must be implemented in a timely, aggressive, and thorough manner. This means, for example, not only putting the policies themselves in place, but also attending to the development of supporting policies that are needed to help make these TLU policies effective. While their adoption can result in considerable benefits to Iowa's environment and consumers, careful, comprehensive, and detailed planning and implementation, as well as consistent support of these policies will be required if these benefits are to be achieved.

Figure 5-2. Aggregate GHG Emission Reductions, 2009–2020



Transportation and Land Use Sectors
Policy Descriptions

The policy options described briefly here not only result in significant emission reductions but also offer a host of additional benefits, such as reduced local air pollution; more livable, healthier communities; and increased transportation choices. A more thorough description of these policy options along with their goals, implementation strategies, and other details is available in Appendix H.

TLU-1. Smart Growth Bundle with Transit

This policy option calls for incentives and programs to encourage smart growth, including downtown revitalization, transit-oriented development, and enhancing the pedestrian and bicycle infrastructure, thereby reducing VMT. Current land-use development practices increase vehicle travel by dispersing destinations, which separates activities and favors automobile travel over alternative modes. "Smart growth" planning by local, regional, and state governments refers to development that reduces sprawl and maximizes environmental, fiscal, and economic resources. Under this policy option, Iowa would encourage, facilitate, and undertake a set of smart growth activities related to the following initiatives: downtown revitalization including infill and brownfield redevelopment, transit-oriented development, smart growth planning, the development of pedestrian and bicycle infrastructure, growth management planning, and the reformation of local zoning, tax, and building codes. Additionally, this policy option would provide both technical and financial support to local and regional agencies.

TLU-1a. Expand & Improve Transit Infrastructure

The goal of this policy option is to achieve an annual ridership increase of 100% by the year 2020, to be measured on a per capita basis. This will be achieved by making improvements to existing transit service, such as increasing service frequency, offering more forms of transit, improving the quality of service, promoting ridesharing activities, and reducing travel times on selected transit routes. Additionally fare reductions, employer subsidies, and state incentives may all be offered to assist in increasing ridership. This policy option will shift passenger transportation from single-occupant vehicles to public transit, thereby reducing GHG emissions.

Additional funding will be provided by increasing state financing to at least 25% for transit systems across the state with increasing ridership or the ability to document VMT-reducing strategies. State legislation will also be proposed to enable new transportation-related fees, generated solely by users in a regional area, to be allocated directly to RTAs for VMT-reducing services.

TLU-2. GHG Impacts for State and Local Capital Funding (to be a model for climate-friendly development patterns)

The focus of this policy option is to ensure that state and local capital funding programs for the development, siting, and expansion of state facilities as well as funding used for community development, is utilized to promote policies and facilities that support GHG emission reductions. This includes making state and local government buildings location-efficient with compact development design, and ensuring that capital funding for infrastructure and funding for community development goes towards policies and development that promotes GHG reductions. Programs such as "complete streets", smart growth development, and the development or enhancement of transit are all identified as projects that support GHG emission reductions and for which funding associated with this policy option could be dedicated.

TLU-4. Support Passenger Rail Service In Iowa

This policy option will focus on reducing single occupant vehicle travel by establishing and promoting a statewide passenger rail system in Iowa to supplement existing long-distance service. This rail system will include regional rail service from Dubuque to Chicago and between Omaha and Chicago with stops in Des Moines, Iowa City / Cedar Rapids, and the Quad Cities. A key to the success of this statewide passenger rail system will be in providing connections to other modes of transportation.

TLU-5a. Adopt Best Workplaces for Commuters in Iowa

This policy option focuses on reducing the VMT associated with commuters traveling to and from work. By making the daily commute more efficient or possibly eliminating the need for commuting to work, this policy reduces GHG emissions by reducing VMT. Promoting strategies such as telecommuting, carpooling, and vanpooling, and the use of alternative modes of transportation such as transit, bicycling, and walking to work this policy can be very effective at reducing VMT and roadway congestion during the peak commuting hours. The success of this policy option would depend upon buy-in from employers.

TLU-5b. Distributed Workplace Model

This policy option focuses on the commuting patterns of Iowa's knowledge-based workforce. The Distributed Workplace Model is a community work model that moves beyond the "work from home" methodology of telecommuting and remotely supporting employees, and instead provides community-based multi-location work centers that will enhance access for both employers and employees. These work centers will accommodate a cluster of employees working for multiple employers, thereby reducing VMT associated with the commute to work.

TLU-6. Light-Duty Vehicle Fuel Efficiency Incentives

This policy option focuses on reducing GHG emissions within Iowa by improving the fuel economy of the light duty vehicle fleet by providing incentives such as feebates, tax credits for low-GHG vehicles, operating incentives for low-GHG vehicles, and vehicle registration fees which are reduced for low-emission vehicles and increased for high-emission vehicles. The goal of this policy would be to increase the fuel economy of the light duty vehicle fleet in Iowa by 20% by 2012, 100% by 2020, and 250% of more by 2050. This policy option would need to pass through the legislative process and implemented by state and local government agencies in partnership with the affected parties.

This policy option assumes no direct correlation between fuel economy and GHG emission efficiency. Although it is likely that an increase in fuel economy will result in reduced GHG emissions, the amount of this decrease or potential increase is dependent upon the carbon content and energy content of the fuel.

TLU-7a. Fuel Efficient Operations for Light-Duty Vehicles

This policy option focuses on improving the efficiency of light-duty vehicles by increasing the utilization of simple add on devices such as fuel efficient tires, and providing education on how to efficiently operate and maintain light duty vehicles. Maintenance tips would include items such as keeping tires properly inflated and regularly changing oil and air filters.

TLU-8. New Vehicle Standards for Increased Fuel Economy and Reduced Greenhouse Gas Emissions

This policy option promotes the development of a state clean car program. This program would go beyond the current federal CAFÉ emissions standards for cars and light trucks and would come from the “Tier 2” state clean car standards expected to be proposed in the near future under the federal Clean Air Act. The goals of this program would be to improve fuel economy by 20% by 2012, 100% by 2020, and 250% or more by 2050.

TLU-9. Freight Strategies (Truck and Rail)

This policy option proposes reducing Iowa’s overall GHG emissions generated by freight movement through a combination of identifying actions to support efficient freight movement, removing both physical and operational bottlenecks, encouraging railroad capital investment, and providing incentives for trucking companies to invest in hybrid technology.

TLU-10. Fuel Strategies: Low-Carbon Fuel Standard (20% Reduction)

This policy option seeks to reduce GHG emissions by decreasing the carbon intensity of vehicles fuels sold in Iowa. By setting a Low Carbon Fuel Standard (LCFS), all fuel providers in Iowa would be required to ensure the mix of fuel they sell into the Iowa market meets, on average, a declining standard for GHG emissions measured in CO2 equivalent per unit of fuel energy. This policy option does not specify any particular fuel or vehicle technology, leaving the door open to both current technology and future advances in the development of law-carbon fuels. The creation in Iowa of a LCFS will compliment the Federal Renewable Fuel Standard (RFS) creating additional demand of Iowa's renewable fuels across the country and increasing exports of Iowa's renewable fuels across the country as other states begin formalizing their own state standards for renewable fuels and GHG controls.

Chapter 6
Agriculture, Forestry, and Waste Management

Overview of GHG Emissions

While the agriculture, forestry, and waste management (AFW) sectors are responsible for significant greenhouse gas emissions, the sector is also a significant sink for greenhouse gases in soils and in forest stocks. The gross AFW contribution to carbon dioxide equivalent (CO_2e) emissions in 2005 was 30 million metric tons (MMt), or about 25% of the state's total. However, the AFW contribution to net emissions in 2005 was only 3 $MMtCO_2e$ due to the net sequestration of carbon in the forestry and agriculture sectors. As described in the Iowa Inventory and Forecast (I&F) report, it is important to recognize that emissions from fossil fuel consumption within the AFW sectors are included within the residential, commercial, and industrial (RCI) sectors (particularly the industrial sector).

Agricultural emissions include methane (CH_4) and nitrous oxide (N_2O) emissions from enteric fermentation, manure management, agricultural soils management, and agriculture residue burning. These emissions were estimated to be about 28 $MMtCO_2e$ in 2005. As shown in Figure 6-1, emissions from soil carbon losses from agricultural soils, manure management, fertilizer application, and crop residues all make significant contributions to the sector totals. Emissions include CO_2 emissions from oxidized soil carbon, application of urea, and application of lime. Sector emissions also include N_2O emissions resulting from activities that increase nitrogen in the soil, including fertilizer (synthetic, organic, and livestock) application and production of nitrogen-fixing crops (legumes).

The largest source of emissions in the agricultural sector is the agricultural soils category, whose emissions are projected to hold steady from 1990 to 2025, accounting for 62% (15.7 $MMtCO_2e$) of total gross agricultural emissions in 1990 and 60% (15.3 $MMtCO_2e$) in 2025. In 1990, enteric fermentation accounted for about 20% (5.04 $MMtCO_2e$) of total gross agricultural emissions. Enteric fermentation emissions decreased slightly to 4.26 $MMtCO_2e$ between 1990 and 2005 due to the decline in livestock populations during this period. Both the dairy cattle and beef cattle populations are projected to decrease in the future, and enteric fermentation emissions are estimated to decrease to 2.98 $MMtCO_2e$ in 2025, or about 12% of agricultural emissions.

The manure management category accounted for 18% (4.49 $MMtCO_2e$) of total agricultural emissions in 1990 and increased to 24% (6.64 $MMtCO_2e$) by 2005. Manure management is projected to increase slightly by 2025, to account for 27% (7.01 $MMtCO_2e$) of total agricultural emissions at that time. This is largely due to the projection that the swine population will increase between 2005 and 2025.

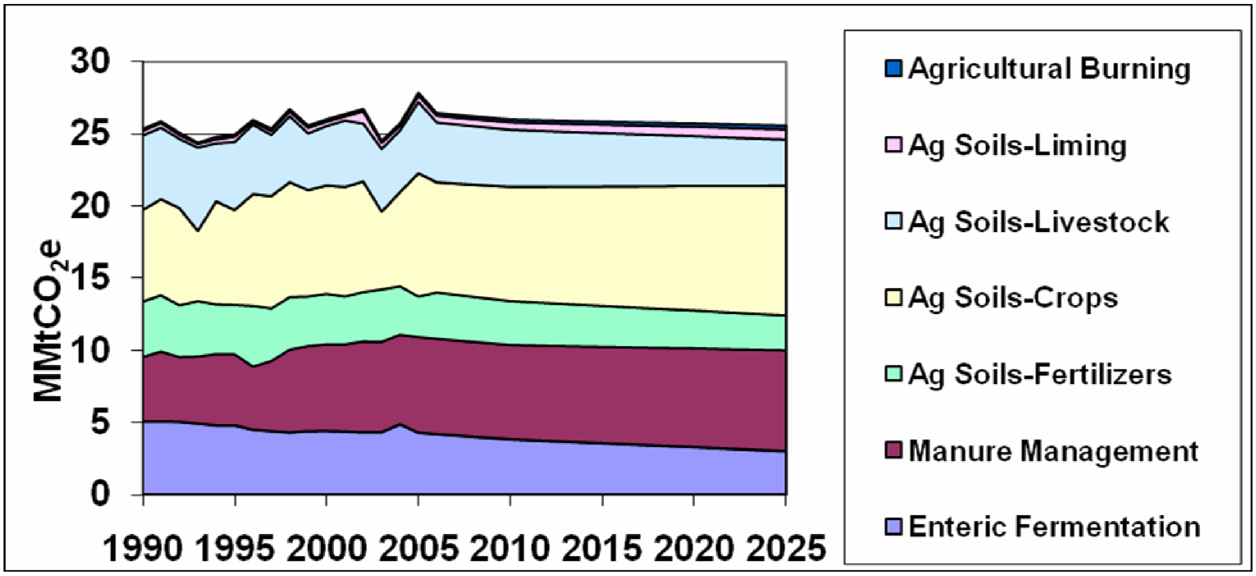
Forestland emissions refer to the net CO_2 flux[1] from forested lands in Iowa, which account for about 8% of the state's land area.[2] As shown in Table 6-1, U.S. Forest Service (USFS) data

[1] "Flux" refers to both emissions of CO_2 to the atmosphere and removal (sinks) of CO_2 from the atmosphere.

[2] Total forested area and forest type percentages provided by P. Tauke, Iowa Department of Natural Resources [DNR]) to M. Stein (DNR) on March 21, 2008. The total land area in Iowa is 35.8 million acres (http://www.50states.com/iowa.htm).

suggest the total flux estimate including all forest pools is –12.2 $MMtCO_2e$/yr between 1990 and 2003, and is –24.4 $MMtCO_2e$/yr between 2003 and 2005.[3] These totals include large sink estimates for soil carbon (–4.3 and –9.2 $MMtCO_2$/yr). The negative trend in carbon flux (sequestration) is likely due to the increase in timberland between 1990 and 2005.

Figure 6-1. Historical and projected gross GHG emissions from the agriculture sector, Iowa, 1990–2025



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent

Notes: Ag Soils – Crops category includes: incorporation of crop residues and nitrogen-fixing crops (no cultivation of histosols estimated); emissions for agricultural residue burning are too small to be seen in this chart.

Table 6-1. Annual forest carbon fluxes for Iowa

Forest Pool	1990-2003 Flux ($MMtCO_2$)	2003-2005 Flux ($MMtCO_2$)
Forest Carbon Pools (non-soil)	–7.76	–15.1
Soil Organic Carbon	–4.28	–9.17
Harvested Wood Products	–0.12	–0.12
Totals	**–12.2**	**–24.4**
Totals (excluding soil carbon)	**–7.88**	**–15.3**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent

Note: Positive number indicates net emission. Based on U.S. Forest Service input, emissions from soil organic carbon are excluded from the forestry sector summary due to a high level of uncertainty.

Table 6-2, below, summarizes the estimated flux for the entire forestry and land use sector.

[3] Jim Smith, USFS, *US. Forest Carbon Calculation Tool: Forest-Land Carbon Stocks and Net Annual Stock Change* (http://www.nrs.fs.fed.us/pubs/2394), December 2007.

Table 6-2. Forestry and land use flux and reference case projections ($MMtCO_2e$)

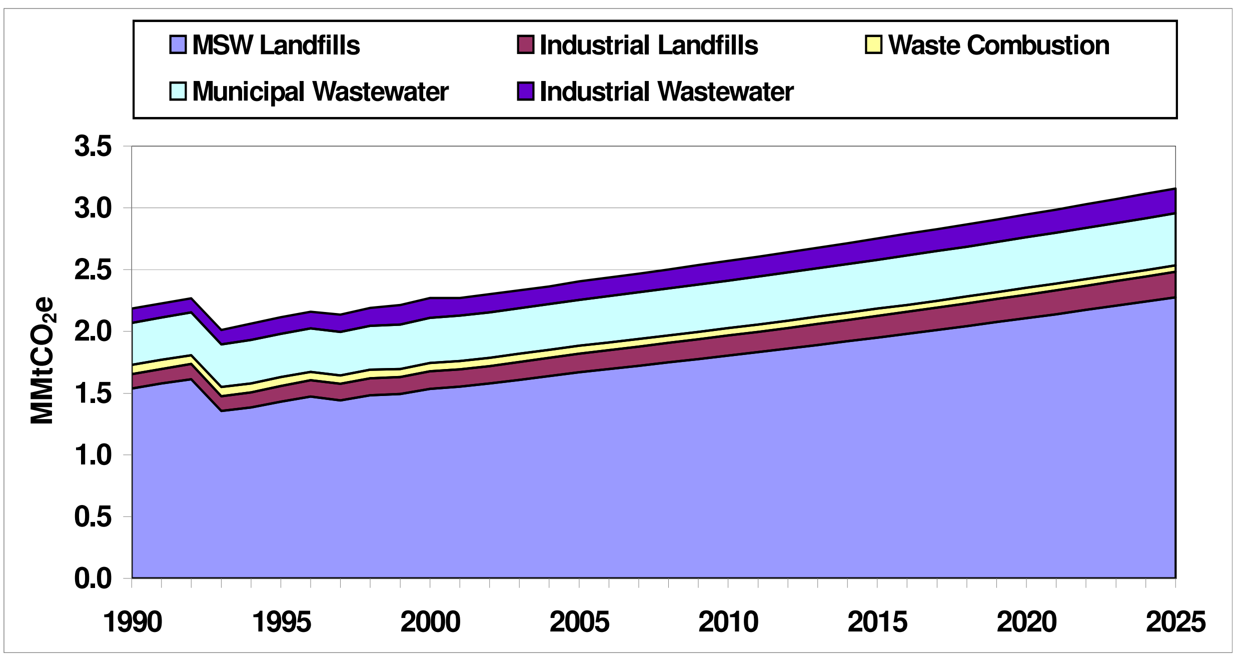
Subsector	1990	1995	2000	2005	2010	2020
Forested Landscape (excluding soil carbon)	–7.88	–7.88	–7.88	–15.3	–15.3	–15.3
Urban Forestry and Land Use	–2.59	–1.31	–0.65	–0.63	–0.63	–0.63
Forest Wildfires	N/A	N/A	N/A	N/A	N/A	N/A
Sector Total	**–10.5**	**–9.19**	**–8.53**	**–15.9**	**–15.9**	**–15.9**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Note: Positive numbers indicate net emission. N/A = not available.

Figure 6-2 shows estimated historical and projected emissions from the management and treatment of solid waste and wastewater. Emissions from waste management consist largely of CH_4 emitted from landfills, while emissions from wastewater treatment include both CH_4 and N_2O. Emissions are also included for municipal solid waste (MSW) combustion. Figure 6-2 illustrates that emissions from MSW landfills are projected to increase significantly through 2025. Overall, the waste management sector accounts for about 2% of Iowa's total gross emissions per year from 1990 through 2025.

Figure 6-2. Estimated historical and projected emissions from waste and wastewater management in Iowa



$MMtCO_2e$ = million metric tons carbon dioxide equivalent; MSW = municipal solid waste.

Opportunities for GHG mitigation in the AFW sector involve measures that can reduce emissions within the sector or in other sectors. Examples of reductions that can occur within the sector include changes in crop management practices that reduce GHG emissions by building soil carbon (indirectly sequestering carbon from the atmosphere); more efficient nutrient application (reducing N_2O emissions—note that emissions outside of the AFW sectors are also reduced here due to the embedded energy in nutrients and the potential for lower energy consumption during their application); reforestation projects that achieve GHG reductions by increasing the carbon sequestration capacity of the state's forests; and landfill gas collection and control, which reduces methane emissions from landfills.

For GHG reductions outside of the AFW sectors, actions taken within the sectors, such as production of liquid biofuels, can offset emissions in the transportation sector, while biomass energy can reduce emissions in the energy supply, residential, commercial, and industrial sectors. Similarly, actions that promote solid waste reduction or recycling can reduce emissions within the AFW sectors (future landfill CH_4), as well as emissions associated with the production of recycled products (recycled products often require less energy to produce than similar products from raw materials). Finally, urban forestry projects can reduce energy consumption within buildings through shading and wind protection.

Following are primary opportunities for GHG mitigation identified by the Iowa Climate Change Advisory Council (ICCAC).

- **Nutrient management:** Increasing the efficiency and improving the distribution of nutrient application can reduce on-field application of nitrogen and reduce formation of N_2O. Reductions may also occur when nitrogen runoff and leaching are reduced.
- **Wetlands and drainage:** Redesigning Iowa drainage systems with the consideration of GHG benefits can result in significant GHG benefits over the longer term through reduced nitrogen transport to water resources, which reduces N_2O emissions by reducing denitrification from wet and seasonally flooded croplands.
- **Expanded use of forest and agricultural biomass:** Expanding the use of biomass energy from residue removed from forested areas during treatments to reduce fire risk, from crop residues and purpose-grown crops, and from livestock manure/poultry litter can achieve GHG benefits by offsetting fossil fuel consumption (to produce either electricity or heat/steam). Programs to expand sustainably procured biomass fuel production will most likely be needed to supply a portion of the fuel mix for the renewable energy goals under the Energy Efficiency and Conservation (EEC) and Clean and Renewable Energy (CRE) Subcommittees.
- **Manure management and methane utilization:** The capture and utilization of methane from livestock manure can reduce GHG emissions through reduced methane emissions and through offsetting fossil fuel-based energy production and the associated GHG emissions. Additionally, implementing improved manure handling and storage programs, practices, and technologies can reduce methane emissions from animal operations.
- **Land management to promote sequestration benefits:** Significant opportunities exist through the adoption of a number of different land management practices that either reduce emissions or increase sequestration. These include increasing the use of conservation tillage practices, converting marginal agricultural land to higher-sequestration permanent cover, implementing conservation grazing practices, establishing afforestation programs, and increasing urban tree coverage.

- **Cellulosic biofuels:** Producing renewable fuels, such as ethanol from energy crops, crop residue, forestry residue, or municipal solid waste can produce significant reductions when they are used to offset consumption of fossil fuels (e.g., gasoline and diesel in the transportation sector). This is particularly true when these fuels are produced using processes and/or feedstocks that emit much lower GHG emissions than those from conventional sources (e.g., corn-based ethanol).
- **Improved on-farm (or first point of purchase) energy use and efficiency:** On-farm energy efficiency and renewable energy offer emission savings and reduced costs to land owners.
- **Changes in municipal solid waste management practices:** Concentrating on enhancing the source reduction, recycling, and organics management (e.g., composting practices) in the state can result in significant GHG emission reductions. Also, for waste remaining after full implementation of these "front-end" practices, appropriate GHG-beneficial "end-of-life" practices should be implemented, including enhanced landfill gas collection and utilization.

Key Challenges and Opportunities

Within the agriculture sector, the ICCAC recommends programs to promote farming practices that achieve GHG benefits, such as conservation tillage where soil management programs increase soil carbon levels, thereby indirectly sequestering carbon from the atmosphere. These programs were estimated to achieve reductions of approximately 9 $MMtCO_2e$ per year by 2020 through the implantation of conservation tillage practices on 75% of annual cropland by 2020.

Additionally, initiatives to reduce methane emissions from livestock manure through improved manure handling and storage practices and the capture and utilization of methane offer significant potential at low or negative costs. However, the feasibility of utilizing methane and displacing natural gas or electricity may be limited by the lack of sufficiently large dairy farms, seasonal variability, and the limited demand by nearby industries.

ICCAC policy option AFW-3 promotes the expanded use of biomass as an energy source for producing electricity, heat, or steam. Use of biomass to replace fossil fuels was estimated to reduce approximately 20 $MMtCO_2e$ by 2020. The ICCAC conducted a limited assessment of the available biomass resources in the state, which indicated that sufficient resources are available through 2020 to achieve the goals for both the cellulosic biofuels policy option (discussed below) and this biomass for energy option. A key challenge to the implementation of this policy is the proximity of the feedstock to the end user.

The ICCAC found significant opportunity in promoting biofuels production using feedstocks and production methods with superior GHG benefits (i.e., superior to conventional starch-based ethanol), almost 10 $MMtCO_2e$ by 2020. The ICCAC noted that there may be an overlap between the cellulosic biofuels option with agricultural options that seek to increase and maintain crop acreage in no-till production or in conservation management programs (i.e., in relation to using crop residue as an energy feedstock).

Within the forestry sector, afforestation, unmanaged grazed forested land, and urban forestry (all components of AFW-5) have the potential to deliver over 1 $MMtCO_2e$/year of GHG reductions in 2020. By 2020, these programs call for establishing 250,000 acres of new forestlands, improving management practices on 500,000 acres of unmanaged grazed forested land, and increasing the canopy cover of urban forest in Iowa communities by 25%.

AFW-8 and AFW-9 provide an integrated set of policy options for future management of municipal solid waste in Iowa. AFW-8 focuses on “front-end” waste management technologies—source reduction, recycling, and composting—while AFW-9 focuses on “end-of-use” waste management approaches. Source reduction and recycling will result in avoided landfill GHG emissions, as well as avoided product/packaging life-cycle GHG emissions. The combined front-end waste management elements produce substantial GHG savings—almost 5 $MMtCO_2e$ in 2020.

Overview of Policy Options and Estimated Impacts

As noted above, the nine policy options for the AFW sectors address a diverse array of activities. Taken as a whole, they offer significant cost-effective emission reductions, as shown in Table 6-3.

Figure 6-3 shows the breakdown of the cumulative emission reductions (2009–2020) anticipated from the recommended actions in the AFW sectors. The greatest emission reductions achieved (31%) come from implementation of land management to promote sequestration benefits (AFW-5). The majority of these reductions are associated with increasing the use of conservation tillage practices.

The expanded use of agriculture and forestry biomass feedstocks for electricity, heat, or steam production (AFW-3) also offers significant GHG reductions, even after accounting for overlap with the CRE Subcommittee policies. Significant reductions are also achieved through AFW-6 cellulosic fuel incentives (16%), AFW-8 waste management strategies (11%), and AFW-4 large-scale manure/methane management, capture, and utilization (9%). Emission reductions from waste management strategies are life-cycle GHG reductions that occur both within and outside of Iowa (resulting from lower energy use and GHG emissions to create, transport, and dispose of new products and packaging that are avoided through source reduction and recycling). It is important to note that AFW-3 and AFW-6 overlap with policy options under the Transportation and Land Use (TLU) and CRE Subcommittees, respectively. After accounting for overlap, these policies contribute a significantly smaller proportion to the AFW sector total.

Table 6-3, the summary list of policy options, and Figure 6-3, a pie chart showing the percentage of avoided greenhouse gas emissions by policy, are on the following two pages.

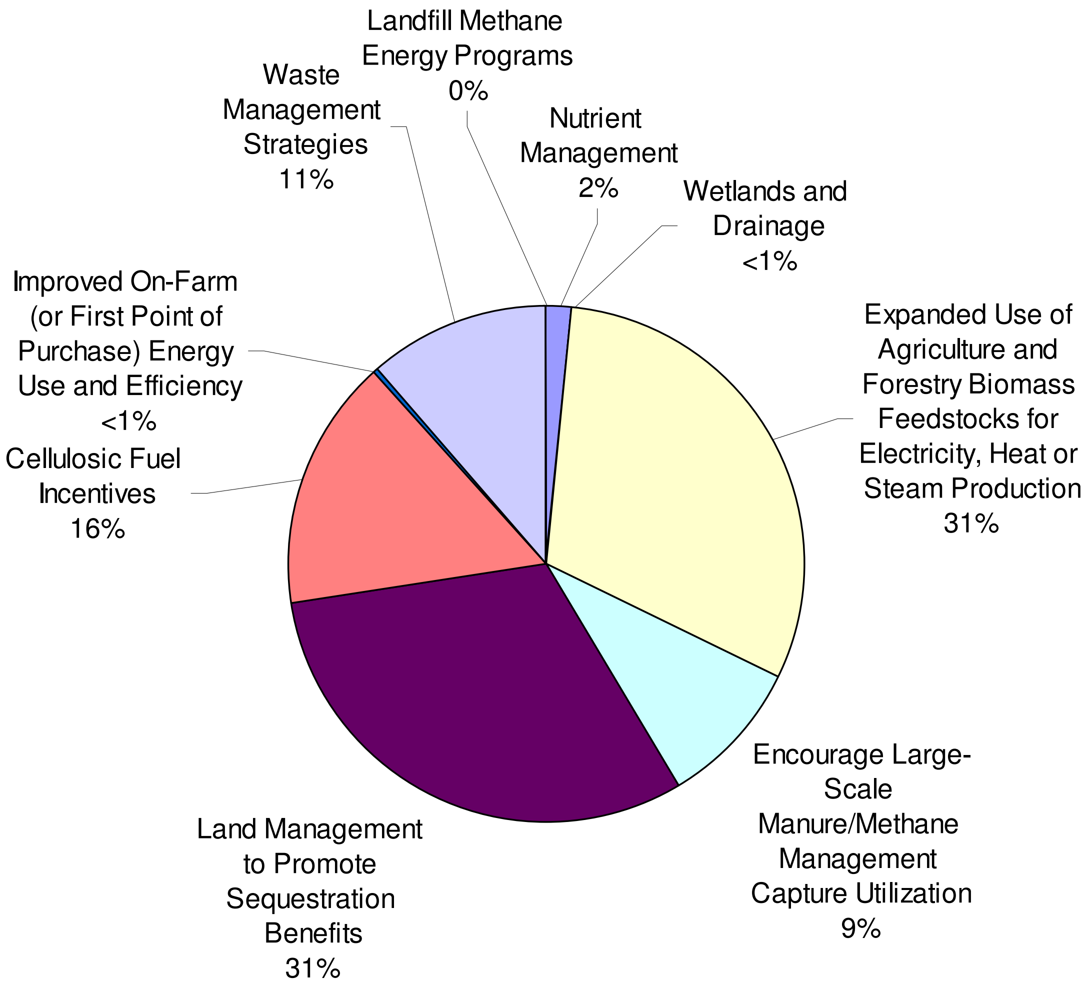
Table 6-3. Summary List of Policy Options

No.	Policy Option	GHG Reductions ($MMtCO_2e$) 2012	2020	Total 2009–2020	Net Present Value 2009–2020 (Million $)	Cost-Effectiveness ($/$tCO_2e$)	Level of Support
AFW-1	Nutrient Management						Majority (7 Objections)
	Increase Efficiency of Fertilizer	0.11	0.53	3.0	–$103	–$34	
	Seasonally Flooded Areas	0.002	0.009	0.05	$10	$194	
	Improved Nutrient Distribution	0.02	0.1	0.55	$373	$693	
AFW-2	Wetlands and Drainage	0.01	0.16	0.57	$120	$218	Super Majority (5 Objections)
AFW-3	Expanded Use of Agriculture and Forestry Biomass Feedstocks for Electricity, Heat, or Steam Production	4.4	20	113	$4,281	$38	Unanimous
AFW-4	Encourage Large-Scale Manure/Methane Management Capture Utilization						Unanimous
	Methane Management Capture Utilization	0.8	3	17	$63	$4	
	Manure Management	0.2	0.7	4.6	–$38	–$8	
AFW-5	Land Management to Promote Sequestration Benefits						Unanimous
	Conservation Tillage	2.9	9	56	–$6	–$0.1	
	Agriculture Land Conversion	0.1	0.4	2.6	$199	$76	
	Conservation Grazing	0.1	0.3	1.7	–$116	–$67	
	Afforestation	0.2	0.6	4.1	$216	$53	
	Unmanaged Grazed Forested Land	0.3	0.8	5.5	$93.7	$17	
	Urban Forestry	0.1	0.4	2.4	–$99	–$41	
AFW-6	Cellulosic Biofuel*	2.0	9.8	49	–$1,410	–$29	Unanimous
AFW-7	Improved On-Farm (or First Point of Purchase) Energy Use and Efficiency						Unanimous
	Renewable Energy	0.02	0.08	0.5	$23	$51	
	Energy Efficiency	0.2	0.9	5.9	–$610	–$104	
AFW-8	Waste Management Strategies	1.5	4.1	26.5	–$220	–$8	Unanimous
AFW-9	Landfill Methane Energy Programs	0.2	0.8	4.8	$4	$0.8	Unanimous
	Sector Total After Adjusting for Overlaps	**11**	**37**	**233**	**$2,139**	**$9**	
	Reductions From Recent Actions	**0.0**	**0.0**	**0.0**	**$0.0**	**$0.0**	
	Sector Total Plus Recent Actions	**11**	**37**	**233**	**$2,139**	**$9**	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons carbon dioxide equivalent; $/$tCO_2e$ = dollars per ton of carbon dioxide equivalent.

* Note that the costs/savings of this option include a $1.01/gallon federal subsidy for cellulosic ethanol.

Figure 6-3. Percentage of avoided greenhouse gas emissions by policy



Agriculture, Forestry, and Waste Management Sectors
Policy Descriptions

The AFW sectors include emission mitigation opportunities related to the use of biomass energy, protection and enhancement of forest and agricultural carbon sinks, control of agricultural CH_4 and N_2O emissions, production of renewable liquid fuels, production of additional biomass energy, forestation on nonforested lands, and an increase in municipal solid waste source reduction, recycling, composting, and landfill gas collection.

AFW-1 Nutrient Management

This policy option promotes the use of improved manure management practices that reduce GHG emissions associated with manure handling and storage, including manure composting to reduce CH_4 emissions, movement of manure from nutrient-rich to nutrient-deficient areas, and improved methods for application to fields (for reduced N_2O emissions). Application improvements include incorporating manure into soil instead of surface spraying or spreading.

AFW-2 Wetlands and Drainage

This policy promotes the redesigning of drainage infrastructure over the next fifty years. Designing to reduce nitrogen transport to water resources also reduces N_2O emissions in Iowa and downstream, with significant global GHG benefits over the longer term. This is due to the function of strategically targeted and designed denitrification wetland systems and the long life of both the wetlands and the drainage systems.

AFW-3 Expanded Use of Agriculture and Forestry Biomass Feedstocks for Electricity, Heat, or Steam Production

This policy dedicates a sustainable quantity of biomass from agricultural industry residues, agricultural lands, wood industry process residues, unused forestry residues, agroforestry resources, and dedicated energy crops to efficient conversion to heat, steam, or electricity. This biomass should be collected and used in an environmentally acceptable manner, considering proper facility siting and feedstock use (e.g., proximity of users to biomass, impacts on water supply and quality, control of air emissions, cropping management, nutrient management, soil and nonsoil carbon management, and impacts on biodiversity and wildlife habitat). The objective is to create concurrent reduction of GHG emissions due to displacement of fossil fuel, considering life-cycle emissions associated with viable collection, hauling, and energy conversion and distribution systems. Local electricity or steam production yields the greatest net energy payoff.

Note: This option is linked with some Clean and Renewable Energy (CRE) options (e.g., CRE-2[4] *and CRE-13). AFW-3 focuses on the supply elements of the implementation of a biomass-to-energy program (e.g., availability, collection, and distribution), while the CRE options focus on the demand side (e.g., generation infrastructure and purchasing for consumers).*

AFW-4 Encourage Large-Scale Manure/Methane Management Capture Utilization

This policy is aimed at improving manure handling and storage practices; reducing methane emissions from livestock manure by installing large-scale anaerobic digester systems at concentrated animal feeding operations (CAFOs); and utilizing methane captured from the digesters to create heat or power, which offsets fossil fuel-based energy production and the associated GHG emissions. This option is focused on implementing these projects on a large scale (e.g., community-based systems or large CAFOs).

AFW-5 Land Management to Promote Sequestration Benefits

This policy option addresses a range of land management practices. On cultivated lands, the amount of carbon stored in the soil can be increased by the adoption of such practices as continuous conservation and no-till cultivation. By minimizing mechanical soil disturbance, these practices reduce the oxidation of soil carbon compounds and allow more stable aggregates to form. Converting marginal agricultural land used for annual crops to permanent cover (e.g., grassland/rangeland) increases the soil carbon or carbon in biomass. Rotational grazing, where animals are regularly moved from field to field, can reduce soil disturbance, improve plant vigor, and enhance soil carbon levels. Establishing forests on land that has not historically been forested (e.g., afforestation of agricultural land) and maintaining and improving the health and longevity of urban trees enhance the carbon stored in tree biomass. Indirect emission reductions from urban forestry may also occur by reducing heating and cooling needs as a result of planting shade trees.

AFW-6 Cellulosic Biofuels

This policy promotes sustainable in-state production of cellulosic biofuels from agriculture, forestry, and MSW feedstocks (raw materials) to displace the use of conventional petroleum-based fuels. It also promotes advanced biofuel production systems that improve the embedded energy content and carbon profile of biofuels. It focuses on feedstocks that favor energy production and are carbon neutral or carbon negative and that have multiple positive environmental benefits, such as maintaining carbon sequestration potential and soil productivity, and decreasing water and fossil fuel inputs during their production. This could help provide a strong economic market within the state and reduce GHG emissions through avoided fossil fuel consumption. This option also promotes the in-state development of cellulosic material and perennials that are able to be utilized.

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[4] CRE-2 incorporates or adjusts for biomass used by CRE-5 and CRE-8.

Note: This option is linked with option TLU-10. AFW-6 focuses on the supply elements of the implementation of a biofuels program, while TLU-10 focuses on the demand side (e.g., vehicle technology requirements, E10, E85).

AFW-7 Improved On-Farm (or First Point of Purchase) Energy Use and Efficiency

On-farm energy efficiency and renewable energy offer emission savings and reduced costs to landowners. Renewable energy can be produced and used on site at agriculture operations (e.g., installing solar or wind power, using hydropowered generators for irrigation, and converting diesel farm equipment to more efficient or renewable energy technology). The use of energy-efficient products, such as improved grain dryers, heat exchangers (dairy), electric motors, and energy-efficient building design, also offers significant potential for GHG reduction.

AFW-8 Waste Management Strategies

This policy option focuses on reducing the volume of waste from residential, commercial, and government sectors through programs that reduce the generation of waste. Reducing generation at the source reduces landfill emissions and upstream production emissions. Increasing recycling or reusing waste limits GHG emissions associated with landfill methane generation and with the production and transport of products and packaging from virgin materials (noting that different recycled materials will exhibit different costs and benefits on a life-cycle basis). Increasing recycling programs, creating new recycling programs, providing incentives for recycling construction materials, developing markets for recycled materials, and increasing average participation and recovery rates for all existing recycling programs can reduce overall emissions. Increasing organics management programs, such as composting, reduces GHG emissions associated with landfilled organic waste.

AFW-9 Landfill Methane Energy Programs

This policy promotes activities that further reduce GHG production by encouraging the use of energy recovery technologies. The focus is on the utilization of methane at landfills through the enabling of anaerobic digesters to capture and utilize that energy through electric power, heating, or liquefied natural gas. These technologies will help reduce GHG emissions from waste management, while producing cleaner energy. They make a twofold contribution to climate protection, by reducing emissions of methane and other GHGs into the atmosphere (via collection and control), and offsetting energy that would have otherwise come from fossil fuels. Methane gas generation by landfills is a GHG reduction strategy that may benefit from a cap-and-trade system, encouraging landfills to install flares at a minimum and possibly achieve electric generation if the economic incentives are sufficient.

Chapter 7
Cross-Cutting Issues

Overview of Cross-Cutting Issues

Some issues relating to climate policy cut across multiple sectors. The Iowa Climate Change Advisory Council (ICCAC) addressed such issues explicitly in a separate Cross-Cutting Issues (CC) Subcommittee (SC). Cross-cutting options typically encourage, enable, or otherwise support emission mitigation activities and/or other climate actions. The types of policies considered for this sector are not readily quantifiable in terms of greenhouse gas (GHG) reductions and costs or cost savings. Nonetheless, if successfully implemented, they help build a foundation for other options and will contribute to GHG emission reductions and implementation of the ICCAC's policy options described in Chapters 3–6 of this report.

The CC SC developed options for eight policies (see Table 7-1) that were then reviewed, revised, and ultimately adopted by the ICCAC members present and voting. Seven of the options are focused on enabling GHG emission reductions and mitigation activities, while one (CC-7-Adaptation and Vulnerability) addresses adaptation to the changes expected from the effects of GHGs that will remain in the atmosphere for decades.

Key Challenges and Opportunities

The ICCAC was charged with identifying a baseline case and GHG reduction scenarios with at least one of those scenarios aimed at achieving a 50% reduction of GHGs below a baseline year by 2050. in addition, the ICCAC chose to look at a second scenario aimed at achieving a 90% reduction of GHGs below the baseline by 2050. ICCAC established 2005 as the baseline year and identified a short-term target of reducing the 2005 GHG baseline by 1% by 2012 and a mid-term target of 11% by 2020 on the way to a 50% reduction by 2050. In the second scenario ICCAC identified a short-term target of reducing the 2005 GHG baseline by 3% by 2012 and a mid-term target of 22% by 2020 on the way to a 90% reduction by 2050.

The ICCAC based its options on its review of the potential overall emission reduction estimates (as compared to the GHG emissions inventory and forecast for business as usual) for 37 of 54 policy options for which emission reductions were quantified. It also considered the goals and scenarios adopted by several other states in its deliberations. While 17 other ICCAC policy options were not readily quantifiable, some of them would most likely achieve additional reductions, including several of the Cross-Cutting policy options.

The ICCAC just completed its first year of operation and has at least two more years to function under the original legislation. One of the first challenges it has is to develop its ongoing role and the priority areas it should focus on first following completion of this report. It will need to develop more detailed implementation plans and strategies to carry out many of the initiatives proposed herein. A key challenge will be to identify resources that can be used to facilitate development of such implementation plans and strategies. A closely related challenge for the state will be to identify available resources needed to implement many of the initiatives outlined in this report. ICCAC will need to work closely with the Iowa Department of Natural Resources (DNR), the Iowa Power Fund and the Iowa Energy Center to examine these opportunities.

Table 7-1. Cross- Cutting Issues Policy Options

Policy No.	Policy Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2020 (Million $)	Cost-Effective-ness ($/t$CO_2$e)	Status of Option
		2012	2020	Total 2009–2020			
CC-1	GHG Inventories, Forecasting, Reporting, and Registry	*Not Quantified*					Unanimous
CC-2	Statewide GHG Reduction Scenarios	*Not Quantified*					Majority (4 Objections)
CC-3	State and Local Government GHG Emissions (Lead by Example)	*Not Quantified*					Unanimous
CC-4	Public Education and Outreach	*Not Quantified*					Unanimous
CC-5	Tax and Cap Policies—Lead Transferred to the CRE SC	*Not Quantified*					Transferred
CC-6	Seek Funding for Implementation of ICCAC options	*Not Quantified*					Unanimous
CC-7	Adaptation and Vulnerability	*Not Quantified*					Unanimous
CC-8	Participate in Regional and Multi-state GHG Reduction Efforts	*Not Quantified*					Unanimous
CC-9	Encourage the Creation of a Business-Oriented Organization To Facilitate Investment in Climate-Related Business Opportunities and To Share Information and Strategies, Recognize Successes, and Support Aggressive GHG Reduction Goals	*Not Quantified*					Unanimous

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t$CO_2$e = dollars per metric ton of carbon dioxide equivalent; ICCAC = Iowa Climate Change Advisory Council; CRE = Clean and Renewable Energy; SC = ICCAC.

Overview of Policy Options and Estimated Impacts

Cross-cutting issues include policies that apply across the board to all sectors and activities. Cross-cutting options typically encourage, enable, or otherwise support emission mitigation activities and/or other climate actions. The ICCAC developed eight such policy options for implementation in Iowa. All are enabling policy options that are not quantified in terms of tons of GHG reduction or costs.

Detailed descriptions of the individual Cross-Cutting policy options as presented to and approved by the ICCAC can be found in Appendix J of this report. Following are highlights of some of the options approved by ICCAC:

The state needs to enhance its capacity to conduct inventory, forecasting, reporting and registry functions. It should have the capacity to inventory and forecast all statewide anthropogenic sources and sinks annually with projections out twenty years. It needs to develop a mandatory GHG emission reporting system for sources over de minimis levels and will need to formulate consistent protocols to use in doing so.

ICCAC is presenting two GHG reduction scenarios to the Governor and Legislature to meet a 50% and a 90% reduction level, respectively, below 2005 levels by 2050. It is anticipated that the Legislature will take up the issue of goals and scenarios in the 2009 session and may provide more specific direction regarding selection of short, mid and long-term reduction goals and scenarios. If so the ICCAC may be called on to assist in prioritizing and designing more detailed implementation strategies. The state should also develop a tracking system to measure progress over time in achieving GHG reductions against the above goals and scenarios.

The state has already embarked on numerous initiatives to reduce GHG emissions and will need to continue to do so. ICCAC suggests that the Governor should consider establishing a Governors Challenge to the state agencies and people of Iowa to find more reductions. The state should also assist local governments in their efforts to join the state in "leading by example" to find more reductions. The state and local governments should find additional energy efficiencies and GHG reductions in their procurements for buildings, vehicle fleets and office equipment.

A key to building a broad base of awareness and support for the policy options included in this report will require a public education and outreach effort. The ICCAC has identified numerous strategies over the next three years to do so in conjunction with academic, business, local government and other partners in this process.

Given Iowa's vulnerability to impacts of climate change the state should develop a Climate Change Adaptation Plan to identify plan for and manage these impacts.

The state is a participant in the Midwestern Governors Climate Accord and Energy Security and Climate Stewardship Platform. The state should continue this proactive engagement with other states in the region in developing cost-effective multi-state reduction strategies.

Finally, it has been demonstrated that there are numerous economic and employment opportunities associated with implementation of many of the GHG reduction policy options being recommended by ICCAC. The Council encourages the creation of a business oriented entity to capitalize on these opportunities to create green jobs in Iowa and to promote new business ventures in this arena.

Cross-Cutting Issues
Policy Descriptions

CC-1. Inventories, Forecasting, Reporting and Registry

Policy Description

Greenhouse gas (GHG) emission inventories and forecasts are essential for understanding the magnitude of all emission sources and sinks (both man made [anthropogenic] and natural), the relative contribution of various types of emission sources and sinks to total emissions, and the factors that affect trends over time. Inventories and forecasts help to inform state leaders and the public on statewide trends and mitigation opportunities and in verifying GHG reductions associated with implementation of action plan initiatives.

GHG reporting supports tracking and management of emissions. It can help sources identify emission reduction opportunities, reduce risks associated with possible future GHG mandates through early participation, and construct periodic state GHG inventories. GHG reporting is a precursor for sources to participate in GHG reduction programs, and/or a GHG emission registry, as well as to secure "baseline protection" (i.e., credit for early reductions).

A GHG registry enables recording of GHG emissions in a central repository with "transaction ledger" capacity to support tracking, reductions management, and "ownership" of documented *emission* reductions; it offers recognition opportunities; and/or provides a mechanism for regional, multi-state, and cross-border cooperation. Properly designed registry structures also provide a foundation for possible future trading programs.

CC-2. Statewide GHG Reduction Scenarios

Policy Description

To date, Iowa has not adopted any mandatory statewide GHG reduction goals. Iowa Code Reference 455B.152(3)(a) and (b) and 455B.152(4), which the Iowa legislature passed in 2007, requires the IDNR to establish a GHG inventory and a voluntary GHG gas registry for tracking, managing, and crediting entities in the state that reduce their generation of GHGs. Under the same legislation, the ICCAC is required to recommend a baseline year from which to calculate future GHG reductions, and to develop multiple scenarios to reduce GHG emissions in Iowa by 2050, including interim years with targeted goals. A 50% reduction scenario by 2050 was specified in the legislation, and the ICCAC in its January 1, 2008, interim report recommended an additional scenario of 90% reduction by 2050, with subsequent scenarios to be determined for interim years of 2012 and 2020. The baseline year for Iowa is recommended in the Interim Report to be 2005.

Governor Culver issued the Green Government Executive Order (Executive Order 6) on February 21, 2008, which sets the goal of reducing "the use of electricity, natural gas, fuel oil and water in all state office buildings by at least 15% overall in the next 5 years, taking into account growth in the state workforce and/or changes in building operations." This follows Governor Vilsack's Executive Order 41 to reduce electricity and natural gas by 15% by 2010 from the year 2000 baseline. These executive orders are establishing policy goals of greater than 1.5% per year reductions in the use of fossil fuels for state building operations in the near term, and presumably they will result in similar GHG reductions for state buildings if fully implemented.

Legislation in 2007 also produced the Iowa Office of Energy Independence (OEI) and the Iowa Plan for Energy Independence. The plan "shall provide cost effective options and strategies for reducing the state's consumption of energy, dependence on foreign sources of energy, use of fossil fuels, and GHG emissions. The options and strategies developed in the plan shall provide for achieving energy independence from foreign sources of energy by the year 2025." In addition, the Midwestern Governors Association adopted the Energy Security and Climate Stewardship Platform for the Midwest, which specifies an energy efficiency goal of at least 2% per year reduction in natural gas and electricity use to be achieved by 2015.

Transitioning from the fossil fuel age to a new mix of energy sources like energy conservation, efficiency, cellulosic biofuels, and wind power is already creating "green collar" jobs and invigorating the economy in Iowa. Early action alternatives have much greater effect in mitigating future climate change and its impacts compared to later reductions. Reductions for developed countries in the range of 25%–40% by 2020 and 80%–95% by 2050 were discussed in the initial Bali round of the Framework Convention on Climate Change in December 2007. It is recognized that "substantial deviation from baseline" will also be necessary for developing economies in Latin America, the Middle East, East Asia, and centrally planned Asia.

CC-3. State and Local Government GHG Emissions (Lead by Example)

Policy Description

State of Iowa property belongs to all Iowans, and its expansion and upkeep is funded by Iowans' tax dollars. The same is true for each Iowan's public school and city or county government. The majority of Iowans believe strong action is required to reduce GHG emissions. Government buildings, office equipment, and vehicles are present in every Iowa community and are among the biggest energy consumers in the state. As such, they represent a very significant opportunity for changing the course of Iowa's energy use.

State and local governments should be at the forefront of energy efficiency and renewable energy. By installing the most efficient technology and tapping local power sources, governments can reduce their own GHG emissions, create a significant opportunity for businesses to create and install efficient and/or renewable technologies, create a tested pool of Iowa-specific best practices, build communities' sense of pride in their governments (perhaps boosted by tax decreases and economic benefit), and spur residents and businesses to pursue energy efficiency and renewable energy.

CC-4. Public Education and Outreach

Policy Description

The goal of climate change education extends well beyond the goal of conventional education, because it seeks not only to impart cognitive knowledge, but also to translate knowledge into positive action. Failure to appreciate this distinction has led to stagnation and lack of successful approaches in creating a public that is literate about issues relevant to climate change. According to the seminal work of Hungerford and Volk (1990),[1] there are three levels of environmental awareness:

- *Simple Awareness*—Knowing about the existence and importance of an environmental issue, but being unfamiliar with its complexities and having little relationship to personal change or action.
- *Personal Conduct Knowledge*—Understanding an environmental issue that lends itself to changes in personal conduct, but does not require detailed comprehension.
- *Environmental Literacy*—The outcome of a sound program of environmental education in which the learner progresses to deeper knowledge, and can apply it to address complex environmental issues and make wiser decisions.

Public education and outreach programs should address the public's responsibility to maintain clean air, pure water, and fertile soil for their children and future generations. Adding to the challenge is that environmental information absorbed by the public stems from a diverse and unconnected smattering of sources that includes television, radio, print media, environmental groups, government publications, the Internet, the classroom, personal readings, chatting with friends, and other experiences. In general there is no quality control for the information. In the end, those seeking to learn about environmental issues are often left with little more than a collection of factoids, numerous and often conflicting opinions, and very little understanding—not enough to get beyond the "simple awareness" level cited above. Undoubtedly, excellent resources are available for public environmental education, but they may be lost in the background noise emanating from the cacophony of messages from disparate other sources.

There is not much detailed information about the level of climate change awareness in Iowa. The available evidence, however, suggests that it may not extend much past "simple awareness," because there doesn't appear to be significant change in personal conduct with respect to steps that would mitigate climate change. For example, optimizing energy efficiency is a major strategy for reducing GHG emissions, but a recent comprehensive study commissioned by the Iowa Utility Association shows enormous untapped potential in realizing that goal for Iowa.

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[1] Hungerford, H.R. and T.L. Volk (1990). Changing learner behavior through environmental education. *Journal of Environmental Education* Spring; 21(3):8–21. Available at: http://eric.ed.gov:80/ERICWebPortal/custom/portlets/recordDetails/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=EJ413973&ERICExtSearch_SearchType_0=no&accno=EJ413973.

There is an urgent need for a comprehensive, objective, and authoritative climate change education campaign for Iowa that will improve the knowledge base and motivate individuals, communities, and organizations to take action to will reduce their GHG emissions**.**

CC-5. Tax and Cap Policies

Policy Description

The lead for developing this policy option was transferred by the ICCAC to the Clean and Renewable Energy Subcommittee. (See Chapter 4.)

CC-6. Seek Funding and Financing for Implementation of ICCAC Options

Policy Description

Funding must be obtained to implement some ICCAC options. In Iowa there are two organizations that fund projects related to the ICCAC goals: the Iowa Power Fund and the Iowa Energy Center. (See Appendix J for a description of these organizations.) Out-of-state and federal funding sources should also be considered. For all sources of funding, success would be enhanced through partnerships with other organizations and agencies.

CC-7. Adaptation and Vulnerability

Policy Description

Because of the existing buildup of GHGs in the atmosphere from past and current emissions, Iowa will experience effects of climate change for years to come, even if immediate action is taken to reduce its future GHG emissions. While Iowa may be less dramatically affected than coastal or arid regions of the country, the state will need to adapt to different sets of vulnerabilities, which may include impacts such as increased public health risks, urban infrastructure demands, and refugee movement. Thus, it is essential that the state develop a plan to manage the projected impacts of global climate change affecting Iowa, while broader mitigation efforts to lower atmospheric concentrations worldwide are being developed and implemented. Part of our adaptation must include strategies for mitigating and addressing human suffering, so that no one segment of the population or any of Iowa's natural resources or natural heritage sites suffers catastrophically.

CC-8. Participate in Regional and Multi-State GHG Reduction Efforts

Policy Description

Regional approaches undertaken in collaboration with partner states or other organizations can offer broader and more economically efficient opportunities to reduce GHG emissions across Iowa’s economy. Iowa has already joined several organizations, including the Midwestern Greenhouse Gas Accord, the Midwestern Governors Energy Security and Climate Stewardship Platform, and multistate Climate Registry initiatives. These developments should be continued and should form the basis for Iowa’s own programs. To the extent that Iowa’s needs may not be fully met by these initiatives, Iowa should consider developing supplemental or ancillary registry capacity or opportunity. (See CC-1.)

CC-9. Encourage the Creation of a Business-Oriented Organization to Facilitate Investment in Climate-Related Business Opportunities and to Share Information and Strategies, Recognize Successes, and Support Aggressive GHG Reduction Goals

Policy Description

Numerous economic and business opportunities can arise from implementing a comprehensive GHG reduction strategy for Iowa. A variety of job creation possibilities are implicit in new approaches to transportation, land use, green construction, recycling and reuse, and energy-efficient products and services. The state should work with public and private entities to identify, promote, and finance these opportunities for economic development and job creation. Iowa should also work to keep existing green jobs in Iowa and prevent them from moving out of state.

The growth of the "green industry" has the potential to benefit low- to mid-skill workers who can no longer depend on traditional manufacturing jobs. Since green jobs require applied technical skills, they generally pay decent wages. Unlike blue-collar jobs, many green-collar jobs require local employees and cannot be outsourced.

Another component of economic development is the promotion of buying locally-produced foods, goods, and products. Consumer support for the local economy helps sustain Iowa businesses, jobs, and tax base, while reducing the consumption of fuel (and CO_2 emissions) in the transportation of foods and products over great distances.

Appendix A
Creation of Iowa Climate Change Advisory Council (ICCAC)

The Iowa Climate Change Advisory Council was created pursuant to Section 5 of Senate File 485 located at page 3, line 5 of the law, reproduced below.

SENATE FILE 485

AN ACT RELATING TO GREENHOUSE GAS EMISSIONS.

BE IT ENACTED BY THE GENERAL ASSEMBLY OF THE STATE OF IOWA:

Section 1. Section 455B.131, Code 2007, is amended by adding the following new subsection:

NEW SUBSECTION. 6A. "Greenhouse gas" means carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

Sec. 2. Section 455B.134, subsection 3, paragraph d, Code 2007, is amended to read as follows:

d. (1) All applications for conditional permits for electric power generating facilities shall be subject to such notice and opportunity for public participation as may be consistent with chapter 476A or any agreement pursuant thereto under chapter 28E. The applicant or intervenor may appeal to the commission from the denial of a conditional permit or any of its conditions. For the purposes of chapter 476A, the issuance or denial of a conditional permit by the director or by the commission upon appeal shall be a determination that the electric power generating facility does or does not meet the permit and licensing requirements of the commission. The issuance of a conditional permit shall not relieve the applicant of the responsibility to submit final and detailed construction plans and drawings and an application for a construction permit for control equipment that will meet the emission limitations established in the conditional permit.

(2) In applications for conditional permits for electric power generating facilities the applicant shall quantify the potential to emit greenhouse gas emissions due to the proposed project.

Sec. 3. Section 455B.134, subsection 3, Code 2007, is amended by adding the following new paragraph:

NEW PARAGRAPH. g. All applications for construction permits or prevention of significant deterioration permits shall quantify the potential to emit greenhouse gas emissions due to the proposed project.

Sec. 4. NEW SECTION. 455B.152 GREENHOUSE GAS INVENTORY AND REGISTRY.

1. DEFINITIONS. For purposes of this section, "greenhouse gas" means carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, or sulphur hexafluoride.

2. GREENHOUSE GAS INVENTORY.

a. By January 1, 2008, the department shall establish a method for collecting data from producers of greenhouse gases regarding generated greenhouse gases. The data collection method shall provide for mandatory reporting to collect information from affected entities individually and shall include information regarding the amount and type of greenhouse gases generated, the type of source, and other information deemed relevant by the department in developing a baseline measure of greenhouse gases produced in the state.

b. The department may allow a series of reporting requirements to be phased in over a period of time and may provide for phasing in by producer sector, geographic area, size of producer, or other factors. The reporting requirements shall apply to the departments, agencies, boards, and commissions of the state, in addition to any other entities subject to the reporting requirements established by the department.

3. GREENHOUSE GAS REGISTRY.

a. The department shall establish a voluntary greenhouse gas registry for purposes of cooperating with other states in tracking, managing, and crediting entities in the state that reduce their generation of greenhouse gases or that provide increased energy efficiency.

b. The department shall develop a mechanism to coordinate the information obtained in the greenhouse gas inventory with the greenhouse gas registry.

4. AVAILABILITY. By January 1, 2009, the greenhouse gas registry shall be made available on an internet website.

Sec. 5. NEW SECTION. 455B.851 IOWA CLIMATE CHANGE ADVISORY COUNCIL.

1. The department shall create an Iowa climate change advisory council consisting of twenty=three voting members serving three=year staggered terms and four nonvoting, ex officio members.

2. a. The voting members shall be appointed by the governor and shall represent the following:

(1) The university of Iowa center for global and regional environmental research.

(2) The university of northern Iowa center for energy and environmental education.

(3) The Iowa farm bureau.

(4) The Iowa public transit association.

(5) Rural electric cooperatives.

(6) Investor=owned utilities.

(7) Municipal utilities.

(8) The Iowa utilities board.

(9) One association with environmental interests or activities.

(10) One association with conservation interests or activities.

(11) The international brotherhood of electrical workers.

(12) The Iowa association of business and industry.

(13) The Iowa energy center.

(14) The Iowa renewable fuels association.

(15) The office of consumer advocate of the department of justice.

(16) A representative from local government.

(17) The director of the office of energy independence.

(18) A manufacturer of equipment used for alternative energy production.

(19) The department of agronomy at Iowa state university of science and technology.

(20) Four members of the general public.

b. The four nonvoting, ex officio members shall consist of four members of the general assembly, two from the senate and two from the house of representatives, with not more than one member from each chamber being from the same political party. The two senators shall be designated by the majority leader of the senate after consultation with the president and the minority leader of the senate. The two representatives shall be designated by the speaker of the house of representatives after consultation with the majority and minority leaders of the house of representatives.

3. Voting members of the council shall serve at the pleasure of the governor and shall serve without compensation.

4. The chairperson of the council shall be designated by the governor and may convene the council at any time.

5. A vacancy in the membership shall not impair the right of a quorum to exercise all the rights and perform all the duties of the council. A majority of the council members then appointed constitutes a quorum. A majority vote of the quorum is required for council action.

6. The department shall provide necessary staff assistance to the council.

7. After consideration of a full range of policies and strategies, including the cost=effectiveness of the strategies, the council shall develop multiple scenarios designed to reduce statewide greenhouse gas emissions including one scenario that would reduce such emissions by fifty percent by 2050. The council shall also develop short=term, medium=term, and long=term scenarios designed to reduce statewide greenhouse gas emissions and shall consider the cost=effectiveness of the scenarios. The council shall establish a baseline year for purposes of calculating reductions in statewide greenhouse gas emissions. The council

shall submit the proposal to the governor and the general assembly by January 1, 2008.

8. The council may periodically adopt recommendations designed to encourage the reduction of statewide greenhouse gas emissions.

9. By September 1 of each year, the department shall submit a report to the governor and the general assembly regarding the greenhouse gas emissions in the state during the previous calendar year and forecasting trends in such emissions. The first submission by the department shall be filed by September 1, 2008, for the calendar year beginning January 1, 2007.

JOHN P. KIBBIE
President of the Senate

PATRICK J. MURPHY
Speaker of the House

I hereby certify that this bill originated in the Senate and is known as Senate File 485, Eighty=second General Assembly.

MICHAEL E. MARSHALL
Secretary of the Senate

Approved ________, 2007

CHESTER J. CULVER
Governor

Appendix B
Description of the Iowa Climate Change Action Council Process

The following memo laying out the work plan and process the Iowa Climate Change Advisory Council (ICCAC) would use in developing its recommendations was presented at the Council's second meeting, December 13, 2008.

Memorandum

To: Iowa Department of Natural Resources

CC: Dr. Jerry Schnoor, University of Iowa, ICCAC Chair

From: The Center for Climate Strategies

Re: Work Plan for the Iowa Climate Change Advisory Council Process

Date: December 13, 2007

This memorandum outlines the proposed work plan for the Iowa Climate Change Advisory Council (ICCAC). Initially, the purpose and goals of the process are described, including the proposed general outline of the Final Report and the overall timing and milestones. Also described are the design of the process, including key principles and guidelines. A set of general ICCAC meeting agendas follows, showing the progression of the process over time. Finally, an outline of the budget and funding plan are presented, along with a description of the project team.

Purpose and Goals of the Iowa Climate Change Advisory Council

In the 2007 legislative session, Gov. Culver signed into law SF 485, which requires the development of a greenhouse gas (GHG) inventory and voluntary registry and also establishes the Iowa Climate Change Advisory Council. This Council is charged with identifying opportunities for Iowa to respond to the challenge of global climate change by becoming more energy efficient and energy independent while spurring economic growth. The Governor and the Iowa Department of Natural Resources (IDNR) have asked the Center for Climate Strategies (CCS) to assist the ICCAC in developing an Iowa climate action plan. ICCAC members voted to endorse this request and role by CCS at its opening meeting on October 18 and on a subsequent ICCAC conference call on November 15, 2007. Through this memorandum, we are responding to the request, asking for review and approval of our proposed work plan and making a commitment to provide substantial cost share to ensure success of the project. Upon approval, we propose to move quickly to support the process.

The ICCAC is a broad-based group of Iowa stakeholders charged with making a comprehensive set of state-level policy recommendations to the Governor and General Assembly in a climate action plan. CCS proposes to facilitate the ICCAC in a consensus-building process, in close coordination with the IDNR and the ICCAC Chair, Dr. Jerry Schnoor (professor of civil and environmental engineering at the University of Iowa).

The goals of the ICCAC process include

1. Review and approval of a current and comprehensive planning inventory and forecast of GHG emissions in Iowa from 1990 to 2025.[1]
2. Development of a recommended set of individual policy recommendations and scenarios to reduce GHG emissions in Iowa to meet one goal of 50% reduction by 2050, as well as short-term, medium-term, and long-term scenarios to reduce statewide GHG emissions while considering the cost-effectiveness of the scenarios.
3. Development of recommended baselines for establishing targets for statewide reductions in the amount of GHGs emitted by activities in Iowa by January 1, 2008, as well as establishing short-term, medium-term, and long-term GHG emission reduction targets by December 31, 2008.

Final Report

The ICCAC Final Report to the Governor and General Assembly is expected no later than December 31, 2008. It will compile and summarize the final recommendations of the ICCAC and cover the following areas:

1. Executive Summary
2. History and Status of State Actions
3. Inventory and Forecast of Iowa GHG Emissions
4. Proposed Goals for Reducing GHG Emissions in Iowa
5. Recommended Policy Actions by Sector
    a. Energy Supply
    b. Residential, Commercial, and Industrial
    c. Transportation and Land Use
    d. Agriculture, Forestry, and Waste Management
    e. Cross-Cutting Issues (such as Emissions Reporting, Registries, Education, and Goals)
6. Technical Appendixes

Timing and Milestones

The first in-person meeting of the ICCAC was held October 18, 2007. The next meeting is scheduled for December 17, 2007. A total of six additional meetings will be held according to the schedule outlined below. CCS will issue the Final Report of the ICCAC after its final meeting. For each of the five Subcommittees (SCs) of ICCAC, two or more teleconference calls or meetings will be held between each of the ICCAC meetings.

[1] This inventory is for planning and forecasting purposes only and may differ from the GHG inventory for 2007 that the IDNR is required by SF 485 to submit to the Governor and General Assembly by September 1, 2008.

The following draft schedule is suggested for planning purposes. Mid-course alterations may be necessary.

Draft ICCAC Meetings Calendar

Date*	Meeting
October 18, 2007	1st ICCAC meeting—already held
December 17, 2007	2nd ICCAC meeting
January 1, 2008	Interim proposal to the Iowa Legislature on the establishment of baselines and 2050 GHG emissions targets
February 2008	3rd ICCAC meeting
April 2008	4th ICCAC meeting
June 2008	5th ICCAC meeting
September 2008	6th ICCAC meeting
December 2008	7th ICCAC meeting
December 31, 2008	Final ICCAC Report Expected
Between ICCAC Meetings	Subcommittee conference calls and meetings

*Note: dates are subject to change.

Design of the Process

The ICCAC process will follow the format of CCS policy development processes used successfully in a number of current and completed state-level climate action planning initiatives. The CCS planning process combines techniques of alternative dispute resolution, community collaborative decision making, and corporate strategic planning in a form of facilitation and technical analysis known as "evaluative facilitation." This consensus-building model supports informed and collaborative self-determination by a broadly representative group of designated stakeholders and technical experts. Activities of the ICCAC will be transparent, inclusive, stepwise, fact-based, and consensus driven. The ICCAC process will seek but not mandate consensus and will use formal voting to determine the level of support for individual options.

The ICCAC process relies on intensive use of information and interaction and requires substantial organization and communication among facilitators, participants, and technical analysts. CCS will oversee and manage this information exchange and decisional process in partnership with the IDNR. CCS will provide central coordination of ICCAC and SC activities through a project director team and a group of CCS technical facilitators and consultants. The CCS team provides close coordination of ICCAC, SC, facilitation, and technical support activities.

To facilitate learning, collaboration, and task completion by the ICCAC members, CCS will provide a series of decision templates for each step in the process, including a catalog of state actions with ranking criteria, a balloting form for identification of initial priorities for analysis, a policy option template for drafting and analysis of individual recommendations, a quantification principles and guidelines document for each SC, and a format for the Final Report.

CCS will also provide meeting materials for each ICCAC meeting and SC teleconference call, including a PowerPoint presentation of the discussion items, an agenda and notice of the meeting, a draft summary of the previous meeting for review and approval, and additional handouts as needed. Materials will be provided by CCS in advance through Web site posting and e-mail notification with a goal of 7 days' advance notice and no less than 48 hours advance notice. Decision items will be noted. CCS will provide and manage a project Web site (www.iaclimatechange.us) in close coordination with the IDNR. All Web site materials may be reviewed by the IDNR prior to posting. Examples of CCS project Web sites can be found at www.climatestrategies.us.

The ICCAC process includes the following key principles and guidelines:

- **The process is fully transparent.** All materials considered by the ICCAC and SCs are posted to the project Web site, and all meetings are open to the public. The quantification of all potential policy options is transparent with respect to the data sources, methods, key assumptions, and uncertainties used by CCS in its collaboration with participants. In addition, policy design parameters and implementation methods for recommended actions are fully transparent, including goal levels, timing, coverage of parties, and implementation mechanisms. The transparency of technical analysis, policy design, and participant viewpoints is critical to the identification and resolution of potential conflicts.

- **The process is inclusive.** A diverse group of ICCAC members, in combination with additional SC members chosen by the IDNR and ICCAC, represent a broad spectrum of interests and expertise in Iowa. A ground rule for participation is to be supportive of the process, but members are free to disagree on specific decisions within the process. The public is also invited to provide meaningful review of and input to decisions.

- **The process is stepwise.** Each step of the process builds incrementally on the previous steps toward a final product. Sufficient time, information, and interaction are provided between steps to ensure that participants are comfortable with decisions and the results are of high quality.

- **The process will seek but not mandate consensus.** Votes will be taken by the ICCAC at key milestones in the process in order to advance to the next steps. Alternatives that address barriers to consensus will be developed by the ICCAC and SCs with the assistance of CCS, as needed. Voting by the ICCAC will follow established state procedures. A quorum requires that a simple majority of members are available to participate. After initial votes are taken, specific barriers to consensus will be identified, and conflicts will be resolved by developing alternatives, as needed, to proceed. Final votes by the ICCAC include support at one of three levels: unanimous consent (no objection), super-majority (five objections or fewer), and majority (less than half object). Typically the early stages of the process proceed with unanimous consent or a super-majority if needed. Final recommendations may include recommendations at all three levels. Almost all final recommendations in prior processes have enjoyed unanimous consent, with a few falling short. The Final Report by CCS will document ICCAC recommendations and views on each policy option, including barriers to consensus and alternative views as needed.

- **The process is comprehensive.** The ICCAC will explore solutions in all sectors and across all potential implementation methods, including a variety of voluntary and mandatory implementation mechanisms. The total number of policies considered and recommended by the ICCAC is typically 50 or more. Recommendations may include state-level and multistate actions (regional and national). Mitigation of all GHGs will be examined, including carbon dioxide, methane, nitrous oxide, and synthetic gases. Units will be expressed in million metric tons of carbon dioxide equivalents ($MMtCO_2e$). Similarly, all forms of energy supply and use and all forms of economic development are open for consideration as they relate to GHG mitigation actions. Any significant actions taken by the executive or legislative branches during the process will be included in an updated reference case forecast of emissions.

- **The process is guided by clear decision criteria for the selection and design of recommended actions.** These include consideration of 1) GHG reduction potential; 2) cost or cost savings per ton of GHGs removed (i.e., “cost effectiveness”); 3) co-benefits, including economic, environmental, and energy policy improvements; and 4) feasibility issues.
- **The process is quantitative.** Results of ICCAC decisions will include explicit descriptions of policy design parameters and results of economic analysis. Recommendations can include both quantified and non-quantified actions, with emphasis on quantification of GHG reduction potential and cost or cost savings (i.e., cost-effectiveness) for as many recommendations as possible. Additional quantification needs related to co-benefits or feasibility issues will be evaluated on a case-by-case basis pending ICCAC input and available resources.
- **The process covers short-, medium-, and long-term periods of action.** The time period of analysis for emissions inventories and reference case projections includes the years 1990–2020. Recommendations for action typically include the present to year 2020, with estimated benefit and cost impacts being reported for intermediate years such as 2010 and 2020. These time frames can be adjusted, if needed, to consider longer time horizons.
- **This process is implementation-oriented.** The goal of the process is ultimate adoption of specific policies by the State of Iowa, based on planning recommendations of the ICCAC and subsequent, more detailed analyses as needed. Accordingly, implementation, design, and feasibility issues are provided at a conceptual level appropriate to support further consideration by the Governor and General Assembly.

ICCAC Meeting Objectives and Agendas

The objectives and agendas for each of the ICCAC and SC meetings are listed below, with notes regarding each decision item.

MEETING ONE

- Organizational meeting held October 18, 2007
  - Discussion of baselines and reduction scenarios for 2012, 2020, 2040, and 2050
  - Review of state climate action planning processes
  - Presentation of facilitation and technical team (CCS)
  - Identification of SC and ICCAC preferences
  - Review of public records and open meeting requirements

  - Establishment of the date and time for the next ICCAC meeting

Interim ICCAC and/or SC calls will cover 1) review and approval of the work plan process and schedule, 2) review of progress on the draft inventory and reference case projections, 3) review of and suggested additions to the catalog of policy options, 4) review of other state goals and targets, and 5) formulation of draft Interim Report elements.

MEETING TWO

- Objectives:
  - Addition of potential actions to the draft catalog of state actions (by vote)
  - Review of Iowa Actions to Date document
  - Completion of Interim Report to the Governor and General Assembly (by vote)
- Agenda:
  - Introductions
  - Review and approve previous draft meeting summary (by vote)
  - Review and approve additional actions to include in the catalog of possible Iowa policy actions (by vote)
  - Discuss the process for identifying initial priorities for SC analysis
  - Discuss GHG reduction goals, targets, and approaches in other states
  - Review and approve Interim Report to the Governor and Legislature, including how to address the baseline years and targets (by vote)
  - Provide update on next steps

Interim ICCAC and/or SC calls will cover 1) any final edits to the Interim Report, 2) early ranking of options in the catalog and straw voting for initial “priority for analysis” options, and 3) review of goals and targets in other states and development of preliminary options for Iowa GHG reduction goals.

MEETING THREE

- Objectives:
  - Approval of any additions to the list of priority for analysis policy options if/as needed (by vote)
  - Review and approval of revisions to the emissions inventory and forecast (by vote if/as needed)
  - Preparation for straw proposal phase of the process (briefing and discussion)
  - Review of options for establishing GHG emission reduction goals and targets for Iowa
- Agenda:
  - Introductions
  - Review and approval of previous draft meeting summary (by vote)

- Review and approve SC lists of initial policy priorities for analysis (by vote)
- Approve the GHG Emissions Inventory and Forecast for Iowa (by vote)
- Discuss the process for developing straw policy design proposals
- Discuss options for GHG emission reduction goals and targets for Iowa
- Determine the next meeting agenda, time, location, and date
- Consider public input

Interim SC calls will cover 1) development of straw proposals for draft policy priorities for analysis and 2) formulation of preliminary proposed GHG reduction goals for Iowa.

MEETING FOUR

- Objectives:
  - Approval of SC suggested straw proposals for policy design (goals, timing, coverage of parties) (by vote)
  - Approval of any additions to the list of priority for analysis policy options if/as needed (by vote)
  - Preparation for quantification phase of the process (briefing and discussion)
- Agenda:
  - Introductions
  - Review and approve previous draft meeting summary
  - Review and approve straw proposals for policy design
  - Discuss quantification principles and guidelines and key assumptions for SC analysis of policy options
  - Determine next meeting agenda, time, location, and date
  - Consider public input

Interim SC calls will cover 1) review of proposed quantification procedures for individual options, including proposed data sources, methods, and assumptions; 2) review of first round of quantification results; and 3) identification of early consensus options for recommendation for ICCAC approval.

MEETING FIVE

- Objectives:
  - Review and approval of early consensus policy recommendations (by vote)
  - Identification of specific barriers to consensus, and potential alternatives for non-consensus policy options (discussion) to be considered further by SCs
  - Review of options for establishing GHG emission reduction goals and targets for Iowa
- Agenda:

- Introductions
- Review and approve previous draft meeting summary (by vote)
- Begin review and approval of the list of draft policy options, with results of analysis for individual options
- Identify barriers and alternatives for remaining options, with guidance for additional work on options to SCs
- Review progress and plans for Final Report
- Discuss options for GHG emission reduction goals and targets for Iowa
- Determine next meeting agenda, time, location, and date
- Consider public Input

Interim SC calls will cover 1) final revisions to alternative policy option design parameters, quantification approaches, and/or implementation mechanisms as needed, and 2) final analysis of options and alternative approaches.

MEETING SIX

- Objectives:
  - Review and approval of draft pending policy recommendations not yet approved, including additional options if/as needed (by vote)
  - Review and approval of proposed GHG emission reduction goals and targets for Iowa (by vote)
- Agenda:
  - Introductions
  - Review and approve previous draft meeting summary (by vote)
  - Review and approve the list of final draft pending policy options, with results of analysis for individual options and cumulative emissions reductions potential for all options combined (by vote)
  - Identify barriers and alternatives for remaining options, with guidance for additional work on options to SCs (if needed)
  - Approve proposed GHG emission reduction goals for Iowa (by vote)
  - Review progress of and plans for Final Report
  - Determine next meeting agenda, time, location, and date
  - Consider public input

Interim SC calls (if needed) will cover 1) final revisions to alternative policy option design parameters, quantification approaches, and/or implementation mechanisms as needed, and 2) final analysis of options and alternative approaches.

Interim ICCAC and SC calls may be used to 1) review and approve the draft ICCAC Final Report for public review and comment, 2) review and approve the appropriate process for distribution and collection of comments on the draft ICCAC Final Report, 3) consider comments received, and 4) formulate the proposed Final Report for action by the ICCAC.

MEETING SEVEN

- Objectives:
  - Review and approval of Final ICCAC Report (by vote)
  - Review of procedures for announcement and distribution of Final Report
- Agenda:
  - Approve the Final ICCAC Report (by vote)
  - Approve procedures for announcement and distribution of the Final Report
  - Determine next steps

Development Steps for Draft and Final ICCAC Report

- Draft report language by CCS to the ICCAC and the public
- First round of review and inputs to CCS
- Updated draft report language to the ICCAC and the public
- ICCAC calls to discuss suggested changes to the Final Report
- Final ICCAC meeting to approve the Final ICCAC Report
- Final ICCAC Report transmitted to the IDNR by CCS

Participant Roles and Responsibilities

The ICCAC process involves a number of parties with specific roles and responsibilities, as follows:

Governor

The Governor convenes the climate action plan process and ICCAC under SF 485, appoints members of the ICCAC, requests and receives final recommendations from the ICCAC for a comprehensive state climate action plan, appoints a chair, acts on final recommendations as deemed appropriate, and forwards recommendations and early reports to the Iowa General Assembly.

IDNR

The IDNR will announce and convene the process on behalf of the Governor, recommend additional members to the SCs, and receive recommendations from the ICCAC process through CCS for transmittal to the Governor. The IDNR and ICCAC Chair will work in partnership with CCS to support timely and orderly completion of tasks, good-faith participation, and resolution of issues by ICCAC members. The Chair and IDNR will enforce ground rules, open and close ICCAC meetings, coordinate agency activities related to support of the process, assist CCS by providing support for successful completion of the process, and provide day-to-day assistance to CCS with coordination, communications, logistics, and technical support.

Center for Climate Strategies

With full endorsement of the ICCAC, the Governor and the IDNR have asked CCS to partner in forming and conducting a participatory statewide climate action planning process to meet the goals of the ICCAC. CCS will work in partnership with the IDNR and Chair to achieve the overall goals of the process. In this role, CCS will design the ICCAC process and provide facilitation and technical support to the ICCAC and its SCs through a team of project managers, facilitators, and technical analysts.

CCS serves as an impartial and expert party and does not take positions on issues or direct the parties toward particular solutions. As such, CCS serves as a group mediator, but not as an arbitrator. CCS will manage and facilitate meetings and votes during meetings, schedule meetings in coordination with the Chair, develop meeting agendas, produce documents for ICCAC and SC consideration, and perform and present technical analyses.

CCS abides by the Model Standards of Conduct for Mediators approved by the American Arbitration Association, the Litigation Section and the Dispute Resolution Section of the American Bar Association, and the Society of Professionals in Dispute Resolution. CCS also ensures that adequate funding exists to successfully complete the process through private sources.

ICCAC

The ICCAC is appointed by the Governor in consultation with the IDNR and under requirements of SF 485. It makes final recommendations for specific climate policy actions and goals, and approves a final Iowa GHG emissions inventory for planning purposes and forecast.[2] ICCAC members are appointed to respond to the goals and timelines of the process. CCS will facilitate ICCAC activities, provide supporting analysis of options under consideration, and deliberate and cast votes in an open-group format.

Subcommittees

ICCAC SCs will be composed primarily of ICCAC members assigned to specific sector-based SCs of interest by the IDNR, with guidance by CCS; they may include non-ICCAC individuals with technical expertise and interest of importance to the process. The SCs will provide guidance to ICCAC members on decisions related to milestones in the stepwise process but will not make binding decisions or votes. SCs will also provide assistance to CCS in the identification, design, and quantification of policy recommendations. Sector-based SCs include

a. Clean and Renewable Energy [Energy Supply under typical CCS nomenclature]

b. Energy Efficiency and Conservation [Residential, Commercial and Industrial under typical CCS nomenclature, i.e., energy efficiency and conservation, industrial processes]

c. Transportation and Land Use

d. Agriculture, Forestry, and Waste Management

e. Cross-Cutting Issues (such as reporting, registries, public education, and goals)

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[2] This is not the same inventory for 2007 that IDNR is required to submit to the Governor and General Assembly by September 1, 2008.

Government Agencies

Agency participants provide liaison to ICCAC and SC meetings and related activities in support of the IDNR and CCS team by providing technical review and input. The IDNR may also appoint agency representatives as SC members.

The Public

The public is invited to attend ICCAC meetings and provide review and input to ICCAC and SC members. Other public input mechanisms may be developed as needed based on guidance from the IDNR.

Participant Guidelines

ICCAC and SC members are expected to follow certain codes of conduct during the process:

- Participants are expected to support the process and its concept fully and, through the group process, in good faith directly collaborate toward the goals of the ICCAC and SCs.
- Participants are expected to act as equals during the process to ensure that all members have equal footing during deliberations and decisions.
- Participants must attend meetings and stay current with information provided to the group and the decisions of the group.
- Participants are asked not to reconsider decisions already made in the stepwise process. Once the ICCAC reaches a milestone by vote, it moves to the next step.
- Participants represent only themselves or the organizations they were named to the Council to act on behalf of when making ICCAC decisions. They should come to meetings prepared to make decisions so as allow the process to move forward.
- Participants should speak about the process only on their own behalf to the media or in other public settings.
- Participants should refrain from personal criticisms and provide objective, fact-based comments and alternatives during ICCAC and SC discussions.

Project Budget

CCS and IDNR have agreed on a budget for the project. The estimated CCS budget for completion of startup and completion of the ICCAC process covers the core facilitation process and quantification of approximately 50 policy recommendations. Changes in the number of meetings, number of policy options, or type of analysis may require additional budget support.

Project Funding

CCS works with a group of private foundation donors to provide cost share to its state partners to ensure a timely and successful launch and completion of the planning processes and other phases of the project. Key donors have pledged support for the ICCAC. Pending the approval by IDNR of this work plan, CCS pledges adequate core commitments to launch the process and fully fund its completion.

Project Team

The CCS project team consists of the following members (CCS may alter the team configuration based on need during the process):

Facilitation and Project Management

- Tom Peterson, Tom Looby, Randy Strait, Ken Colburn

Inventory and Forecast Team

- Randy Strait, Maureen Mullen

Subcommittee Facilitators and Consultants

Clean and Renewable Energy [Energy Supply]

- Donna Boysen, Michael Lazarus, others

Energy Efficiency and Conservation [Residential, Commercial, and Industrial]

- Donna Boysen, Michael Lazarus, others

Agriculture, Forestry, and Waste Management

- Steve Roe, Katie Bickel, Peter Kuch, Joe Pryor, others

Transportation and Land Use

- Lewison Lem, Bill Cowart, Tiffany Batac

Cross-Cutting Issues

- Tom Looby, Ken Colburn, Randy Strait, Linda Schade

Appendix C
Members of ICCAC Subcommittees

* Member of Iowa Climate Change Advisory Council (ICCAC)
CCS = Center for Climate Strategies

Agriculture, Forestry, and Waste Management

Karey Claghorn, Deputy Secretary of Agriculture, State of Iowa
Richard Cruse,* Professor, Department of Agronomy, Iowa State University
Thomas Hadden III,* Executive Director, Metro Waste Authority
Dean Lemke, Chief, Water Resource Bureau, Division of Soil Conservation,
Iowa Department of Agriculture and Land Stewardship
David Miller,* Economist, Director of Research and Commodity Services, Iowa Farm Bureau Federation
Duane Sand, Special Projects Consultant, Iowa Natural Heritage Foundation
Dawn Snyder,* Education Programs Director, Woodbury County Conservation Board
Paul Tauke, State Forester, Iowa Department of Natural Resources
Elwynn Taylor, Extension Climatologist, Iowa State University
Peter Thorne, Professor and Director, Health Sciences Research Center, University of Iowa

Steve Roe, CCS Lead Facilitator
Joe Pryor, CCS Co-Facilitator
Jackson Schreiber, CCS Consultant

Clean and Renewable Energy

Michelle Arenson, Manager, Wind Project Development, Alliant Energy
Roxanne Carisch,* CEO, Electric Distribution Co-op, Calhoun County Electric Cooperative Association
Dean Crist, Vice President, Regulation, MidAmerican Energy Company
Thomas Fey,* Lobbyist/Consultant, Fey & Gomez, Inc.
Michelle Kenyon Brown, Executive Director, Iowa Renewable Energy Association (I-Renew)
Robert Loyd,* Plant Manager, Clipper Turbine Works, Clipper Windpower
Pam Mackey-Taylor, Chair, Iowa Chapter of the Sierra Club
Jeff Myrom, Senior Environmental Policy Analyst, MidAmerican Energy Company
Donovan Olson,* State Representative, Iowa Legislature
Norman Olson,* BECON Facility Director, Iowa Energy Center, Iowa State University
John Pearce, Utilities Specialist, Iowa Utilities Board
Krista Tanner,* Board Member, Iowa Utilities Board
Wally Taylor, Environmental Attorney, Sierra Club
Mike Thatcher, Vice President of Generation, Corn Belt Power Cooperative

Tom Peterson, CCS Facilitator

Hal Nelson, CCS Facilitator
Adam Rose, CCS Consultant

Cross-Cutting

Teresa Galluzzo,* Research Associate, Iowa Policy Project
Rev. Robert Grant, Director of Environmental Studies Program, St. Ambrose University
Pat Higby, Energy Educator, Center for Energy and Environmental Education, University of Northern Iowa
Nile Lanning,* Retired Line Forman, Alliant Energy
Richard Ney,* Environmental Engineer/Consultant, Sebesta Blomberg & Associates, Inc.
Jerald Schnoor,* Professor, Center for Global and Regional Environmental Research, University of Iowa
Bill Stigliani,* Professor and Director, Center for Energy and Environmental Education, University of Northern Iowa

Tom Looby, CCS Facilitator
Linda Schade, CCS Consultant
June Taylor, CCS Consultant

Energy Efficiency and Conservation

Gordon Dunn, Utilities Specialist, Iowa Utilities Board
Jennifer Easler,* Attorney, Office of Consumer Advocate, State of Iowa
Marian Gelb,* Executive Director, Iowa Environmental Council
Bob Haug, Executive Director, Iowa Association of Municipal Utilities
Bob Holmes, Senior Regulatory Planning Consultant, Alliant Energy
Rick Leuthauser, Manager, Energy Efficiency, MidAmerican Energy Company
David Osterberg, Clinical Associate Professor, Department of Occupational & Environmental HealthUniversity of Iowa
Julie Smith,* Attorney/Lobbyist, Iowa Association of Municipal Utilities
Roya Stanley,* Director, Office of Energy Independence, State of Iowa
Ralph Watts,* State Representative, Iowa Legislature
Cathy Woollums,* Senior Vice President, Environmental Services, MidAmerican Energy Holding Company

Tom Peterson, CCS Facilitator
Hal Nelson, CCS Facilitator

Transportation and Land Use

Bruce Anderson, General Counsel, Iowa Auto Dealers Association
Stuart Anderson, Transportation Engineer Executive, Office of Systems PlanningIowa Department of Transportation
Dawn Carlson, President, Petroleum Marketers and Convenience Stores of Iowa (PMCI)

Scott Cirksena, City Council Member, City of Clive
Franklin Cownie,* Mayor, City of Des Moines
Robert Hogg,* State Senator, Iowa Legislature
Steve Kettering,* State Senator, Iowa Legislature
Robert Miklo, Senior Planner, City of Iowa City
Brad Miller, General Manager, Des Moines Area Regional Transportation (DART)
Larry Roehl, Engineer, Louisa County
Neil Volmer, Director, Planning, Programming, and Modal Division, Iowa Department of Transportation
Stephanie Weisenbach, Program Coordinator, 1000 Friends of Iowa

Jason Miles, CCS Facilitator
Lewison Lem, CCS Facilitator
Bill Cowart, CCS

Appendix D
Greenhouse Gas Emissions Inventory and Reference Case Projections

A separate report titled "Iowa Greenhouse Gas Inventory and Reference Case Projections, 1990–2025," was used throughout the Iowa Climate Change Advisory Council (ICCAC) process to provide detailed documentation on current and projected emissions. The preliminary draft report (April 2008), was reviewed by the Council and its five Subcommittees and revised to address comments approved by the ICCAC as the process and analysis moved forward.

The final report, incorporating comments provided by the Subcommittees that were approved by the ICCAC at their September 2008 meeting and incorporated into the final report during October, is available at: http://www.iaclimatechange.us/Inventory_Forecast_Report.cfm. At the 7th ICCAC meeting in November 2008 the Council received the final I-F Report and agreed to file and forward it to the Governor and Legislature.

Appendix E
Methods for Quantification

The following memo was presented and discussed in detail at the fifth meeting of the Iowa Climate Change Advisory Council (ICCAC) on June 12, 2008. It sets forth the Center for Climate Strategies' methods for cost analysis of the options considered for recommendation by the Council. The specific approaches of the technical Subcommittees working in each sector were also outlined in separate memos for each Subcommittee and provided to the Council. Those sector specific assumptions have been incorporated into assumptions outlined in the Appendices for each Subcommittee.

Memorandum

To: Iowa Climate Change Advisory Council

From: The Center for Climate Strategies

Subject: Quantification of Climate Mitigation Policy Options

Date: June 7, 2008

This memo summarizes key elements of the recommended methodology for estimating GHG impacts and cost effectiveness for draft policy options for analysis considered amenable to quantification. The quantification process is intended to support custom design and analysis of draft policy options, and provide both consistency and flexibility. Feedback is encouraged.

Key guidelines include:

- Focus of analysis: **Net GHG reduction potential** in physical units of million metric tons (MMt) of carbon dioxide equivalent (CO_2e) and **net cost per metric ton reduced** in units of dollars per metric ton of carbon dioxide equivalent ($/$tCO_2e$). Where possible, full life cycle analysis is used to evaluate the net energy (and emissions) performance of actions (taking into account all energy inputs and outputs to production). Net analysis of the effects of carbon sequestration is conducted where applicable.
- Cost-effectiveness: Because monetized dollar value of GHG reduction benefits are not available, physical benefits are used instead, measured as dollars per metric ton of carbon dioxide equivalent ($/$tCO_2e$) (cost or savings per ton) or "cost effectiveness" evaluation. Both positive costs and cost savings (negative costs) are estimated as a part of compliance cost.
- Geographic inclusion: Measure GHG impacts of activities that occur within the state, regardless of the actual location of emissions reductions. For instance, a major benefit of

recycling is the reduction in material extraction and processing (e.g. aluminum production). While a policy option may increase recycling in Iowa, the reduction in emissions may occur where this material is produced. Where significant emissions impacts are likely to occur outside the state, this will be clearly indicated. These emissions reductions are counted towards the achievement of the state's emission goal, since they result from actions taken by the state.

- Direct vs. indirect effects: "Direct effects" are those borne by the entities implementing the policy recommendation. For example, direct costs are net of any financial benefits or savings to the entity. "Indirect effects" are defined as those borne by the entities other than those implementing the policy recommendation. Indirect effects will be quantified on a case-by-case basis depending on magnitude, importance, time available, need and availability of data. (See additional discussion and list of examples below.)
- Non-GHG (external) impacts and costs: Include in qualitative terms where deemed important. Quantify on a case-by-case basis as needed depending on need and where data are readily available.
- Discounting and annualizing: Discount a multi-year stream of net costs (or savings) to arrive at the "net present value cost" of the cost of implementing a policy option. Discount costs in constant 2005 dollars using a 5% annual real discount rate for the project period of 2009 through 2020 (unless otherwise specified for the particular policy option). Capital investments are represented in terms of annualized or amortized costs through 2020. Create an annualized cost per ton by dividing the present value cost or cost savings by the cumulative reduction in tons of GHG emissions.
- Time period of analysis: Count the impacts of actions that occur during the project time period and, using annualized emissions reduction and cost analysis, report emissions reductions and costs for specific target years of 2012 and 2020. Where additional GHG reductions or costs occur beyond the project period as a direct result of actions taken during the project period, show these for comparison and potential inclusion.
- Aggregation of cumulative impacts of policy options: In addition to "stand alone" results for individual options, estimate cumulative impacts of all options combined. In this process we avoid simple double counting of GHG reduction potential and cost when adding emission reductions and costs associated with all of the policy recommendations. To do so we note and or estimate interactive effects between policy recommendations using analytical methods where significant overlap or equilibrium effects are likely.
- Policy design specifications and other key assumptions: Include explicit notation of timing, goal levels, implementing parties, the type of implementation mechanism, and other key assumptions as determined by the Iowa Climate Action Council (ICCAC).
- Transparency: Include policy design choices (above) as well as data sources, methods, key assumptions, and key uncertainties. Use data and comments provided by ICCAC to ensure best available data sources, methods, and key assumptions using their expertise and knowledge to address specific issues in Iowa. Modifications will be made through facilitated decisions.

For additional reference see the economic analysis guidelines developed by the Science Advisory Board of the US EPA available at: http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html.

An addendum with examples of direct and indirect net costs and savings starts on the following page.

Examples of Direct/Indirect Net Costs and Savings

Note: These examples are meant to be illustrative.

Energy Efficiency and Conservation (EEC)/ Residential, Commercial, and Industrial (RCI) Sectors

Direct Costs and/or Savings

- Net capital costs (or incremental costs relative to standard practice) of improved buildings, appliances, equipment (cost of higher-efficiency refrigerator versus refrigerator of similar features that meets standards)
- Net operation and maintenance (O&M) costs (relative to standard practice) of improved buildings, appliances, equipment, including avoided/extra labor costs for maintenance (less changing of compact fluorescent light (CFL) or light-emitting diode (LED) bulbs in lamps relative to incandescent)
- Net fuel (gas, electricity, biomass, etc.) costs (typically as avoided costs from a societal perspective)
- Cost/value of net water use/savings
- Cost/value of net materials use/savings (for example, raw materials savings via recycling, or lower/higher cost of low-global warming potential (GWP) refrigerants)
- Direct improved productivity as a result of industrial measures (measured as change in cost per unit output, for example, for an energy/GHG-saving improvement that also speeds up a production line or results in higher product yield)

Indirect Costs and/or Savings

- Re-spending effect on economy
- Net value of employment impacts
- Net value of health benefits/impacts
- Value of net environmental benefits/impacts (value of damage by air pollutants on structures, crops, etc.)
- Net embodied energy of materials used in buildings, appliances, equipment, relative to standard practice
- Improved productivity as a result of an improved working environment, such as improved office productivity through improved lighting (though the inclusion of this as indirect might be argued in some cases)

Clean and Renewable Energy (CRE)/ Energy Supply (ES) Sector

Direct Costs and/or Savings

- Net capital costs (or incremental costs relative to reference case technologies) of renewables or other advanced technologies resulting from policies

- Net O&M costs (relative to reference case technologies) renewables or other advanced technologies resulting from policies
- Avoided or net fuel savings (gas, coal, biomass, etc.) of renewables or other advanced technologies relative to reference case technologies resulting from policies
- Total system costs (net capital + net O&M + avoided/net fuel savings + net imports/exports + net transmission and distribution (T&D) costs) relative to reference case total system costs

Indirect Costs and/or Savings

- Re-spending effect on economy
- Higher cost of electricity reverberating through economy
- Energy security
- Net value of employment impacts
- Net value of health benefits/impacts
- Value of net environmental benefits/impacts (value of damage by air pollutants on structures, crops, etc.)

Agriculture, Forestry, and Waste Management (AFW) Sectors

Direct Costs and/or Savings

- Net capital costs (or incremental costs relative to standard practice) of facilities or equipment (e.g., manure digesters and associated infrastructure, generator; ethanol production facility)
- Net O&M costs (relative to standard practice) of equipment or facilities
- Net fuel (gas, electricity, biomass, etc.) costs or avoided costs
- Cost/value of net water use/savings

Indirect Costs and/or Savings

- Net value of employment impacts
- Net value of human health benefits/impacts
- Net value of ecosystem health benefits/impacts (wildlife habitat; reduction in wildfire potential; etc.)
- Value of net environmental benefits/impacts (value of damage by air or water pollutants on structures, crops, etc.)
- Net embodied energy of water use in equipment or facilities relative to standard practice
- Reduced VMT and fuel consumption associated with land use conversions (e.g., as a result of forest/rangeland/cropland protection policies)

Transportation and Land Use (TLU) Sector

Direct Costs and/or Savings

- Incremental cost of more efficient vehicles net of fuel savings.
- Incremental cost of implementing Smart Growth programs, net of saved infrastructure costs.
- Incremental cost of mass transit investment and operating expenses, net of any saved infrastructure costs (e.g., roads)
- Incremental cost of alternative fuel, net of any change in maintenance costs

Indirect Costs and/or Savings

- Health benefits of reduced air and water pollution.
- Ecosystem benefits of reduced air and water pollution.
- Value of quality-of-life improvements.
- Value of improved road safety.
- Energy security
- Net value of employment impacts

Appendix F
Energy Efficiency and Conservation Policy Options

Summary List of ICCAC Options

No.	Policy Option	CO_2 Reduction 2012	CO_2 Reduction 2020	Total 2009–2020	Net Present Value 2009–2020 (Million $)	Cost/Ton ($/t$CO_2$e)	Level of Support
EEC-1	Consumer Education Programs	*Not quantified*					Unanimous
EEC-2	Demand-Side Management (DSM)/Energy Efficiency Programs for Natural Gas	0.08	1.24	5.43	–$191.77	–$35.29	Super Majority (4 objections)
EEC-3	Financial Mechanisms for Energy Efficiency	1.62	6.11	36.81	–$805.05	–$21.87	Super Majority (1 objection)
EEC-4	Improved Building Codes for Energy Efficiency	0.05	0.40	1.89	–$46.27	–$24.44	Super Majority (5 objections)
EEC-5	Incentive Mechanisms for Achieving Energy Efficiency	0.35	3.29	16.33	–$350.79	–$21.48	Unanimous
EEC-6	Promotion and Incentives for Improved Design and Construction in the Private Sector	0.00	0.12	0.46	–$11.36	–$24.57	Super Majority (1 objection)
EEC-7	Training and Education for Builders and Contractors	*Not quantified*					Unanimous
EEC-8	Focus on Specific Residential Market Segments	0.09	0.98	4.83	–$122.53	–$25.37	Unanimous
EEC-9	Midwestern Governors Association Energy Security and Climate Stewardship Platform	0.13	4.13	17.14	–$375.69	–$21.92	Majority (9 objections)
EEC-10	Energy Management Training/Training of Building Operators	0.10	1.29	5.48	–$129.49	–$23.63	Super Majority (1 objection)
EEC-11	Rate Structures and Technologies To Promote Reductions	0.04	0.21	1.20	–$25.73	–$21.45	Unanimous
EEC-12	Demand-Side Management (DSM)/Energy Efficiency Programs for Electricity	0.39	4.38	20.33	–$444.81	–$21.88	Super Majority (4 objections)
EEC-13	Government Lead by Example: Improved Design, Construction, and Energy Operations in New and Existing State and Local Government Buildings	0.08	0.36	1.97	1.04	0.53	Majority (6 objections)
EEC-14	More Stringent Appliance Efficiency Standards	0.94	2.20	17.33	–$708.15	–$40.85	Super Majority (2 objections)
	Sector Total After Adjusting for Overlaps	**1.1**	**8.6**	**43.2**	**–$1,064.5**	**–$24.7**	
	Reductions From Recent Actions: EISA (2007) and Executive Orders #6 and 41	**0.44**	**1.42**	**9.19**			
	Sector Total Plus Recent Actions	**1.6**	**10.0**	**52.3**			

CO_2 = carbon dioxide; DSM = demand-side management; NPV = net present value; $/t$CO_2$e = dollars per metric ton of carbon dioxide equivalent; EISA = Energy Independence and Security Act (2007).

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy options is for reference purposes only; it does not reflect prioritization among these important policy options.

Overlap Discussion

The Iowa Climate Change Advisory Council (ICCAC) and the Energy Efficiency and Conservation Subcommittee (EEC SC) have developed 14 policy options to reduce the emissions of greenhouse gases (GHGs) in the residential, commercial, and industrial (RCI) sector. In addition to estimating the impacts of each individual policy option, the *combined* impacts of the policy options in each sector were estimated, assuming that all were implemented together. This involved eliminating any overlaps in coverage that would occur to avoid double counting of impacts. Also, some of the policy options in one sector overlapped with policy options in another sector; therefore, these overlaps were identified and the impact analysis was adjusted to eliminate double counting of impacts associated with these intersectoral overlaps. The following section identifies where these overlaps occurred and explains the methods used to adjust the impacts analysis to avoid double counting of impacts.

EEC Cumulative Impacts Analysis Methodology

To assess the cumulative emission reductions for the policies in the RCI sector, it is necessary to consider any overlaps among the policy options that affect similar types of energy use. Specifically, some policies (such as EEC-3) are defined by their goals for reducing energy use, while others (such as EEC-12 and EEC-2) are defined by addressing a specific type of energy use. Policies were compared in terms of the type of energy use they target and the energy reduction strategies they implement. Overlaps were identified and quantified by sector (RCI or government/institutional), type of energy use targeted (water heating, space heating, etc.), and measure (e.g., solar hot water). If a policy's impact by sector and type of energy use was less than the impact from an overlapping policy for that same sector and type of energy use, it was excluded from the cumulative analysis.

EEC-3 provides tax incentives and other mechanisms that are not covered by utility and nonutility energy efficiency programs. Nonetheless, from the perspective of the practical, achievable potential for the deployment of energy efficiency through 2020, there is significant overlap with EEC-12. This option does not overlap with EEC-2 because, as it is quantified, it does not target natural gas efficiency. In contrast, this option is more aggressive in deploying energy efficiency, as it assumes that 2% of retail sales are conserved by 2010, while this level is not achieved in EEC-12 until 2016. For this reason, this option is assumed to overlap with EEC-12 by 85%, and its delivered reductions in energy and carbon dioxide (CO_2) are reduced by this amount.

EEC-4 improved building codes don't overlap with EEC-12 and EEC-2, at least in theory, because EEC-12 and EEC-2 should be either applied to existing demand or would be for energy efficiency improvements beyond new codes. There are no overlaps for this option.

EEC-5 includes financial mechanisms, such as decoupling utility revenues from sales of electricity or natural gas, allowing utilities to rate-base their energy efficiency expenditures and earn returns on these investments, and allowing utilities to earn interest on customer loans for energy efficiency equipment. In theory, these implementation mechanisms will provide new sources of funding for energy efficiency measures and thus increase their deployment. However, this measure targets an incremental 1.5% of retail sales being conserved via energy efficiency by 2012, which, when combined with EEC-12, would exceed achievable levels of programmatic energy efficiency.[1] Furthermore, the load management and time-of-use measures overlap with EEC-11. This option is assumed to overlap 90% with other options.

EEC-6 looks for ways to improve the efficiency of new buildings and major retrofits beyond existing building codes. Several of the measures that could be used to achieve this are placing caps on consumption of energy per unit area of floor space for new buildings and encouraging building commissioning and recommissioning, including energy tracking and benchmarking. While these measures might improve energy efficiency, they are largely captured under EEC-4 and EEC-12 and EEC-2. This option is assumed to overlap 90% with other options.

EEC-8 focuses on low-income residents who may not receive energy efficiency investments under utility demand-side management (DSM) programs. However, well-designed DSM programs should target low-income residences. This option also targets residential and commercial energy consumers who have significant disincentives for investing in energy efficiency measures due to landlord-tenant market failures. It targets minimum efficiency goals for rental properties, such as using compact fluorescent light bulbs and energy-efficient appliances, with inspections occurring with the departure of current tenants via a pre-rental inspection program before a new tenant takes possession. This option is assumed to overlap 75% with EEC-12 and EEC-2.

EEC-9 adheres to the Midwestern Governors Association (MGA) target for energy efficiency. It is 100% redundant to EEC-12, and is eliminated from the adjusted cumulative totals.

EEC-10 provides a certification program for building operators. Utilities already have such programs, but their reach isn't as large as envisioned under this policy. This option is assumed to overlap 90% with EEC-12 and EEC-2.

EEC-11 quantifies the reduced use of electricity due to more rational pricing mechanisms, such as real-time pricing. Higher prices result in lower energy use overall. The quantification of this option explicitly excludes conservation measures, such as high-efficiency air conditioners and chillers, which are included in EEC-12. This option does not overlap with any others.

The government high-efficiency building standards in EEC-13 typically show little overlap with utility programmatic investments and are additional to code improvements. This option does not overlap with any others.

EEC-14 deploys ENERGY STAR equipment in government, residential, commercial, and industrial facilities. It also raises appliance efficiency standards for products not covered by federal standards, although the list of products that are eligible for state standards shrank considerably after the passage of the Energy Independence and Security Act (EISA) in 2007. EEC-12 and EEC-2 also provide incentives for customers to purchase efficient appliances and office equipment. This option is assumed to overlap 75% with EEC-12 and EEC-2 and other policy options.

[1] The report prepared by Quantec LLC for the Iowa Utilities Association, *Assessment of Energy and Capacity Savings Potential in Iowa, Volume II*, shows the best utility programs in the country are able to achieve incremental energy efficiency investments of slightly over 2% of energy sales (p. I-10). Thus, the combined energy targets under EEC-5 and EEC-12/EEC-2 would be impractical to attain.

Overlaps Between Sectors

The electricity energy efficiency investments from the suite of EEC policy options reduce electricity demand and thus make it possible to meet renewable energy mandates more cost-effectively. For example, under EEC-12, electricity demand in 2020 is reduced by almost 5,000 gigawatt-hours (GWh) versus the reference case. Clean and Renewable Energy option CRE-8b assumes a 20% renewable portfolio standard (RPS) by 2020, which is 4% more of renewable sources of energy (as a percentage of retail sales) than is forecasted under the reference case. Therefore, the implementation of EEC-12 would require 200 GWh fewer of renewable resources to meet the RPS target. Using the renewable energy cost assumptions for CRE-8b, the reduced spending on renewables that cost more than reference case generation in 2020 would result in savings of $0.3 million in that year.

Finally, an additional feedback is that certain CRE policies will have the effect of reducing the GHG emissions associated with energy production, so that EEC policies that target electricity use will have a reduced impact on overall emissions. However, this impact is small and has not been reflected in the analysis beyond the avoided CO_2 methodology that assumes in the later years of the program that 21% new renewables are avoided by implementing the EEC options. See the Annex to this document for a discussion of the avoided CO_2 methodology.

Reductions from Recent Actions

Recent actions are accounted for in the summary table as policies that have been enacted, but that are not in the reference case Iowa inventory and forecast. These include the federal Energy Independence and Security Act (EISA) of 2007, which was signed into law in December 2007. This law contains several requirements that will reduce GHG emissions as they are implemented over the next few years. During the ICCAC process, sufficient information was identified (e.g., implementation schedules) to estimate GHG emission reductions associated with implementing energy efficiency requirements for new appliances and lighting in Iowa under Title III of the EISA.[2] The 2020 residential electricity savings are estimated at 5.5% of sales, and natural gas savings are estimated at 1% of sales from more efficient residential furnaces. The net effect of these reductions was estimated at 1,300 GWh of electricity, and 1,300 billion British thermal units (BBtu) of natural gas savings in Iowa by 2020. The associated GHG reductions for these savings are projected to be 1.1 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) for 2020 using the EEC CO_2 methodology. Note, however, that GHG emission reductions associated with the EISA Title IV (Energy Savings in Buildings and Industry) and Title V (Energy Savings in Government and Public Institutions) requirements have not been quantified because of the uncertainties about how they will be implemented.

[2] American Council for an Energy Eefficient Economy. Annual Energy Independence and Security Act of 2007. Savings Estimates as passed by the Senate. 2008. Available at: http://www.aceee.org/energy/national/EnergyBillSavings12-14.pdf.

Also, Iowa's Executive Orders #41 (Governor Vilsack)[3] and #6 (Governor Culver)[4] to reduce energy use in state buildings will also have an impact on future GHG emissions. The avoided electricity and natural gas GHG emissions are estimated at about 0.30 $MMtCO_2e$ in 2020. These actions are expected to achieve annual energy reductions from state government operations of 5% for 3 years for Executive Order #41 (2007–2010) and 2% a year for 7 years (2008–2015) for Executive Order #6. These forecasted reductions are reduced by implementation rates of 60% and 80%, respectively. The less than 100% implementation rate assumes Executive Order #41 is benchmarked relative to the year 2000, which reduces the energy reduction achievement in current energy levels. Also, there are other means by which state facilities cannot participate in the programs. The reductions from these recent actions are reflected in the energy and GHG reductions quantified in EEC-13.

As mentioned in the text below, Iowa utilities have been pursuing energy efficiency programs for some time. These investments are not quantified in the analysis because EEC SC members indicated that the energy impacts from these efficiency programs are already incorporated into the utility load growth forecasts that were used for the reference case inventory and forecast (i.e., they are already in the baseline). The assumed incremental (new) statewide energy efficiency investments are equal to 0.82% of retail natural gas sales, and 0.69% of electricity sales over the planning period. These investments are deducted from each of the relevant energy efficiency targets in the individual policy options. For example, the energy efficiency target in EEC-12 (culminating at 2% of retail sales) is reduced by 0.69% to an incremental 1.31% of new investments by 2020. This approach avoids double counting reductions from existing programs in the policy options. Assuming incremental energy efficiency investments from existing actions in Iowa remained unchanged from 2006 levels, Iowa's cumulative electric energy efficiency deployment would be approximately 15% of sales in 2020. For natural gas, Iowa's cumulative natural gas energy efficiency deployment would be approximately 19% of sales in 2020. When using the levelized cost estimate assumptions developed for the RCI sector, total utility and participant spending on energy efficiency/DSM from existing actions in the reference case is estimated at $270 million in 2020.

The Iowa Utilities Board (IUB) is reviewing investor-owned utility plans to increase incremental electricity and natural gas investments to 1.5% of natural gas and electricity sales. Because these plans have not been approved, they are not included in the quantitative analyses. However, these targets are similar to those of options EEC-2 and EEC-12 for natural gas and electricity, with the primary difference that the two ICCAC options escalate to investments equal to 2% of sales later in the planning period.

[3] State of Iowa, Executive Department. *Executive Order Number Forty-One*. Available at: http://publications.iowa.gov/2619/1/EO_41.pdf.

[4] State of Iowa, Executive Department. *Executive Order Number Six*. February 2008. Available at: http://publications.iowa.gov/6275/1/06-080221%5B1%5D.pdf.

EEC-1. Consumer Education Programs

Policy Description

The ultimate effectiveness of emission reduction activities in many cases depends on providing information and education to consumers regarding the GHG emission implications of their choices. Public education and outreach is vital to fostering a broad awareness of climate change issues and effects (including co-benefits, such as clean air and public health) among the state's citizens. Such awareness is necessary to engage citizens in actions to reduce GHG emissions in their personal and professional lives. Public education and outreach efforts should integrate with and build upon existing outreach efforts involving climate change and related issues in the state. Ultimately, public education and outreach will be the foundation for the long-term success of all of the mitigation actions proposed in the climate change planning process, as well as those that may evolve in the future.

This option focuses on public education and outreach to stimulate decisions that yield energy efficiency savings. Consumer education is an integral component of most existing DSM programs offered by investor-owned and consumer-owned utilities.

Policy Design

Goals: Achieve at least a 5% reduction in residential energy consumption.

Timing: 1% reduction beginning in 2010 and increased linearly to 5% in 2020.

Implementing Parties: Iowa Office of Energy Independence, community colleges, secondary schools, building professional trade groups, utilities.

Implementation Mechanisms

Possible policy mechanisms include:

- Evaluate techniques for assessing the impact of various educational efforts, and disseminate standard methodology to utilities, the IUB, and others.
- Use the 2007 Iowa Residential Energy Survey to guide educational programs and efforts.
- Implement energy districts. Energy districts are based on the conservation district model of the 1930s and 1940s that created a unique local-state-federal partnership to bring conservation technical and financial assistance to every farm. This locally led process could make energy efficiency a highly visible local economic development tool. Districts could participate in national programs; partner with local business for a "distributed efficiency storefront"; develop agricultural energy initiatives with local conservation district, the U.S. Department of Agriculture (USDA), and Extension partners; develop a local carbon offset program with funds and offsets entirely within county; and work with utilities to encourage local distributed generation.

- Work with the Center for Energy and Environmental Education (CEEE) at the University of Northern Iowa (UNI), the Iowa Department of Education, and other appropriate agencies to better incorporate energy efficiency in education curricula.
- Develop and present/distribute seminars and/or publications aimed at residential consumers about state/federal tax credits for investment in energy-efficient technologies and practices, what renters can do to improve energy efficiency, availability of green mortgages, and sources for self-liquidating financing of energy efficiency technologies.
- Develop and present/distribute seminars and/or publications aimed at housing professionals (builders, architects, realtors, appraisers, bankers, landlords, and others) to extend information about green mortgages, self-liquidating financing, ENERGY STAR, National Association of Home Builders (NAHB) and Leadership in Energy and Environmental Design home certification standards, and benefits of efficiency investments by landlords.
- Develop and present/distribute seminars and/or publications aimed at commercial and industrial consumers to extend information about tax credits, best practices, and such available resources as the Industrial Assessment Center (IAC) at Iowa State University (ISU), the National Building Control Information Program, NAHB, Iowa Energy Center (IEC), etc.
- Develop and present/distribute seminars and/or publications aimed at heating, ventilation, and air conditioning (HVAC) contractors. (Utilities are starting to require very high levels of service that many contractors cannot provide right now.)
- Display energy efficiency measures in retail outlets and other public settings.
- Determine education efforts that will be needed to support other new/expanded energy efficiency initiatives, including (1) expand the Weatherization Assistance Program to make the homes of low-income Iowans more energy efficient, (2) develop minimum energy efficiency standards and enforcement mechanism for rental properties, (3) develop financial incentives to more effectively encourage retrofitting of rental properties with energy-efficient appliances and weatherization measures, and (4) develop financing mechanisms to make energy-efficient appliances affordable for everyone.
- Utilize and promote ISU's IAC to extend information about energy efficiency to Iowa business and industry. Encourage development of K-12 energy efficiency curricula.

Related Policies/Programs in Place

Municipal utilities, through the Iowa Association of Municipal Utilities (IAMU), have developed a new direct mail energy and environmental magazine called *Eco@Home*. IAMU is also developing an energy-related "town meeting kit" for its members.

While utility energy efficiency plans must be cost-effective, the Iowa General Assembly (2007 session) amended Iowa Code § 476.6(14), which provides that educational programs and assessments of consumers' needs for information to make effective choices regarding energy use and energy efficiency need not be cost-effective (Laws of the Eighty-Second G.A., H.F. 918).

Low-income education programs delivered by Community Action Program (CAP) agencies through investor-owned energy efficiency programs include the following:

- Energy efficiency curriculum developed by MidAmerican Energy.
- School energy efficiency kits (4^{th}–6^{th} grades) distributed by Aquila.
- IEC "shall cooperate with the state board of education in developing a curriculum which promotes energy efficiency and conservation" (Iowa Code § 266.39C(4)). After experiencing difficulties implementing a statewide energy curriculum (see Feasibility issues below), IEC has sponsored Iowa teachers (covering both conference and travel expenses) to attend NEED (National Energy Education Development) training conferences. With a range of sponsors and a core staff, NEED has materials available and continuously up to date. In recent years, the NEED training sponsorship has been extended to 4-H leaders.
- IEC devotes the largest portions of its funds to energy efficiency research, demonstration projects, and education projects, addressing energy use in agricultural, industrial, commercial, municipal, and residential settings. In the last several years, IEC has developed the Residential Home Series Booklets (www.energy.iastate.edu/homeseries/index.htm) and has signed cooperative agreements allowing for their reproduction and use in neighboring states.
- USDA's Section 9006 Renewable Energy & Energy Efficiency Program.
- Muscatine Power & Water has been using an energy efficiency curriculum for several years with local schools.
- Some municipal utilities and rural electric cooperatives (RECs) have educational programs or comprehensive curricula in their service territories.
- Independence Municipal Utilities utilizes a new program from its power supplier, Wisconsin Public Power Inc., that may represent an emerging good practice for supporting development of customer-owned small-scale renewable generation.
- Wisconsin has a statewide comprehensive curriculum, called KEEP, which could serve as a model for a similar program in Iowa.
- CEEE has many individual programs for encouraging energy education for students.
- Some utilities provide scholarships for Building Operator Certification training.

Additional resources are available from www.energystar.gov and www.energytaxincentives.org.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of methane (CH_4), and nitrous oxide (N_2O) emissions. For direct fuel use, CO_2 from natural gas combustion and likely very small amounts of CH_4 from the transport of natural gas to end users are reduced.

Estimated GHG Reductions and Net Costs or Cost Savings

Data Sources: Not applicable.

Quantification Methods: Not applicable.

Key Assumptions: Not applicable.

Key Uncertainties

None identified.

Additional Benefits and Costs

All of the other policy options rely on public education for success.

Feasibility Issues

Home rule allows local schools to determine their curricula. This could affect implementation of some of the options.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

EEC-2. Demand-Side Management (DSM)/Energy Efficiency Programs for Natural Gas

Policy Description

A DSM/energy efficiency approach requires actions that influence both the quantity and the patterns of energy consumed by end users. This policy option focuses on DSM/energy efficiency programs run by gas utilities, and may be designed to work in tandem with other strategies that can also encourage efficiency gains.

The 2008 session of the Iowa General Assembly passed legislation to require the establishment of energy efficiency savings goals for all of Iowa's municipal gas utilities and one cooperative gas utility.

Policy Design

Goals: Invest in energy efficiency equal to 1.0% of statewide retail gas sales per year within 3 years; 1.5% per year in 5 years; and 2.0% per year in 7 years.

Timing: Phase in, beginning in 2010.

Parties Involved:

- Extend the DSM obligations and goals to all gas utilities in Iowa. Investor-owned utilities (IOUs) are starting at 0.8%.
- IOUs, the Iowa Utility Association, municipal utilities, IAMU, and consumer cooperatives.

Implementation Mechanisms

Possible policy mechanisms include the following:

- Establish (via IUB) DSM goals for investor-owned utilities.
- Revise existing statutes to incorporate prescribed energy efficiency goals.
- Change the determination of DSM cost-effectiveness by accounting for the estimated valuation of CO_2 emissions avoided by programs.
- Extend the energy efficiency goals and obligations to all gas utilities in Iowa.
- Expand DSM measures eligible for program incentives.
- Extend investor-owned natural gas program funding requirements and eligibility to natural gas transportation customers.
- Expand the scope of utility activity that can contribute to achieving DSM goals to account for natural gas savings accruing when an electric utility provides incentives for installation of geothermal systems and building shell measures in an area in which natural gas service is available.

- Expand the scope of utility activity that can contribute to achieving DSM goals to include actions that are on the utility side of the meter, so-called "infrastructure" investments (a term adopted in Minnesota in 2007).
- Recognize the contribution of increased building energy codes and equipment energy standards toward the achievement of DSM goals.
- Include in the measurement of DSM goals the energy savings from renewable measures that are implemented on the customer side of the meter.

Related Policies/Programs in Place

Natural gas utilities in Iowa must offer cost-effective energy efficiency programs (Iowa Code § 476.6(14)). The IUB establishes energy efficiency goals for rate-regulated gas utilities (Iowa Code § 476.6(16)). DSM offered by municipal and rural electric cooperative utilities is not regulated. Most natural gas transportation customers served by competitive commodity suppliers do not fund energy efficiency programs mandated in § 476.6(16) and are not eligible to participate in these programs.

Investor-Owned Natural Gas Utilities

IOUs have a long history of conducting DSM/energy efficiency programs, under statutes adopted in 1990 and modified in 1996. The IUB conducts contested proceedings for the review of plans, programs, and energy savings goals developed by IOUs. New plans were filed in April 2008, and the IUB has directed the IOUs to include analyses of the effects of goals equivalent to saving 1.5% of retail natural gas sales in Iowa.

Municipal and Cooperative Natural Gas Utilities

Although municipal gas utilities were required to file biennial energy efficiency plans, and many have conducted DSM programs, legislation passed in 2008 requires each utility or group of utilities to determine the maximum potential energy and capacity savings available from actual and projected customer usage through cost-effective energy efficiency measures and programs. Based on the energy efficiency assessment, each utility must establish an energy efficiency goal, along with a set of cost-effective energy efficiency programs designed to meet the goal. The process must be started by July 1, 2008, with a progress report submitted to the IUB by January 1, 2009, and a final report filed by January 1, 2010. The report must include the utility's cost-effective energy efficiency goal, and for each measure utilized by the utility in meeting the goal, the measure's description, projected cost, and the analysis of its cost-effectiveness. On January 1 of each even-numbered year, commencing January 1, 2012, utilities must file a report with the IUB identifying their progress in meeting the energy efficiency goal and any updates or amendments to their energy efficiency plans and goals. This requirement takes the place of the current energy efficiency plan filings.

The assumed incremental (new) statewide natural gas energy efficiency investments are equal to 0.82% of retail sales over the planning period.

Type(s) of GHG Reductions

For direct fuel use, CO_2 emissions from natural gas combustion and likely very small amounts of CH_4 emissions from the transport of natural gas to end users are reduced.

Estimated GHG Reductions and Net Costs or Cost Savings

Table F-2-1. Estimated GHG reductions and net costs of or cost savings from EEC-2

Quantification Factors	2012	2020	Units
GHG emission reductions	0.08	1.24	$MMtCO_2e$
Net present value	–\$6.5	–\$191.8	\$ Million
Cumulative GHG reductions	0.15	5.43	$MMtCO_2e$
Cost-effectiveness	–\$42.62	–\$35.29	$/tCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Assuming incremental energy efficiency investments in Iowa remained unchanged from the 2006 levels reported in IUB (2008), Iowa's cumulative natural gas energy efficiency deployment would be approximately 19% of sales in 2020. When using the levelized cost estimate assumptions developed for the EEC sector, total utility and participant spending on energy efficiency/DSM in the reference case is estimated at $270 million in 2020. Under EEC-2, additional energy efficiency spending is estimated at $113 million in 2020, which achieves another cumulative 8.5% of sales.

Data Sources:

- Energy consumption by sector (billion BBtu). See EEC-12.
- Power station electricity generation (GWh) and fuel use (BBtu). See EEC-12.
- Quantec LLC, Summit Blue Consulting, Nextant, Inc., A-TEC Energy Corporation, and Britt/Makela Group. February 2008. *Assessment of Energy and Capacity Savings Potential in Iowa: Final Report*, vol. I. Prepared for the Iowa Utility Association. (No Web link available.)
- IUB. January 1, 2008. *The Status of Energy Efficiency Programs in Iowa and the 2007 Iowa Residential Energy Survey. Report to the Iowa General Assembly*. p. 50. Available at: http://www.state.ia.us/government/com/util/docs/misc/EE/noi072/noi072_StatusReport.pdf.

Quantification Methods:

- Heat rates (Btu/kWh). See EEC-12.
- GHG emissions associated with end-use consumption (by sector). See EEC-12.
- GHG emissions associated with electricity generation from different technologies and fuels. See EEC-12.

Key Assumptions:

- Levelized costs of gas are $5.45 million Btu (2008 dollars) (Quantec 2008).
- This figure includes all utility and participant costs. Utility fixed costs are assumed to be 24% of the capital cost, based on MEC energy efficiency plan submitted in April 2008 filing Docket # EEP-08-02. Vol II, pp. A1-8. (No Web link available.)
- The annual real escalation rate for the cost of energy efficiency programs is 0%.

- Avoided cost of gas in 2009 is $9.49 MMBtu (2008 dollars). The figure is from 2009–2013 Energy Efficiency Plan Interstate Power and Light Company Docket No. EEP-08-1, p. 31. (No Web link available.)
- The energy efficiency programs begin in 2010.
- The value used for the real rate at which costs are discounted annually is 5%.
- Net present value (NPV) is calculated in 2005 dollars beginning in 2009.
- Energy efficiency costs are expressed as levelized costs over the life of the energy efficiency options. The incremental costs (typically incurred in the first year of program implementation) are spread over all future years of the life of the energy efficiency measures.
- 2008 IOU assessment of potential does not evaluate potential from either natural gas transportation customers in funding and eligibility for DSM programs, or fuel switching by end users.
- Statewide natural gas energy efficiency programs are assumed to be 0.82% of retail sales over the planning period.
- IOU gas sales comprise approximately 90% of statewide gas sales over the planning period.

Key Uncertainties

Energy efficiency investments most likely will not lead to reductions in utility rates, but typically result in reduced energy expenditures (customer bills) over the life of the investment, compared to no investments in energy efficiency.

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased energy efficiency and DSM investments (the avoided CO_2 methodology).[5]

Additional Benefits and Costs

Energy efficiency investments should reduce the bills of utility customers who make the investments, but will probably not lead to absolute reductions in utility rates or bills for all customers. However, cost-effective energy efficiency improvements should reduce overall utility costs and average bills, when compared to more expensive alternatives.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

[5] The Annex to this document defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses and provides several scenarios for the impacts of different mixes of avoided generation technologies.

Level of Group Support

Super Majority (4 objections).

Barriers to Consensus

Unspecified.

EEC-3. Financial Mechanisms for Energy Efficiency

Policy Description

This option refers to financial mechanisms that could increase energy efficiency provided by nonutility entities and investment by providing incentives to a variety of energy consumers to improve energy performance of buildings, equipment, and residences. Some of the utilities active in Iowa have offered such financing mechanisms in other states and for specific market segments in Iowa. At least one Iowa utility has a pilot program for a no-interest revolving loan fund. IEC has offered a revolving loan fund for renewable energy for a number of years.

Policy Design

Goals: Reduce electricity, natural gas, and heating fuels consumption across all end-user categories by 2% of retail sales annually. End users include public-sector, industrial, commercial, multifamily residential, and residential users. GHG reductions and costs of or benefits from natural gas and heating fuels are not quantified in this option.

Timing: Initial 2% realized in 2010, with continued annual decline.

Implementing Parties: All public-sector, residential, commercial, and industrial electricity consumers; nonutility entities delivering financial mechanisms.

Implementation Mechanisms

- Financial and technical assistance for energy audits.
  - Currently the Iowa Department of Natural Resources (DNR) has $600,000 to direct to public and nonprofit facilities to provide energy audits and technical assistance to follow up on audit recommendations. New legislation allows for fees, so the program should be self-funding. Financing for improvements through the Treasurer’s office in a lease/purchase agreement.
  - Provide $1 million to expand energy audit programs for industrial, commercial, and multifamily residential sectors, and offer assistance for building and production facilities owners to follow up on audit recommendations.
  - Provide $10 million revolving low- or no-interest loan fund(s) through IEC or the Iowa Finance Authority for energy efficiency investments, potentially targeted at industrial, commercial, and multifamily residential energy users.
  - Performance contracting is a self-financing mechanism for improvements in energy efficiency. The money saved through less energy consumption is leveraged to pay for financing, installing, operating, and maintaining the energy efficiency measures.
  - Provide $10 million tax credits for purchasing appliances that meet ENERGY STAR 2007 requirements.
  - Provide $10 million in income tax credits to nonresidential and multifamily buildings of at least 20,000 square feet that are constructed or rehabilitated to meet criteria set forth by U.S. Green Building Council or other criteria. Apply credits to three types of alternative

energy sources: photovoltaics, wind turbines, and fuel cells. Allow the credits to be claimed only if they serve a green whole building, a green base building, or green tenant space.

Related Policies/Programs in Place

MGA Stewardship Platform.

Executive Orders #6 (Governor Culver)[6] and #41 (Governor Vilsack).[7] See EEC-13.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions. For direct fuel use, CO_2 from natural gas combustion and likely very small amounts of CH_4 from the transport of natural gas to end users are reduced.

Estimated GHG Reductions and Net Costs or Cost Savings

Table F-3-1. Estimated GHG reductions and net costs of or cost savings from EEC-3

Quantification Factors	2012	2020	Units
GHG emission reductions	1.62	6.11	$MMtCO_2e$
Net present value	–$103.8	–$805.0	$ Million
Cumulative GHG reductions	3.27	36.81	$MMtCO_2e$
Cost-effectiveness	–$31.75	–$21.87	$/tCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Energy Consumption by Sector (BBtu). See EEC-12.
- Power Station Electricity Generation (GWh) and Fuel Use (BBtu). See EEC-12.
- MGA. 2007. *Energy Security and Climate Stewardship Platform for the Midwest*. Midwestern Energy Security and Climate Stewardship Summit. Available at: http://www.midwesterngovernors.org/Publications/MGA_Platform2WebVersion.pdf.

Quantification Methods:

- Heat rates (Btu/kWh). See EEC-12.
- GHG emissions associated with end-use consumption (by sector). See EEC-12.
- GHG emissions associated with electricity generation from different technologies and fuels. See EEC-12.

[6] State of Iowa, Executive Department. *Executive Order Number Six*. February 2008. Available at: http://publications.iowa.gov/6275/1/06-080221%5B1%5D.pdf.

[7] State of Iowa, Executive Department. *Executive Order Number Forty-One*. April 22, 2005. Available at: http://publications.iowa.gov/2619/1/EO_41.pdf.

Key Assumptions:

- GHG reductions and costs or benefits from natural gas and heating fuels are not quantified in this option, so actual reductions from this option are likely to be larger than those presented in the analysis.
- DSM/energy efficiency programs are assumed to displace marginal sources of generation (50% coal, 50% gas) through 2012. From 2013 on, the programs are assumed to displace the new-build mix of 78% coal, 21% renewables, and 1% gas.
- The quantification includes only electric energy efficiency measures.
- The levelized costs of energy efficiency and avoided costs come from EEC-12.
- The energy efficiency programs begin in 2010.
- The value used for the real rate at which costs are discounted annually is 5%.
- The annual real escalation rate for the cost of energy efficiency programs is 0%.
- NPV is calculated in 2005 dollars beginning in 2009.

Key Uncertainties

There is a risk that GHG reductions are overstated and the costs per ton of CO_2-equivalemt (CO_2e) reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased energy efficiency and DSM investments (the avoided CO_2 methodology).[8]

Additional Benefits and Costs

Energy efficiency investments should reduce the bills of utility customers who make the investments, but will probably not lead to absolute reductions in utility rates or bills for all customers. However, cost-effective energy efficiency improvements should reduce overall utility costs and average bills, when compared to more expensive alternatives.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Super Majority (1 objection).

Barriers to Consensus

Unspecified.

[8] The Annex to this document defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses and provides several scenarios for the impacts of different mixes of avoided generation technologies.

EEC-4. Improved Building Codes for Energy Efficiency

Policy Description

Buildings are significant consumers of energy and other resources. Adoption and enforcement of building energy and related codes can be an effective way to eliminate the least efficient energy approaches in new or renovated buildings.

This policy option sets a goal for reducing building energy consumption, to be achieved by increasing standards for the minimum performance of new and substantially renovated commercial and residential buildings through the adoption and enforcement of building codes. Building codes would be made more stringent via incorporation of aspects of advanced/next generation building designs and construction standards, such as sustainable design and green building standards. Building codes should promote further reduction of GHG emissions through adoption of sustainable design or green building standards.

Other aspects of the policy design include:

- Undertaking a comprehensive review of existing state and local building codes in Iowa to determine where increased energy efficiency can be achieved. This review will be undertaken by the new Commission on Energy Efficiency Standards and Practices, established by legislation enacted this year.
- Increasing the stringency of the Iowa Energy Code:
  - Residential—2006 International Energy Conservation Code (IECC)
  - Commercial—2006 IECC (including ASHRAE/IESNA [American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society of North America] 90.1-2004).
- Developing a training and certification program for code officials, builders, and contractors on energy efficiency and related sustainable design standards, and in code enforcement.
- Providing tools to state and local governments for measuring and tracking cost savings.
- Targeting existing buildings for efficiency improvements during both major and minor renovation, through application and enforcement of building codes and with tax rebates or other incentives.
- Allowing compliance flexibility. New and substantially renovated buildings can utilize a combination of increased energy efficiency, switching to low- and no-carbon-based fuels for previously carbon-based end uses, making off-site purchases of grid-supplied “green power,” and/or installing on-site off-grid low/no-CO_2-emitting power-generating equipment.
- Setting caps on consumption of energy per unit area of floor space for new buildings.
- Requiring high-efficiency appliances in new construction and retrofits.
- Providing incentives, such as permitting and fee advantages, tax credits, financing incentives (such as “green mortgages”), or other measures to encourage retrofitting existing residential

and commercial buildings or developing nontraditional off-grid low-carbon and carbon-neutral energy sources. The state can work with financial institutions to develop loan tools for these programs.

Advanced/next-generation building design requirements might include use of specific materials (e.g., local building materials), implementation of specific technologies (e.g., energy-efficient roofing materials and landscaping to lower electricity demand), or attainment of points under an advanced standard (e.g., green building or sustainable design). Energy-reduction targets should be periodically reassessed.

Potential measures supporting this policy can include outreach and public education, public recognition programs, improved enforcement of building codes, encouraging or providing incentives for energy tracking and benchmarking, performance contracting/shared savings arrangements, technical support resources for implementation, and development of a clearinghouse for information on and access to software tools to calculate the impact of energy efficiency and solar technologies on building energy performance.

Policy Design

Goals: Reduce energy consumption per square foot of floor space at new construction and renovated buildings by 15% by 2012 and 50% by 2025.

Timing: New codes become effective initially in 2010, and the final goal is achieved by 2025.

Implementing Parties: Department of Public Safety (code adoption, enforcement), local governments**,** builders, contractors, developers, trade associations (Master Builders Association, NAHB, architects, American Institute of Architects (AIA)–Iowa Chapter, etc.).

Implementation Mechanisms

- Require the periodic and regular (no less than every 3 years) review and adoption of state and local building codes, particularly energy efficiency requirements, to ensure best management practices. At least every 3 years, the state will review (with opportunity for public comment) and adopt more stringent standards for energy efficiency.
- Develop more effective energy building code enforcement mechanisms and monitor compliance.
- Developing a training and certification program for code officials and contractors on energy efficiency codes and sustainable design standards.
- Develop mechanisms to facilitate enforcement in areas of the state where there is currently no building code enforcement.
- Extend enhanced tax credits for “green development” of brownfields and grayfields, starting in 2009. The enhanced tax credits will require compliance with the sustainable design standards established by the Building Code Commissioner.

Related Policies/Programs in Place

- Development of sustainable design standards for the state to be adopted by the Building Code Commissioner.
- Development of the Iowa Green Communities Initiative by the Iowa Department of Economic Development (IDED), establishing “green development” standards for projects receiving funding from the Community Development Division of IDED.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions. For direct fuel use, CO_2 from natural gas combustion and likely very small amounts of CH_4 from the transport of natural gas to end users are reduced.

Estimated GHG Reductions and Net Costs or Cost Savings

Table F-4-1. Estimated GHG reductions and net costs of or cost savings from EEC-4

Quantification Factors	2012	2020	Units
GHG emission reductions	0.05	0.40	$MMtCO_2e$
Net present value	–$3.0	–$46.3	$ Million
Cumulative GHG reductions	0.10	1.89	$MMtCO_2e$
Cost-effectiveness	–$31.45	–$24.44	$/tCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Energy consumption by sector (BBtu). See EEC-12.
- Power station electricity generation (GWh) and fuel use (BBtu). See EEC-12.
- 2001 RECS—U.S. Department of Energy, Energy Information Administration. "Residential Energy Consumption Survey 2001: Consumption and Expenditure Data Tables." Table CE1-1c: Total Energy Consumption in U.S. Households by Climate Zone. Available at: http://www.eia.doe.gov/emeu/recs/recs2001/detailcetbls.html#space.
- Heating degree-days (HDD) data from: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service. Historical Climatology Series 5-1. Monthly State, Regional and National Heating Degree-Days Weighted by Population (Includes Aerially Weighted Temperature and Precipitation. Asheville, NC: National Climatic Data Center. Minnesota. Available at: http://lwf.ncdc.noaa.gov/oa/documentlibrary/hcs/hdd.200507-200607.pdf.
- Cooling degree-days (CDD) data from: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service. Historical Climatology Series 5-2. Monthly State, Regional and National Cooling Degree-Days Weighted by Population (Includes Aerially Weighted Temperature and Precipitation. Asheville, NC: National Climatic Data Center. Available at: http://lwf.ncdc.noaa.gov/oa/documentlibrary/hcs/cdd.200501-200607.pdf.

- CBECS—U.S. Department of Energy, Energy Information Administration. "Commercial Buildings Energy Consumption Survey." Ratio of 1990–1999 buildings to all buildings total energy use. Available at: http://www.eia.doe.gov/emeu/cbecs/pdf/consumption_year const.pdf.

Quantification Methods:

- Heat rates (Btu/kWh). See EEC-12.
- GHG emissions associated with end-use consumption (by sector). See EEC-12.
- GHG emissions associated with electricity generation from different technologies and fuels. See EEC-12.

Key Assumptions:

- Levelized costs and avoided costs are from EEC-12 and EEC-2.
- The energy efficiency programs begin in 2010.
- New residential and commercial space grows at 1.3% and 1.2% per year, respectively.
- Building codes apply to 18.4% of residential electricity use and 54% of commercial electricity end use.
- Transmission and distribution (T&D) losses for electricity are 7%.
- Compliance with this policy is assumed to be 50% at the start of the program and rises to 75% by 2020 under the new compliance regime. For the portion of the new buildings (or retrofits) that don't comply, energy use in these structures is assumed to be 20% higher than the policy level.
- Building energy consumption is a function of Iowa's climate. According to the amount of HDD and CDD, Iowa is in the Residential Energy Consumption Survey climate zone 2 (2001 RECS).
- New commercial buildings in climate zone 2 have higher electric intensity relative to existing stock, so are adjusted upward by 24% (CBECS).
- The annual real escalation rate for cost of energy efficiency programs is 0%.
- Code improvements result in differential efficiency gains for natural gas and electricity:
    - Assumes code or efficiency improvement affects gas and electricity according to fuel use.
    - Residential: Electricity code improvement of 1% results in 2.23% gas improvement.
    - Commercial: Electricity code improvement of 1% results in 0.63% gas improvement (CBECS).
- In each year, the new building stock is "treated" at the new efficiency goal (less noncompliance), and then joins the existing stock in the next year.
- NPV is calculated in 2005 dollars beginning in 2009.

- DSM/energy efficiency programs are assumed to displace marginal sources of generation (50% coal, 50% gas) through 2012. From 2013 on, the programs are assumed to displace the new-build mix of 78% coal, 21% renewables, and 1% gas.
- Energy efficiency costs are expressed as levelized costs over the life of the energy efficiency options. The incremental costs (typically incurred in the first year of program implementation) are spread over all future years of the life of the energy efficiency measures.
- The value used for the real rate at which costs are discounted annually is 5%.

Key Uncertainties

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased energy efficiency and DSM investments (the avoided CO_2 methodology).[9]

Additional Benefits and Costs

Energy efficiency investments should reduce the bills of utility customers who make the investments, but will probably not lead to absolute reductions in utility rates or bills for all customers. However, cost-effective energy efficiency improvements should reduce overall utility costs and average bills when compared to more expensive alternatives.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Super Majority (5 objections).

Barriers to Consensus

Unspecified.

[9] The Annex to this document defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses and provides several scenarios for the impacts of different mixes of avoided generation technologies.

EEC-5. Incentives for Energy Efficiency

Policy Description

The IUB is charged with responsibility for energy efficiency programs and energy efficiency plans by Iowa utilities. IOUs conduct energy efficiency programs under plans that are reviewed and approved by the IUB. Consumer-owned utilities (municipal utilities and electric cooperatives) operate voluntary plans and programs, but must provide reports on their plans to the IUB. The 2008 session of the Iowa General Assembly passed legislation that requires RECs and municipal electric utilities to establish energy efficiency savings goals. Energy efficiency plans in Iowa address both electric and natural gas use through a variety of programs.

Incentive approaches are of three types: (1) incentives offered by governing bodies to utilities to induce superior utility performance in implementing DSM/energy efficiency programs, (2) incentives offered by utilities to customers to induce them to participate in and invest in programs, and (3) incentives offered to other energy efficiency stakeholders.

Policy Design

Goals: Equivalent of 5% of retail sales improvement in energy efficiency from Type 1 incentives 5% improvement from Type 2, and 5% for Type 3.

Timing: Incentives offered and energy improvements realized beginning 2012.

Implementing Parties: Residential and commercial property owners and tenants, government housing and other state and federal government agencies, weatherization and energy service providers, local business associations, community action agencies/human resource development councils, such nongovernmental organizations as Habitat for Humanity, HVAC contractors, building contractors/design firms, lenders, retailers of energy-efficient products and services, and residential/commercial energy audit contractors.

Implementation Mechanisms

Type 1 Incentives to Utilities

Implementation of various incentives to utilities would most likely require legislative action to reverse the statutory decision to terminate incentives to IOUs.

Type 2 Incentives to Utility Customers

Incentives to customers of IOUs are reviewed and authorized by the IUB in contested case proceedings for the review of energy efficiency plans. Proceedings are currently underway for the review of new (2009–2013) energy efficiency plans. Incentives to customers or members of municipal utilities and electric cooperatives are solely at the discretion of each customer-owned utility.

Type 3 Incentives to Other Energy Efficiency Stakeholders, Such as Retailers, Contractors, and Designers

Incentives to these stakeholders from IOUs are implemented after review and authorization of utility plans by the IUB. Incentives to these stakeholders that target customers or members of municipal utilities and electric cooperatives are solely at the discretion of each customer-owned utility. Incentives to these stakeholders from other entities, such as units of state or local government, would require action by those governing bodies.

Related Policies/Programs in Place

Type 1 Incentives to IOUs

IOUs have a long history of conducting DSM/energy efficiency programs under statutes adopted in 1990 and modified in 1996. The original statutes enacted in 1990 authorized the IUB to approve incentives for IOUs. The IUB developed rules that permitted the IOUs to seek incentives, including:

- Carrying charges on energy efficiency program costs, which were deferred until final approval.
- Returns on costs approved for recovery, which were earned over a 4-year amortization period.
- A reward mechanism based on the net societal benefits results of each IOU's programs, up to as much as 25% of the net societal benefits.
- Opportunity to apply for recovery of net revenues reduced by DSM programs.

The revision of the energy efficiency statutes in 1996 removed all of these incentive mechanisms, and substituted an automatic adjustment mechanism for cost recovery, which accelerated IOUs' recovery of costs and eliminated the additional costs of incentives. Incentives are now back in discussion, based on the assumption that Iowa IOUs might improve their DSM performance very much beyond current levels of energy and capacity savings if they are given an incentive for doing so.

Potential mechanisms for incentives to IOUs could include the following:

- Decouple IOU revenues from sales of electricity or natural gas.
- Allow IOUs to rate-base their energy efficiency expenditures and earn returns on these investments.
- Allow IOUs to recover revenues that decrease due to DSM, net of utility system cost savings.
- Allow IOUs to implement a revenue normalization mechanism to recognize the impacts of declining per-customer sales due to DSM and other causes, while also recognizing additional sales due to customer growth.
- Allow IOUs to offer all DSM programs as shared-savings or Pay-As-You-Go loan programs, with the interest or earnings on these loans retained as earnings by the IOUs.
- Offer the IOUs some form of monetary reward based on amounts of capacity and energy saved, recoverable from customers as part of DSM costs.

- Evaluate alternative rate regulation structures to better align utility interests with energy efficiency goals. For example, MidAmerican's revenue sharing mechanism incorporates an element of reward for energy efficiency because energy efficiency contributes to the utility's ability to sell electricity in the wholesale market and generate additional revenues that are, pursuant to the revenue sharing arrangement, allocated between the utility and its customers. Thus, the utility and its customers are rewarded for energy efficiency.
- Allow IOUs to "own" all or part of the "carbon credit" impact of capacity and energy saved by DSM programs, and to retain as earnings any funds received from sale of credits based on these savings, above a certain level.
- Require IOUs to document performance, and penalize IOUs that do not meet specific goals by certain dates, to the extent that there is inadequacy in the current Iowa statutes and rules requiring program documentation, and allow the IUB to conduct prudence reviews and impose penalties.

Type 2 Incentives to Utility Customers

Iowa IOUs offer incentives for participation in DSM programs to customers in many forms, including:

- Rate discounts or payments to participants in load management programs, for savings of peak load electric kilowatt (kW).
- Time-of-use rates to electric customers, which offer lower rates off peak and much higher rates during peak electric use periods.
- Free energy audits and simple on-site energy efficiency measures installed during audits.
- Advanced energy efficiency evaluation and design services, typically for nonresidential customers.
- Assistance to residential homebuilders in the form of training, inspection of homes, cash payments for meeting standards, and certification/recognition of highly efficiency homes.
- Rebates and loans to customers for purchasing energy-efficient appliances and equipment.
- Customer education and training on energy-efficient appliances and measures (insulation, infiltration, building weatherization measures, HVAC sizing and maintenance, etc.).

Other customer incentives may be possible.

Type 3 Incentives, to Other Energy Efficiency Stakeholders

Another solution to the assumption that Iowa IOUs will not improve their DSM performance very much beyond current levels of energy and capacity savings is to transfer the administration of energy efficiency programs to an independent, third-party administrator. The administrator would be subject to a performance-based compensation structure, including incentives for superior performance.

Another means of overcoming the utilities' disincentive to aggressively promote DSM programs and achieve energy efficiency results is to replace the current system of utility-administered incentives with a system that provides incentives directly to retailers of energy-efficient products and services, energy-efficient product lenders, and building contractors/designers. Some utilities currently offer these stakeholders incentives to promote energy-efficient products, including training, free publicity, and per-item restocking payments to dealers and sales people for promotion of energy-efficient appliances and equipment. Similarly, incentives could be paid directly to marketing firms to advertise and educate consumers about energy-efficient products and energy efficiency services.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions. For direct fuel use, CO_2 from natural gas combustion and likely very small amounts of CH_4 from the transport of natural gas to end users are reduced.

Estimated GHG Reductions and Net Costs or Cost Savings

Table F-5-1. Estimated GHG reductions and net costs of or cost savings from EEC-5

Quantification Factors	2012	2020	Units
GHG emission reductions	0.35	3.29	$MMtCO_2e$
Net present value	–$10.7	–$350.8	$ Million
Cumulative GHG reductions	0.35	16.33	$MMtCO_2e$
Cost-effectiveness	–$30.68	–$21.48	$/t$CO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t$CO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Energy consumption by sector (BBtu). See EEC-12.
- Power station electricity generation (GWh) and fuel use (BBtu). See EEC-12.

Quantification Methods:

- Heat rates (Btu/kWh). See EEC-12.
- GHG emissions associated with end-use consumption (by sector). See EEC-12.
- GHG emissions associated with electricity generation from different technologies and fuels. See EEC-12.

Key Assumptions:

- Only GHG emission reductions and cost savings from electricity energy efficiency have been quantified.
- Peak avoided costs and levelized costs are assumed to be the same as from EEC-12
- The energy efficiency programs begin in 2012 and end after 2030.
- The three types of incentives will each improve efficiency by 5.0% *over the improvements made in EEC-12*.
- The annual real escalation rate for the cost of energy efficiency programs is 0.

- The value used for the real rate at which costs are discounted annually is 5%.
- NPV is calculated in 2005 dollars beginning in 2009.
- DSM/energy efficiency programs are assumed to displace marginal sources of generation (50% coal, 50% gas) through 2012. From 2013 on, the programs are assumed to displace the new-build mix of 78% coal, 21% renewables, and 1% gas.
- Energy efficiency costs are expressed as levelized costs over the life of the energy efficiency options. The incremental costs (typically incurred in the first year of program implementation) are spread over future years of the life of the energy efficiency measures.

Key Uncertainties

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased energy efficiency and DSM investments (the avoided CO_2 methodology).[10]

Additional Benefits and Costs

Energy efficiency investments should reduce the bills of utility customers who make the investments, but will probably not lead to absolute reductions in utility rates or bills for all customers. However, cost-effective energy efficiency improvements should reduce overall utility costs and average bills when compared to more expensive alternatives.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

[10] The Annex to this document defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses and provides several scenarios for the impacts of different mixes of avoided generation technologies.

EEC-6. Promotion and Incentives for Improved Design and Construction in the Private Sector

Policy Description

This policy option provides incentives and targets to induce the owners and developers of new and reused (major retrofitted) residential and commercial buildings to improve the buildings' efficiency for using energy and other resources, along with provisions for raising targets periodically and providing resources to building industry professionals to help achieve the desired building performance. This policy can include elements to encourage the improvement and review of energy use goals over time, and to encourage flexibility in contracting arrangements to encourage integrated energy- and resource-efficient design and construction.

Policy Design

Goals: Reduce energy consumption by the equivalent of 10% of retail electric sales and natural gas in residential and commercial buildings. Additional savings beyond 10% result in larger CO_2 reductions, as identified in the Additional Costs and Benefits section.

Timing: Compliance will begin on January 1, 2010.

Implementing Parties: Building industry professionals, architects.

Implementation Mechanisms

Incentives for improved building construction are offered by various utilities. Incentives offered by IOUs are covered in the Types 2 and 3 incentives of EEC-5. Adoption of tax incentives or other government-funded incentives would most likely require legislative action.

Related Policies/Programs in Place

The Iowa Building Code Commissioner has initiated a practice of updating the State Energy Code every 3 years, as new editions of the IECC are published. In addition, annual revisions have been and will continue to be made to the rules to improve enforcement.

During the 2008 session of the Iowa General Assembly, several pieces of legislation were enacted that will encourage greater energy efficiency, including Senate File 517, which extended the applicability of the State Energy Code, provides for the adoption of sustainable design standards for the state by the Building Code Commissioner, and revises provisions related to the Energy Bank administered by the Department of Natural Resources; and Senate File 2386, which establishes a 2-year commission to study and report on ways to improve energy codes and their enforcement in Iowa.

Iowa rate-regulated utilities have a long history of offering energy efficiency programs focusing on new construction practices, under statutes adopted in 1990 and modified in 1996. Programs have differentiated between the residential and nonresidential sectors. In this decade, the rate-regulated utilities have increased their efforts to offer coordinated programs that provide similar program design and program incentives in both sectors. The residential sector has seen multioption programs with both builder option and ENERGY STAR emphases. The nonresidential sector has seen a multi-tiered approach focusing on design team assistance, design team incentives, and owner incentives.

Additional potential elements of this option include:

- Target new, renovated, and/or existing buildings (retrofits).
- Set a cap on consumption of energy per unit area of floor space for new buildings.
- Encourage building commissioning and recommissioning, including energy tracking and benchmarking.
- Set up a "feebate" program to encourage energy efficiency in building design.
- Provide incentives, in the form of tax credits, DSM program support, financing incentives (such as "green mortgages"), or other inducements for retrofitting existing residential and commercial buildings.
- Encourage the use of alternative and local building materials and practices.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions. For direct fuel use, CO_2 from natural gas combustion and likely very small amounts of CH_4 from the transport of natural gas to end users are reduced.

Estimated GHG Reductions and Net Costs or Cost Savings

Table F-6-1. Estimated GHG reductions and net costs of or cost savings from EEC-6

Quantification Factors	2012	2020	Units
GHG emission reductions	0.00	0.12	$MMtCO_2e$
Net present value	–$0.3	–$11.4	$ Million
Cumulative GHG reductions	0.00	0.46	$MMtCO_2e$
Cost-effectiveness	–$177.04	–$24.57	$/tCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Energy consumption by sector (BBtu). See EEC-12.
- Power station electricity generation (GWh) and fuel use (BBtu). See EEC-12.
- RECS 2001—U.S. Department of Energy, Energy Information Administration. "Residential Energy Consumption Survey 2001: Consumption and Expenditure Data Tables." Table CE1-1c: Total Energy Consumption in U.S. Households by Climate Zone. Available at: http://www.eia.doe.gov/emeu/recs/recs2001/detailcetbls.html#space.
- Heating degree-days (HDD) data from: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information

Service. Historical Climatology Series 5-1. Monthly State, Regional and National Heating Degree-Days Weighted by Population (Includes Aerially Weighted Temperature and Precipitation. Asheville, NC: National Climatic Data Center. Minnesota. Available at: http://lwf.ncdc.noaa.gov/oa/documentlibrary/hcs/hdd.200507-200607.pdf.

- Cooling degree-days (CDD) data from: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service. Historical Climatology Series 5-2. Monthly State, Regional and National Cooling Degree-Days Weighted by Population (Includes Aerially Weighted Temperature and Precipitation. Asheville, NC: National Climatic Data Center. Available at: http://lwf.ncdc.noaa.gov/oa/documentlibrary/hcs/cdd.200501-200607.pdf.
- CBECS—U.S. Department of Energy, Energy Information Administration. "Commercial Buildings Energy Consumption Survey." Ratio of 1990–1999 buildings to all buildings total energy use. Available at: http://www.eia.doe.gov/emeu/cbecs/pdf/consumption_yearconst.pdf.

Quantification Methods:

- Heat rates (Btu/kWh). See EEC-12.
- GHG emissions associated with end-Use consumption (by sector). See EEC-12.
- GHG emissions associated with electricity generation from different technologies and fuels. See EEC-12.

Key Assumptions:

- The energy efficiency programs begin in 2010 and continue through 2030.
- New residential and commercial space grows at 1.3% and 1.2% per year, respectively.
- The policy applies to 18.4% of residential electricity use and 54% of commercial electricity use.
- T&D losses for electricity are 7%.
- Compliance with this policy is assumed to be 50% at the start of the program and rises to 75% by 2020 under the new compliance regime. For the portion of the new buildings (or retrofits) that don't comply, energy use in these structures is assumed to be 20% higher than the policy level.
- Building energy consumption is a function of Iowa's climate. According to the amount of HDD and CDD, Iowa is in the Residential Energy Consumption Survey climate zone 2 (RECS 2001).
- New commercial buildings in climate zone 2 have higher electric intensity relative to existing stock, so are adjusted upward by 24% (CBECS).
- Efficiency improvements result in differential efficiency gains for natural gas and electricity:
  - Assumes code or efficiency improvement affects gas and electricity according to fuel use.
  - Residential: Electricity efficiency improvement of 1% results in 2.23% gas improvement.

  - Commercial: Electricity efficiency improvement of 1% results in 0.63% gas improvement (CBECS).
- New residential and commercial space grows at 1.3% and 1.4% per year, respectively.
- In each year, the new building stock is "treated" at the new efficiency goal (less noncompliance) and then joins the existing stock in the next year
- The annual real escalation rate for the cost of energy efficiency programs is 0%.
- The value used for the real rate at which costs are discounted annually is 5%.
- NPV is calculated in 2005 dollars beginning in 2009.
- DSM/energy efficiency programs are assumed to displace marginal sources of generation (50% coal, 50% gas) through 2012. From 2013 on, the programs are assumed to displace the new-build mix of 78% coal, 21% renewables, and 1% gas.

Key Uncertainties

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased energy efficiency and DSM investments (the avoided CO_2 methodology).[11]

Additional Benefits and Costs

Doubling the target to 20% by 2020 raises the GHG reduction to 0.22 million metric tons of carbon dioxide equivalent ($MMtCO_2e$). The cost per ton stays the same at $25.17.

Energy efficiency investments should reduce the bills of utility customers who make the investments, but will probably not lead to absolute reductions in utility rates or bills for all customers. However, cost-effective energy efficiency improvements should reduce overall utility costs and average bills when compared to more expensive alternatives.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Super Majority (1 objection).

Barriers to Consensus

Unspecified.

[11] The Annex to this document defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses and provides several scenarios for the impacts of different mixes of avoided generation technologies.

EEC-7. Training and Education for Builders and Contractors

Policy Description

This option refers to an education and outreach program for building professionals and code enforcement officials to encourage incorporation of energy efficiency and GHG emission reduction measures into construction. These programs can train designers, architects, builders, contractors, and code officials on a variety of relevant energy efficiency issues, such as building shell design, insulation, and proper heating and air conditioning sizing and installation, and can be supported by licensing requirements for design and building trade professionals that address knowledge of techniques for reducing energy use and sustainable design.

Policy Design

Goals: Implement training and education of design and building trade professionals to ensure improvements in energy efficiency and conservation in new and existing buildings.

Timing: Training and education programs in place by 2010.

Implementing Parties: Departments of Public Safety and Natural Resources, Office for Energy Independence, local code enforcement agencies; Iowa Association of Building Officials, AIA–Iowa Chapter, Iowa Engineering Society, Iowa Building Trades Council, Master Builders of Iowa, Associated Building Contractors, Iowa Center for Sustainable Communities; code-writing bodies, including the International Code Council; organizations sponsoring and promoting sustainable design, such as the U.S. Green Building Council; community colleges and universities.

Implementation Mechanisms

The program will train designers, architects, builders, contractors, and code officials on a variety of relevant energy efficiency issues, such as building shell design, insulation, and proper heating and air conditioning sizing and installation, and can be supported by licensing requirements for design and building trade professionals that address knowledge of techniques for reducing energy use and sustainable design.

Related Policies/Programs in Place

- Extension of energy codes to all commercial construction and all new one- and two-family residential construction (Senate File 517).
- Regular updating of State Energy Code.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions. For direct fuel use, CO_2 from natural gas combustion and likely very small amounts of CH_4 from the transport of natural gas to end users are reduced.

Estimated GHG Reductions and Net Costs or Cost Savings

Not quantified.

Data Sources: Not applicable.

Quantification Methods: Not applicable.

Key Assumptions: Not applicable.

Key Uncertainties

None identified.

Additional Benefits and Costs

Energy efficiency investments should reduce the bills of utility customers who make the investments, but will probably not lead to absolute reductions in utility rates or bills for all customers. However, cost-effective energy efficiency improvements should reduce overall utility costs and average bills when compared to more expensive alternatives.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

EEC-8. Technology Improvements in Targeted Markets

Policy Description

This option includes energy efficiency programs, funds, or goals (such as improved weatherization and appliances/HVAC) that focus on specific market segments at rental properties and low-income residential units. Targeting specific market segments can also be an effective component of a regional market transformation alliance.

Policy Design

Goals: Improvement in energy efficiency equal to 15% of retail sales.

Timing: Improvements realized beginning in 2010 at 1% per year for 3 years, then 1.5% for 4 years, then 2% per year until achieved.

Implementing Parties: Builders, contractors, landlords, and others TBD.

Implementation Mechanisms

None identified.

Related Policies/Programs in Place

Since 1990, Iowa's investor-owned electric and gas utilities have been mandated to have separate low-income energy efficiency policies; before then, some companies had done so voluntarily. Another market segment that has unique challenges is rental property (both residential and commercial), where tenants pay energy bills but landlords maintain the facilities. Some policy approaches for these important segments include:

- Expanding Iowa's Weatherization Assistance Program to make the homes of low-income Iowans more energy-efficient.
- Develop minimum efficiency goals for rental properties, such as use of compact fluorescent light bulbs and energy-efficient appliances. Evaluate each unit with the departure of current tenants via a pre-rental inspection program before a new tenant takes possession.
- Provide financial mechanisms to assist with the retrofitting of rental properties with energy-efficient appliances, insulation, and high-efficiency furnaces.
- Establish a shared savings or zero-interest loan program to make energy-efficient appliances affordable for everyone.
- Design policies that allow paying for energy-efficient appliances over time on residential utility bills.

Auction any emission allowances made available in a regional cap-and-trade system, and use the proceeds for renewable energy and energy efficiency investments and assistance for low-income families.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions. For direct fuel use, CO_2 from natural gas combustion and likely very small amounts of CH_4 from the transport of natural gas to end users are reduced.

Estimated GHG Reductions and Net Costs or Cost Savings

Table F-8-1. Estimated GHG reductions and net costs of or cost savings from EEC-8

Quantification Factors	2012	2020	Units
GHG emission reductions	0.09	0.98	$MMtCO_2e$
Net present value	–$6.4	–$122.5	$ Million
Cumulative GHG reductions	0.19	4.83	$MMtCO_2e$
Cost-effectiveness	–$34.15	–$25.37	$/$tCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Energy consumption by sector (BBtu). See EEC-12.
- Power station electricity generation (GWh) and fuel use (BBtu). See EEC-12.
- RECS 2001—U.S. Department of Energy, Energy Information Administration. "Residential Energy Consumption Survey 2001: Consumption and Expenditure Data Tables." Table CE1-1c: Total Energy Consumption in U.S. Households by Climate Zone. Available at: http://www.eia.doe.gov/emeu/recs/recs2001/detailcetbls.html#space.
- Heating degree-days (HDD) data from: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service. Historical Climatology Series 5-1. Monthly State, Regional and National Heating Degree-Days Weighted by Population (Includes Aerially Weighted Temperature and Precipitation. Asheville, NC: National Climatic Data Center. Minnesota. Available at: http://lwf.ncdc.noaa.gov/oa/documentlibrary/hcs/hdd.200507-200607.pdf.
- Cooling degree-days (CDD) data from: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service. Historical Climatology Series 5-2. Monthly State, Regional and National Cooling Degree-Days Weighted by Population (Includes Aerially Weighted Temperature and Precipitation. Asheville, NC: National Climatic Data Center. Available at: http://lwf.ncdc.noaa.gov/oa/documentlibrary/hcs/cdd.200501-200607.pdf.
- CBECS—U.S. Department of Energy, Energy Information Administration. "Commercial Buildings Energy Consumption Survey." Ratio of 1990–1999 buildings to all buildings total energy use. Available at: http://www.eia.doe.gov/emeu/cbecs/pdf/consumption_year const.pdf.

Quantification Methods:

- Heat rates (Btu/kWh). See EEC-12.

- GHG emissions associated with end-use consumption (by sector). See EEC-12.
- GHG emissions associated with electricity generation from different technologies and fuels. See EEC-12.

Key Assumptions:

- The energy efficiency programs begin in 2010, with energy efficiency improvements in rental properties and low-income residential units assumed to be 1% per year for 3 years, 1.5% for 4 years, then 2% per year until a cumulative reduction of 15% is achieved in the targeted buildings. With this trajectory, a 15% cumulative reduction is reached in 2019.
- 31.6% of residential electricity use is eligible for federal assistance, and thus for the program.
- 34% of commercial space is not owner occupied, and thus can benefit from efficiency investments that are likely to have been missed given "owner-tenant" disincentives for efficiency.
- New residential and commercial space grows at 1.3% and 1.2% per year, respectively.
- Efficiency improvements result in the same efficiency gains for natural gas as for electricity.
- The policy applies to 18.4% of residential electricity use and 54% of commercial electricity use.
- T&D losses for electricity are 7%.
- Compliance with this policy is assumed to be 50% at the start of the program and rises to 75% by 2020 under the new compliance regime. For the portion of the new buildings (or retrofits) that don't comply, energy use in these structures is assumed to be 20% higher than the policy level.
- Building energy consumption is a function of Iowa's climate. According to the amount of HDD and CDD, Iowa is in the Residential Energy Consumption Survey climate zone 2 (RECS 2001).
- New commercial buildings in climate zone 2 have higher electric intensity relative to existing stock, so are adjusted upward by 24% (CBECS).
- Efficiency improvements result in differential efficiency gains for natural gas and electricity:
  - Assumes code or efficiency improvement affects gas and electricity according to fuel usage.
  - Residential: Electricity efficiency improvement of 1% results in 2.23% gas improvement.
  - Commercial: Electricity efficiency improvement of 1% results in 0.63% gas improvement (CBECS).
- In each year, the new building stock is "treated" at the new efficiency goal (less noncompliance), and then joins the existing stock in the next year.
- The annual real escalation rate for the cost of energy efficiency programs is 0%.

- DSM/energy efficiency programs are assumed to displace marginal sources of generation (50% coal, 50% gas) through 2012. From 2013 on, the programs are assumed to displace the new-build mix of 78% coal, 21% renewables, and 1% gas.
- The value used for the real rate at which costs are discounted annually is 5%.
- NPV is calculated in 2005 dollars beginning in 2009.

Key Uncertainties

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased energy efficiency and DSM investments (the avoided CO_2 methodology).[12]

Additional Benefits and Costs

Energy efficiency investments should reduce the bills of utility customers who make the investments, but will probably not lead to absolute reductions in utility rates or bills for all customers. However, cost-effective energy efficiency improvements should reduce overall utility costs and average bills when compared to more expensive alternatives.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

[12] The Annex to this document defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses and provides several scenarios for the impacts of different mixes of avoided generation technologies.

EEC-9. Midwestern Governors Association Energy Security and Climate Stewardship Platform

Policy Description

Electricity use in Iowa has increased at 1.5% from 2000 to 2006; consequently, efficiency can reduce any increase in demand. Natural gas increases have been greater than 2% recently.

In November 2007, Governor Culver signed on to the MGA Energy Security and Climate Stewardship Platform.[13] This policy is designed to address the energy efficiency goal of meeting at least 2% of the region's annual retail sales of natural gas and electricity through energy efficiency programs by 2015 and annually thereafter.

This policy option will require all of Iowa's utilities—investor owned, municipal, and cooperatives—to save at least 2% of their annual retail sales of natural gas and electricity through energy efficiency programs by 2015 and annually thereafter.

Policy Design

Goals:

- Translate regional goal of at least 2% of the region's annual retail sales of natural gas and electricity through energy efficiency by 2015 and annually thereafter into an Iowa-specific goal.
- Reduce electricity consumption through efficiency measures every year after 2015.

Timing: See above.

Implementing Parties: All electric and gas suppliers, energy-related centers at the state Regents institutions.

Implementation Mechanisms

Based on MGA accord and Iowa implementation statutes.

Related Policies/Programs in Place

See Governor Culver's Executive Order #6 (February 2008)[14] and Governor Vilsack's Executive Order #41 (April 2005).[15]

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[13] Midwestern Governors Association. 2007. *Energy Security and Climate Stewardship Platform for the Midwest.* Midwestern Energy Security & Climate Stewardship Summit. Available at: http://www.wisgov.state.wi.us/docview.asp?docid=12495.

[14] State of Iowa, Executive Department. *Executive Order Number Six*. February 2008. Available at: http://publications.iowa.gov/6275/1/06-080221%5B1%5D.pdf.

[15] State of Iowa, Executive Department. *Executive Order Number Forty-One*. April 22, 2005. Available at: http://publications.iowa.gov/2619/1/EO_41.pdf.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions. For direct fuel use, CO_2 from natural gas combustion and likely very small amounts of CH_4 from the transport of natural gas to end users are reduced.

Estimated GHG Reductions and Net Costs or Cost Savings

Table F-9-1. Estimated GHG reductions and net costs of or cost savings from EEC-9

Quantification Factors	2012	2020	Units
GHG emission reductions	0.13	4.13	$MMtCO_2e$
Net present value	–$4.1	–$375.7	$ Million
Cumulative GHG reductions	0.13	17.14	$MMtCO_2e$
Cost-effectiveness	–$31.32	–$21.92	$/t$CO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t$CO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Energy consumption by sector (BBtu). See EEC-12.
- Power station electricity generation (GWh) and fuel use (BBtu). See EEC-12.

Quantification Methods:

- GHG emissions associated with end-use consumption (by sector). See EEC-12.
- GHG emissions associated with electricity generation from different technologies and fuels. See EEC-12.

Key Assumptions:

- Only GHG emission reductions and cost savings from electricity energy efficiency have been quantified.
- See EEC-12 for levelized and avoided cost assumptions.
- Iowa utilities begin reducing 2% of their annual retail electricity sales in 2015 and continue through 2030.
- The annual real escalation rate for cost of energy efficiency programs is 0%.
- The annual real escalation rate for cost of energy efficiency programs is 0%.
- The value used for the real rate at which costs are discounted annually is 5%.
- NPV is calculated in 2005 dollars beginning in 2009.
- DSM/energy efficiency programs are assumed to displace marginal sources of generation (50% coal, 50% gas) through 2012. From 2013 on, the programs are assumed to displace the new-build mix of 78% coal, 21% renewables, and 1% gas.

Key Uncertainties

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased energy efficiency and DSM investments (the avoided CO_2 methodology).[16]

Additional Benefits and Costs

Energy efficiency investments should reduce the bills of utility customers who make the investments, but will probably not lead to absolute reductions in utility rates or bills for all customers. However, cost-effective energy efficiency improvements should reduce overall utility costs and average bills when compared to more expensive alternatives.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Majority (9 objections).

Barriers to Consensus

Several members of the ICCAC believe that federal policies to reduce GHG emissions are preferable to regional efforts like the MGA Energy Security and Climate Stewardship Platform.

[16] The Annex to this document defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses and provides several scenarios for the impacts of different mixes of avoided generation technologies.

EEC-10. Energy Management Training/Building Operators

Policy Description

In many facilities, utility bills can be significantly decreased through more efficient equipment and building operation. Administrative and technical training can inform and encourage energy managers, school officials, building operators, and others responsible for facility energy efficiency to utilize methods for minimizing unnecessary energy waste. This policy would increase education and demonstrate the benefits of energy-efficient building operation through government "leading by example" of energy service contracting.

Policy Design

Goals: Require energy managers and facility operators in all sectors to obtain certification for successful completion of the training program.

Timing: Starting in 2010.

Implementing Parties: State and local entities, private energy managers, and facility operators throughout the state.

Implementation Mechanisms

Specifically, this policy involves developing, implementing, and requiring a statewide energy efficiency and conservation education and training program for energy managers and facility operators to learn techniques for improving the efficiency of their steam, process heat, pumping, compressed air, motors, and other systems. Successful completion of this training would be required for energy managers and facility operators in all sectors (residential, commercial, industrial, and institutional) by a licensing or certification requirement, which would need to be established. Continuing education credits would be required annually.

A key organization in implementing energy efficiency training for building operators would be the Building Owners and Managers Association.

Related Policies/Programs in Place

The Building Operator Certification (BOC) is a program component of the Custom Rebate DSM program offered in partnership by the IOUs and the Midwest Energy Efficiency Alliance. As described by the IOUs, BOC is a nationally recognized competency-based training and certification program for operations and maintenance staff working in commercial, institutional, or industrial buildings. BOC achieves energy savings by training individuals directly responsible for maintenance of energy-using building equipment and day-to-day building operations.

Interstate Power and Light Company caps program impacts at a maximum of 10% of the customer's 12 months' kilowatt-hour (kWh) and therm usage. IOU Building Operator program reports average energy savings achieved by program participants as 0.18 kWh and 0.71 therms per participant's square foot of facility.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions. For direct fuel use, CO_2 from natural gas combustion and likely very small amounts of CH_4 from the transport of natural gas to end users are reduced.

Estimated GHG Reductions and Net Costs or Cost Savings

Table F-10-1. Estimated GHG reductions and net costs of or cost savings from EEC-10

Quantification Factors	2012	2020	Units
GHG emission reductions	0.03	0.53	$MMtCO_2e$
Net present value	–$1.9	–$51.6	$ Million
Cumulative GHG reductions	0.05	2.16	$MMtCO_2e$
Cost-effectiveness	–$39.80	–$23.89	$/t$CO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t$CO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- ACEEE 2008—American Council for an Energy Efficient Economy. February 2008. *Energy Efficiency: The First Fuel for a Clean Energy Future*. *Resources for Meeting Maryland's Electricity Needs.* Report No. E082, p. 84. Available at: http://aceee.org/pubs/e082.pdf?CFID=534012&CFTOKEN=57232379.
- CBECS 2006a—U.S. Department of Energy, Energy Information Administration. "2003 Commercial Buildings Energy Consumption Survey Detailed Tables." Table A2. Available at: http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html - buildingchar03.
- Interstate Power and Light. *DSM Plan*. Vol. I, pp. 100-101. No Web link available.

Quantification Methods:

- GHG emissions associated with end-use consumption (by sector). See EEC-12.
- GHG emissions associated with electricity generation from different technologies and fuels. See EEC-12.

Key Assumptions:

- Building manager certification trains 5% of building operators in year 1 rising to 75% in 2020. (Subcommittee assumption)
- Training program applies to heating, cooling, and ventilation energy use at commercial buildings, which is 41% of energy use.
- 50% of commercial buildings (by square footage) have energy managers who are trained under the program. The remaining 50% of commercial buildings do not receive benefits under the program. The estimate is derived from square footage by principal building activity from CBECS (2006a) data for the Midwest region. It assumes: (1) that all education, mercantile, office, and service buildings have energy managers who would participate, and (2) that the other building types, including warehouses, places of religious worship, and

health care facilities don't have energy managers and, therefore, don't participate. These two stringent assumptions are likely to average each other out and provide a rough estimate for likely coverage of the program.

- Energy savings is equal to 10% of cooling load and 7.5% of heating and ventilation load, which equates to 4% of net energy savings (ACEEE 2008).
- Efficiency improvements result in differential efficiency gains for natural gas and electricity:
    - Assumes code or efficiency improvement affects gas and electricity according to fuel use.
    - Commercial: Electricity efficiency improvement of 1% results in 0.63% gas efficiency improvement (CBECS 2006a).
- The annual real escalation rate for cost of energy efficiency programs is 0%.
- The value used for the real rate at which costs are discounted annually is 5%.
- NPV is calculated in 2005 dollars beginning in 2009.
- DSM/energy efficiency programs are assumed to displace marginal sources of generation (50% coal, 50% gas) through 2012. From 2013 on, the programs are assumed to displace the new-build mix of 78% coal, 21% renewables, and 1% gas.

Key Uncertainties

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased energy efficiency and DSM investments (the avoided CO_2 methodology).[17]

Additional Benefits and Costs

Energy efficiency investments should reduce the bills of utility customers who make the investments, but will probably not lead to absolute reductions in utility rates or bills for all customers. However, cost-effective energy efficiency improvements should reduce overall utility costs and average bills when compared to more expensive alternatives.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Super Majority (1 objection).

Barriers to Consensus

Unspecified.

[17] The Annex to this document defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses and provides several scenarios for the impacts of different mixes of avoided generation technologies.

EEC-11. Rate Structures

Policy Description

This policy option could include various elements of utility rate design that are geared toward reducing GHG emissions, often with other benefits as well, such as reducing peak power demand. The overall goal is to present rate structures so as to better reflect the actual economic and environmental costs of producing and delivering electricity as those costs vary by time of day, day of the week, season of the year, and from year to year. In this way, rates provide consumers with information reflecting the impacts of their consumption choices.

The reduction of GHGs from changes in rate structures can come from two sources. The first is the reduction of absolute levels of energy use by consumers due to higher prices. Real-time pricing and smart metering give consumers information about their energy use that enables them to better rationalize their use. Time-of-use pricing, or other schemes to reflect rational pricing that result in price increases during peak periods, potentially reduces demand by the estimated price elasticity of demand, typically by –0.20% to –0.50% (U.S. EIA 2003), so that a 10% increase in prices would lead to a 2%– 5% reduction in demand. In a survey of experience with smart metering, Owen and Ward (2006) found energy savings of 0%–10%.

The other source of GHG reductions from policies to reduce peak demand is energy efficiency measures that reduce demand during peak periods, such as high-efficiency air conditioners and chillers. These measures are included in the existing DSM measures in EEC-12 (DSM/energy efficiency) and EEC-14 (appliance standards). These measures also reduce new generation capacity investments, which are not quantified for GHG reductions because they are covered under other policy options.

The GHG impacts of other types of rate structures are more difficult to quantify. Curtailment programs that allow loads to be shifted during peak periods might result in different emission profiles as these loads move from peak to shoulder or baseload periods. Overall CO_2 savings from these programs are also difficult to quantify; thus, they are not quantified for this policy.

Policy Design

Goals: Reduce electricity consumption through pricing by 2% of retail sales.

Timing: Compliance will begin on January 1, 2010.

Implementing Parties: All Iowa utilities and utility customers.

Implementation Mechanisms

- Programs for customers of IOUs are reviewed and authorized by the IUB in contested case proceedings for the review of energy efficiency plans. Proceedings—labeled EEP (energy efficiency plan) proceedings—are currently underway for the review of new (2009–2013) EEPs. The current plans of IOUs include two types of rate programs: residential direct-load-control programs and nonresidential interruptible programs.

- The relationship of EEP proceedings to traditional rate proceedings for rate and revenue design in programs besides direct-load-control and interruptible programs, such as those listed in the Related Polices section below, has not been taken up in Iowa. The other rate design options (beyond interruptible and direct-load-control), to the extent currently available, have been implemented through general rate case proceedings. The IUB examines rate-regulated utilities' rate structures in rate proceedings to be sure that the rate structures in place send the appropriate price signals.
- Section 1252 of the Energy Policy Act of 2005 established the Public Utilities Regulatory Policies Act (PURPA) Standard 14, entitled "Time-Based Metering and Communications." Standard 14 directed the IUB to consider adopting four types of time-based rate schedules: time-of-use pricing, critical peak pricing, real-time pricing, and load management programs. The IUB declined to adopt PURPA Standard 14 in its entirety, finding that rate proceedings are the appropriate forum for many of these issues (IUB Docket No. NOI-06-3, March 6, 2007). The IUB intends to begin informal discussions with interested participants regarding these topics and potential pilot projects.
- Programs for customers or members of municipal utilities and electric cooperatives are solely at the discretion of each customer-owned utility. The IUB hopes the consumer-owned utilities will be active in ongoing discussions and potential pilot programs to test other rate design options beyond the well-established load management programs.

Related Policies/Programs in Place

Rate-regulated utilities have employed two types of rate structures for many years and, in some cases, for many decades:

- **Seasonal rates—**These rates typically have higher prices in the season of the year when demand and prices are the highest. In Iowa the higher season is typically a summer period of 3–4 months.
- **Time-of-day (TOD) rates—**These rates typically price electricity higher at times of higher power demand, based on either a two- or three-tiered time-differentiated structure, and thus better reflect the actual cost of generation, transmission, and distribution. Time-of-use rates may or may not have a significant impact on total GHG emissions, but do affect on-peak power demand and, thus, both the need for peaking capacity and fuel for peaking plants.

Other possible policy mechanisms include several that have been offered on a much more limited basis:

- **Critical peak pricing (CPP)—**Also known as extreme-day pricing, CPP refers to programs aiming to reduce system demand by encouraging customers to reduce their loads for a limited number of hours during the year. CPP programs integrate a pricing structure similar to TOD, with the distinction of more extreme pricing signals for the critical events. (A price structure in which the extreme price is fixed by tariff reduces to a multi-tiered time-of-day rate.)
- **Real-time pricing—**A tariff structure for customers to pay electric rates tied to market prices for energy. The prices are typically posted by the utility based on day-ahead hourly prices, but could be posted on a real-time basis.

- **Inverted block pricing**—Also known as tiered/increasing peak, under this policy mechanism rates for electricity and natural gas use include a rate for some base usage level and increased rates for higher levels of consumption.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions. For direct fuel use, CO_2 from natural gas combustion and likely very small amounts of CH_4 from the transport of natural gas to end users are reduced.

Estimated GHG Reductions and Net Costs or Cost Savings

Table F-11-1. Estimated GHG reductions and net costs of or cost savings from EEC-11

Quantification Factors	2012	2020	Units
GHG emission reductions	0.04	0.21	$MMtCO_2e$
Net present value	–$2.6	–$25.7	$ Million
Cumulative GHG reductions	0.08	1.20	$MMtCO_2e$
Cost-effectiveness	–$32.21	–$21.45	$/t$CO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t$CO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Energy consumption by sector (BBtu). See EEC-12.
- Power station electricity generation (GWh) and fuel use (BBtu). See EEC-12.
- Owen, Gill, and Judith Ward. March 2006. *Smart Meters: Commercial, Regulatory and Policy Drivers*. Appendix 2. "Sustainability First." Available at: http://www.sustainabilityfirst.org.uk/docs/smartmeterspdfappendices.pdf.
- Quantec LLC, Summit Blue Consulting, Nextant, Inc., A-TEC Energy Corporation, and Britt/Makela Group. February 2008. *Assessment of Energy and Capacity Savings Potential in Iowa: Final Report*, vol. I. Prepared for the Iowa Utility Association. (No Web link available.)
- U.S. EIA 2003—U.S. Department of Energy, Energy Information Administration. 2003. "Price Responsiveness in the AEO2003 NEMS Residential and Commercial Buildings Sector Models." Available at: http://www.eia.doe.gov/oiaf/analysispaper/elasticity/.

Quantification Methods:

- Heat rates (Btu/kWh). See EEC-12.
- GHG emissions associated with end-use consumption (by sector). See EEC-12.
- GHG emissions associated with electricity generation from different technologies and fuels. See EEC-12.

Key Assumptions:

- Peak avoided costs and levelized costs are assumed to be the same as for EEC-12. A host of measures could fall under this category, from smart meters to interruptible load programs. These measures tend to have low capital costs; thus, using the levelized costs estimates from Quantec (2008) is a conservative assumption.
- The annual real escalation rate for cost of energy efficiency programs is 0%.
- The value used for the real rate at which costs are discounted annually is 5%.
- NPV is calculated in 2005 dollars beginning in 2009.
- Demand-response measures are assumed to reduce electricity demand by 5%. This number is a midpoint from the survey in which Owen and Ward (2006) found energy savings from smart meters to vary by 0%–10%. This is consistent with what price elasticity of demand would predict. If peak price tariffs are 10%–20% higher than nonpeak tariffs, then demand reductions would range from 2.5% to 10% using price elasticities of –0.20% to –0.5%.
- The installation of demand-response measures increases from 2% of total sales in the beginning of the program to 40% by 2020 as the program gets implemented. Assuming a 5% demand reduction and 40% participation, the program reaches the target of 2% of retail sales by 2020.
- The program applies only to peak load hours, which are assumed to be January–March and April–September, 0700–2300 hours, for a total of 44% of total annual hours.
- Residential, commercial, and industrial customers all implement the program at the same rate.
- Existing and planned (business-as-usual [BAU]) demand-response measures are 50% of the total policy reductions (subcommittee assumption).
- DSM/energy efficiency programs are assumed to displace marginal sources of generation (50% coal, 50% gas) through 2012. From 2013 on, the programs are assumed to displace the new-build mix of 78% coal, 21% renewables, and 1% gas.

Key Uncertainties

There is uncertainty as to the benefits and costs of rate options and rate designs that are dependent on utility-wide implementation of real-time metering (IUB Docket No. NOI-06-3).

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased energy efficiency and DSM investments (the avoided CO_2 methodology).[18]

Additional Benefits and Costs

Metering and associated infrastructure investments needed to support real-time pricing offer the potential for additional cost savings to the utility.

[18] The Annex to this document defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses and provides several scenarios for the impacts of different mixes of avoided generation technologies.

Energy efficiency investments should reduce the bills of utility customers who make the investments, but will probably not lead to absolute reductions in utility rates or bills for all customers. However, cost-effective energy efficiency improvements should reduce overall utility costs and average bills when compared to more expensive alternatives.

Feasibility Issues

- Identifying the cost of metering and associated infrastructure investment needed to support various pricing options.
- Designing rate programs that customers will embrace.
- Quantifying the energy impacts associated with various rate options.
- Educating customers about pricing options in order to obtain anticipated energy benefits.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

EEC-12. Demand-Side Management (DSM)/ Energy Efficiency Programs for Electricity

Policy Description

DSM/energy efficiency is a policy approach that requires actions that influence both the quantity and the patterns of energy consumed by end users. This policy option focuses on DSM/energy efficiency programs run by electric utilities, and may be designed to work in tandem with other strategies that can also encourage efficiency gains.

Policy Design

Goals: Invest in energy efficiency equal to 1.0% of retail electricity sales per year within 3 years; 1.5% per year in 5 years; and 2.0% per year in 7 years.

Timing: Phase in, beginning in 2010.

Implementing Parties:

- Extend the DSM obligations and goals to all electric utilities in Iowa. IOUs are starting at 0.8% of retail sales; municipal utilities and rural electric cooperatives start at varying levels.
- IOUs and the Iowa Utility Association, municipal utilities and the IAMU, electric cooperatives and the Iowa Association of Electric Cooperatives.

Implementation Mechanisms

Possible policy mechanisms include:

- Have the IUB establish DSM goals for investor-owned utilities.
- Revise existing statutes to incorporate prescribed energy efficiency goals.
- Change the determination of DSM cost-effectiveness by accounting for the estimated valuation of CO_2 emissions avoided by programs.
- Extend the DSM obligations and goals to all to all electric utilities in Iowa.
- Expand DSM measures eligible for program incentives.
- Expand the scope of utility activity that can contribute to achieving DSM goals to include actions that are on the utility side of the meter, so-called “infrastructure” investments.
- Recognize the contribution of increased building energy codes and equipment energy standards to the achievement of DSM goals.
- Include in the measurement of DSM goals the energy savings from renewable measures that are implemented on the customer side of the meter.

Related Policies/Programs in Place

Electric utilities in Iowa must offer cost-effective energy efficiency programs (Iowa Code §§ 476.6(14)). The IUB establishes energy efficiency goals for IOUs (Iowa Code § 476.6(16)). DSM offered by non-rate-regulated utilities is not regulated (Iowa Code § 476.6(16)).

Investor-Owned Electric Utilities

Iowa IOUs have a long history of conducting DSM/energy efficiency programs, under statutes adopted in 1990 and modified in 1996. The IUB conducts contested proceedings for the review of plans, programs, and energy saving goals developed by IOUs. New plans were filed in April 2008, and the IUB has directed the IOUs to include analyses of the effects of goals equivalent to saving 1.5% of retail electric sales in Iowa.

Municipal and Cooperative Electric Utilities

Although the rural electric cooperatives and municipal electric utilities were required to file biennial energy efficiency plans, and many have historically conducted DSM programs, legislation passed in 2008 requires each utility or group of utilities to determine the maximum potential energy and capacity savings available from actual and projected customer usage through cost-effective energy efficiency measures and programs. Based on this assessment, each utility must establish an energy efficiency goal and a set of cost-effective energy efficiency programs designed to meet the energy efficiency goal.

The process must be started by July 1, 2008, with a progress report submitted to the IUB by January 1, 2009, and a final report filed by January 1, 2010. The report must include the utility's cost-effective energy efficiency goal, and for each measure utilized by the utility in meeting the goal, the measure's description, projected cost, and the analysis of its cost-effectiveness. On January 1 of each even-numbered year, commencing January 1, 2012, utilities must file a report with the IUB identifying their progress in meeting the energy efficiency goal and any updates or amendments to their energy efficiency plans and goals. This requirement will take the place of the current energy efficiency plan filings.

IOU BAU electric efficiency investments equate to 0.8% of load in 2008. The assumed incremental (new) statewide electric energy efficiency investments are equal to 0.69% of retail sales over the planning period. Proposed energy efficiency plans, pending IUB determination, would achieve 1.3%–1.5% of retail sales by 2012.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions. For direct fuel use, CO_2 from natural gas combustion and likely very small amounts of CH_4 from the transport of natural gas to end users are reduced.

Estimated GHG Reductions and Net Costs or Cost Savings

Table F-12-1. Estimated GHG reductions and net costs of or cost savings from EEC-12

Quantification Factors	2012	2020	Units
GHG emission reductions	0.39	4.38	$MMtCO_2e$
Net present value	–$24.6	–$444.8	$ Million
Cumulative GHG reductions	0.78	20.33	$MMtCO_2e$
Cost-effectiveness	–$31.60	–$21.88	$/t$CO_2$e

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t$CO_2$e = dollars per metric ton of carbon dioxide equivalent.

Assuming incremental energy efficiency investments in Iowa remained unchanged from 2006 levels reported in IUB (2008), Iowa's cumulative electric energy efficiency deployment would be approximately 15% of sales in 2020. When using the levelized cost estimate assumptions developed for the EEC sector, total utility and participant spending on energy efficiency/DSM in the reference case is estimated at $270 million in 2020. Under EEC-12, additional energy efficiency spending is estimated at $178 million in 2020, which achieves another cumulative 10% of sales.

Data Sources:

- Capital costs—Quantec LLC, Summit Blue Consulting, Nextant, Inc., A-TEC Energy Corporation, and Britt/Makela Group. February 2008. *Assessment of Energy and Capacity Savings Potential in Iowa: Final Report*, vol. I. p. ES-3. Prepared for the Iowa Utility Association. (No Web link available.)
- IUB. January 1, 2008. The Status of Energy Efficiency Programs in Iowa and the 2007 Iowa Residential Energy Survey. Report to the Iowa General Assembly. p. 50. Available at: http://www.state.ia.us/government/com/util/docs/misc/EE/noi072/noi072_StatusReport.pdf.
- Expert testimony in IUB Interventions filed relative to the EEP filings of the regulated utilities.

Energy Consumption by Sector (BBtu)

- Historical energy consumption in the state, by sector, is from the U.S. Department of Energy, Energy Information Administration, State Energy Data System. Available at: http://www.eia.doe.gov/emeu/states/_seds.html.
- To calculate projected energy consumption through 2030, growth factors were applied to the historical 2005 data. The growth factors are based on a combination of two parameters:
  - One accounts for growth within the RCI sectors, with growth factors for the residential sector based on projected population growth (from U.S. Bureau of the Census, Population Estimates Branch, and State Library of Iowa, State Data Center Program [http://data.iowadatacenter.org/datatables/State/stpopest19002007.xls] and State Library of Iowa, State Data Center Program, "Iowa Census Data Tables: Projections" http://data.iowadatacenter.org/browse/projections.html); growth in the commercial sector based on non-manufacturing employment growth projections; and industrial-sector growth based on manufacturing employment. Employment projections were taken from Iowa Workforce Development, Labor Market and Economic Research Bureau, "Iowa

Statewide Projections (2004–2014)" (http://iwin.iwd.state.ia.us/pubs/statewide/indprojstatewide.pdf).

  - The other factor is growth in electricity sales, which was calculated based on historical retail sales from U.S. Department of Energy, Energy Information Administration, "Iowa Electricity Profile," Table 8: Retail Sales, Revenue, and Average Retail Price by Sector, 1990 Through 2006. Available at: http://www.eia.doe.gov/cneaf/electricity/st_profiles/iowa.html.

Power Station Electricity Generation (GWh) and Fuel Use (BBtu)

- Gross generation for 2005 was obtained from the EIA database (EIA-906/920) on fuel stocks at all electric power sector generating facilities, broken down by fuel type. (See U.S. Department of Energy, Energy Information Administration. Form EIA-906: Power Plant Report and Form EIA-920: Combined Heat and Power Plant Report. Available at: http://www.eia.doe.gov/cneaf/solar.renewables/page/state_profiles/rspt05ar.xls.)

- Data for later years were projected from the 2005 figure based on projections of growth in generation for the Mid-Continent Area Power Pool (MAPP) region. The projected regional consumption and generation data are from U.S. Department of Energy, Energy Information Administration, "Supplemental Tables to the Annual Energy Outlook 2008," Data Tables 62–91: Electricity Generation & Renewable Resource. Available at: http://www.eia.doe.gov/oiaf/aeo/supplement/index.html. On-site usage was subtracted from all generation figures.

Quantification Methods:

Heat Rates (Btu/kWh)

- Heat rates indicate how much fuel is used (Btu) to generate a given amount of electricity (kWh). They vary greatly, depending on the type of power stations and the fuel used. Heat rates are used to convert figures for electricity into figures for fuel use, so the fuel use can be converted into GHG emissions using GHG emission factors. Heat rates for 2005 for each type of generation and fuel were calculated from 2005 fuel use (in BBtu), divided by 2005 generation (GWh). Projections for 2006 and beyond are based on annual combustion efficiency growth rates for the MAPP region. Combustion efficiency for a given year is calculated for each fuel type as the fuel use (in quadrillion Btu) divided by the electricity generated (in billion kWh), and the combustion efficiency growth rate applied to this value is based on the change in combustion efficiency from the previous year.

GHG Emissions Associated With End-Use Consumption (by Sector)

- Historical CO_2 data by sector (and further broken down by fuel type) were calculated by two U.S. Environmental Protection Agency (EPA) State Greenhouse Gas Inventory Tool (SIT) software modules: the Fossil Fuel Combustion Module and—for emissions from industrial sources—the SIT module for industry. CH_4 and N_2O emissions were calculated by the Stationary Combustion Module and—for emissions from industrial sources—the SIT module for industry.

- Projected emissions through 2030 were based on the 2005 data, with growth factors compounded from year to year as discussed above for energy consumption.

GHG Emissions Associated With Electricity Generation From Different Technologies and Fuels

- The projected data for each GHG were calculated for each fuel and generation type (e.g., non-lignite coal in a steam plant) as a direct product of the projected generation data (in GWh) described above. Metric tons (t) of CO_2 are calculated from generation as:

  tCO_2 = GWh × (Btu/kWh) × (tCO_2/MBtu) × (% of that fuel in the fuel mix)
  where (Btu/kWh) is the heat rate and (tons CO_2/MBtu) is the CO_2 emission factor, where MBtu is thousands of Btu

  CH_4 and N_2O emissions were calculated similarly, and were then converted to CO_2e using global warming potentials of 21 for CH_4 and 310 for N_2O. The emission factors used for each GHG were the same as those used in the EPA SIT software modules.

Key Assumptions:

- The levelized cost of energy efficiency measures is $37.13/megawatt-hour (MWh) (2008 dollars) in 2009. This figure includes all utility and participant costs. Utility fixed costs are assumed to be 24% of the capital cost, based on MidAmerican's energy efficiency plan filing Docket #EEP-08-02, Vol. II, p. A1-8. (No Web link available.)
- The levelized cost of peak electricity demand-response measures is $37.13/MWh (2008 dollars). This figure includes all utility and participant costs. Utility fixed costs are assumed to be 24% of the capital cost, based on MidAmerican's energy efficiency plan filing Docket #EEP-08-02, Vol. II, p. A1-8. (No Web link available.)
- The avoided cost of electricity in 2009 is $0.3072/MWh (2008 dollars). This figure is from 2009–2013 Energy Efficiency Plan, Interstate Power and Light Company Docket No. EEP-08-1, 23-Apr-08, p. 33, Values base case without externality factor. (No Web link available.)
- The avoided cost of peak electricity in 2009 is $72/MWh (2008 dollars). This figure is from 2009–2013 Energy Efficiency Plan, Interstate Power and Light Company Docket No. EEP-08-1, 23-Apr-08, p. 33, Values base case without externality factor. (No Web link available.)
- T&D losses are 7%. From IA_ES_Forecast.xls assumptions tab. Net average T&D losses 2005–2030. Available at: http://www.iaclimatechange.us/Inventory_Forecast_Report.cfm.
- The energy efficiency programs begin in 2010.
- The annual real escalation rate for the cost of energy efficiency programs is 0%.
- NPV is calculated in 2005 dollars beginning in 2009.
- DSM/energy Efficiency programs are assumed to displace marginal sources of generation (50% coal, 50% gas) through 2012. From 2013 on, the programs are assumed to displace the new-build mix of 78% coal, 21% renewables, and 1% gas.
- Energy efficiency costs are expressed as levelized costs over the life of the energy efficiency options. The incremental costs (typically incurred in the first year of program implementation) are spread over all future years of the life of the energy efficiency measures.
- Statewide electricity energy efficiency programs are assumed to be 0.69% of retail sales over the planning period.

- IOU electric sales comprise approximately 76% of statewide electricity sales over the planning period.
- The value used for the real rate at which costs are discounted annually is 5%.

Key Uncertainties

Construction of new generation plants, while actively discussed in the state, is not certain. In addition, some existing generation units are likely to be retired.

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased energy efficiency and DSM investments (the avoided CO_2 methodology).[19] The sensitivity analysis in Table F-12-2 indicates the outcomes of applying different assumptions about avoided generation for EEC-12.

Table F-12-2. Sensitivity analysis incorporating various assumptions for EEC-12

Scenarios	Avoided Generation Mix		EEC-12 Outcomes		
	2009–2012	2013–2020	Year 2020 Reductions ($MMtCO_2e$)	Cumulative 2009–2020 Reductions ($MMtCO_2e$)	2009–2020 ($/t$CO_2e$)
Reference: Marginal then New Build	50% coal, 50% gas	78% coal, 21% renewables, 1% gas	4.4	20.3	–$22
Marginal (More Coal Case)	50% coal, 50% gas	50% coal, 50% gas	4	18.9	–$24
Marginal (More Gas Case)	35% coal, 65% gas	35% coal, 65% gas	3.6	16.7	–$27

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t$CO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Additional Benefits and Costs

Energy efficiency investments should reduce the bills of utility customers who make the investments, but will probably not lead to absolute reductions in utility rates or bills for all customers. However, cost-effective energy efficiency improvements should reduce overall utility costs and average bills when compared to more expensive alternatives.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

[19] The Annex to this document defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses and provides several scenarios for the impacts of different mixes of avoided generation technologies.

Level of Group Support

Super Majority (4 objections).

Barriers to Consensus

Several members of the ICCAC believe that this option does not adequately assess the costs and benefits, reflect the impact of different load growth scenarios, or reflect the impact of how electric utilities manage existing generation fleet resources.

EEC-13. Government Lead by Example: Improved Design, Construction, and Energy Operations in New and Existing State and Local Government Buildings

Policy Description

The state of Iowa and municipal and county governments and school districts can provide leadership in energy efficiency by adopting policies that improve the energy efficiency of new and renovated public buildings, and the equipment and appliances used therein. This policy option provides targets to improve the efficiency of energy use in new and existing state and local government buildings that are much higher than code standards.

Policy Design

Goals:

- Require that all new construction and major renovations of government-owned buildings, including schools and publicly owned hospitals, meet sustainable design standards.
- Starting in 2008, all new state buildings and major renovations will be designed to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 50% of the regional average for that building type.
- All state and local governments will require the procurement of energy-efficient equipment, including lighting, office equipment, and other appliances, such as ENERGY STAR. (This goal element is quantified under EEC-14.)
- The fossil fuel reduction standard for all new buildings will be increased to:
  - 60% in 2010
  - 70% in 2015
  - 80% in 2020
  - 90% in 2025

All state buildings will be carbon-neutral in 2030 (zero net energy, using no fossil fuel GHG-emitting energy to operate).

Timing: See above.

Implementing Parties: State and local governments, the Capitol Planning organization, all three Regents institutions, Iowa Association of Counties, League of Cities, Iowa Association of School Boards, Iowa State Education Association, School Administrators of Iowa, private contractors, Iowa State Building & Construction Trades Council.

Implementation Mechanisms

These goals can be met by a combination of demand-reduction measures, on-site carbon-neutral generation, and grid-based green power purchases that exceed the amount of green power purchases currently provided by the utility.

- **Require Sustainable Design Standards:** Mandate that all new construction and major renovations of government-owned buildings, including schools and publicly owned hospitals, meet sustainable design standards, with increasingly more stringent requirements.
- **Collect Data on State and Local Government Building and Facilities Energy Use:** A key implementation mechanism for this option will be to first provide a thorough assessment of the status and energy consumption of all existing state and local government buildings, including establishing a database of buildings and building attributes, including floor area, insulation level, energy-using equipment, and history of energy consumption. This baseline, or "carbon footprint," will be used to assess program success.
- **Benchmark State Buildings:** Benchmarking is the process of using the data on building size, use, and energy use to quickly compare a building against others of similar size and use to determine how efficiently the building is operating. It is an important step in identifying and prioritizing opportunities for energy savings.
- **Commission State Buildings:** Building commissioning is a process of reviewing and tuning up the operation of building systems and controls, much like tuning up a vehicle. Potential targets for commissioning might include commissioning state buildings upon completion of construction or renovation, and whenever the energy use in a building shows an unexpected and unexplained increase in energy use.
- **Purchase Green Power:** Iowa should enter into agreements to purchase green power for a portion of the state's electricity needs, as laid out in Iowa Gov. Tom Vilsack's April 2005 Executive Order #41 on Energy Efficiency and Renewable Energy,[20] and Iowa Gov. Chet Culver's February 2008 Executive Order #6 on the same topic.[21] The state should increase purchases over time, until 30% of power needs are met through direct use of renewable energy or green power purchased by 2030.
- **Set Energy Use Targets:** Targets for energy use in the operation of state buildings might include capping state and local buildings' and facilities' energy use per square foot. Motion sensors, which are a specific technology for reducing lighting energy use in government buildings, may have broad application.
- **Renovate State and Local Buildings and Facilities Through a Buildings and Facilities Energy Program:** Within 5 years, the state should renovate all state and local buildings and facilities with more than 5,000 square feet, and smaller buildings identified through an energy benchmark process as having a high potential for energy savings. State and local buildings and facilities energy programs will provide funds for energy audits, engineering analyses, and renovation costs.
- **Develop and Use Renewable Energy Resources:** The state should evaluate the potential for direct use of solar, wind, biomass, geothermal, and hydropower to meet the needs of state government operations, and should invest in these renewable resources whenever they are practical and cost-effective, and use them as a means to lead by example.

[20] State of Iowa, Executive Department. *Executive Order Number Forty-One*. April 22, 2005. Available at: http://publications.iowa.gov/2619/1/EO_41.pdf.

[21] State of Iowa, Executive Department. *Executive Order Number Six*. February 2008. Available at: http://publications.iowa.gov/6275/1/06-080221%5B1%5D.pdf.

- **Require Carbon-Neutral Bonding:** Climate-neutral bonding will require that any building projects financed with the issuance of state, county, or local/municipal bonds result in no net increase in GHG emissions. If a new construction project is expected to increase emissions, there must be GHG emission reductions to offset the increase within the state or particular jurisdiction. Offsets could include on-site renewable energy development, renewable energy purchases, energy efficiency (in existing state buildings), carbon sequestration (tree planting), and switching to cleaner or renewable fuels. Any GHGs emitted after the bond-financed project becomes operational will be required to be offset. The new buildings could also offset their emissions by purchasing renewable electricity from their local utility. Paying a premium for what's known as "green pricing" electricity will usually be a more expensive offset option than energy efficiency. A community or state could install its own renewable energy project as a way to offset its GHG emissions.
- **Conduct Monitoring and Verification:** Building energy use will need to be reviewed periodically.

Related Policies/Programs in Place

See Governor Culver's Executive Order #6, which requires state buildings to reduce energy use by 15% by 2015.[22] Elements of this policy include:

- Government buildings, facilities, and related operations (including wastewater and water utilities) will be in operation for many years and should be designed in a manner that meets or exceeds private-sector-mandated building and trade energy efficiency. When life-cycle cost are considered, the discount rate should be smaller and the assumptions of future energy prices should be higher than those commonly considered in the private sector, so that the state may be seen as a leader in energy efficiency and workforce efficiency. All new state buildings and facilities, and renovations and additions must meet sustainable design standards established by the Building Code Commissioner at increasingly stringent levels over time, and must meet or exceed the energy efficiency and renewable energy goals stated in the order.
- Existing state and local government buildings must be retrofitted for energy efficiency achieving 100% of cost-effective energy efficiency by 2015. To meet this goal, the state and local governments must benchmark all buildings and facilities within the next 3 years.
- Energy performance and operations of state and other government buildings must be audited (in tandem with an audit program). Audit results could be used to target and prioritize investments in improving government building energy efficiency.
- Efficiency goals must be improved and reviewed over time, and contracting arrangements must be made more flexible to encourage integrated energy-efficient design and construction.
- The implementation infrastructure (meters, accounting systems, staff, etc.) should be established as soon as possible.

[22] State of Iowa, Executive Department. *Executive Order Number Six*. February 2008. Available at: http://publications.iowa.gov/6275/1/06-080221%5B1%5D.pdf.

- "Retained savings" policies should be established that enable government agencies to retain funds saved by reducing energy bills and use the funds for further investment in energy efficiency/renewable energy measures or other uses.
- Carbon-neutral bonding is required for new construction and for renovations and additions. A carbon-neutral performance standard will require architects and engineers to design and build buildings that meet a climate-neutral requirement, meet or exceed the state's existing sustainable building guidelines, and save the taxpayers money as life-cycle costs will yield lower operational costs.
- Incentives should focus on specific technologies, including white roofs, rooftop gardens, and landscaping to lower electricity demand, and solar photovoltaics to provide electricity when demand is highest.

Potential supporting measures for this option include training and certification of building-sector professionals, but could also include surveys of government energy and water use, energy benchmarking, measurement, and tracking programs for municipal and state buildings.

Executive Order #41 (Governor Vilsack) requires that all state agencies reduce energy consumption per square foot per degree-day in all conditioned facilities (buildings) by an average of 15% by 2010 relative to 2000 levels.[23]

Iowa Code 473.13A—Energy conservation measures identified and implemented.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions. For direct fuel use, CO_2 from natural gas combustion and likely very small amounts of CH_4 from the transport of natural gas to end users are reduced.

Estimated GHG Reductions and Net Costs or Cost Savings

Table F-13-1. Estimated GHG reductions and net costs of or cost savings from EEC-13

Quantification Factors	2012	2020	Units
GHG emission reductions	0.08	0.36	$MMtCO_2e$
Net present value	$0.0	$1.0	$ Million
Cumulative GHG reductions	0.14	1.97	$MMtCO_2e$
Cost-effectiveness	–$0.16	0.53	$/tCO₂e

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Energy consumption by sector (BBtu). See EEC-12.
- Power station electricity generation (GWh) and fuel use (BBtu). See EEC-12.

[23] State of Iowa, Executive Department. *Executive Order Number Forty-One*. April 22, 2005. Available at: http://publications.iowa.gov/2619/1/EO_41.pdf.

- RECS 2001—U.S. Department of Energy, Energy Information Administration. "Residential Energy Consumption Survey 2001: Consumption and Expenditure Data Tables." Table CE1-1c: Total Energy Consumption in U.S. Households by Climate Zone. Available at: http://www.eia.doe.gov/emeu/recs/recs2001/detailcetbls.html#space.

- Heating degree-days (HDD) data from: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service. Historical Climatology Series 5-1. Monthly State, Regional and National Heating Degree-Days Weighted by Population (Includes Aerially Weighted Temperature and Precipitation. Asheville, NC: National Climatic Data Center. Minnesota. Available at: http://lwf.ncdc.noaa.gov/oa/documentlibrary/hcs/hdd.200507-200607.pdf.

- Cooling degree-days (CDD) data from: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service. Historical Climatology Series 5-2. Monthly State, Regional and National Cooling Degree-Days Weighted by Population (Includes Aerially Weighted Temperature and Precipitation. Asheville, NC: National Climatic Data Center. Available at: http://lwf.ncdc.noaa.gov/oa/documentlibrary/hcs/cdd.200501-200607.pdf.

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- CBECS 2006a—U.S. Department of Energy, Energy Information Administration. October 2006. "2003 Commercial Buildings Energy Consumption Survey: Detailed Tables." Table A2: Census Region, Number of Buildings and Floorspace for All Buildings (Including Malls), 2003. Available at: http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html - buildingchar03.

- CBECS 2006b—U.S. Department of Energy, Energy Information Administration. October 2006. "2003 Commercial Buildings Energy Consumption Survey: Detailed Tables." Table B5: Census Region and Divisions, Floorspace for Non-Mall Buildings, 2003. West South Central region for state and local governments. Available at: http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/pdf2003/alltables.pdf.

Quantification Methods:

- Heat rates (Btu/kWh). See EEC-12.
- GHG emissions associated with end-use consumption (by sector). See EEC-12.
- GHG emissions associated with electricity generation from different technologies and fuels. See EEC-12.

Key Assumptions:

- The reduction in GHGs from state buildings begins in 2008, with new buildings or major renovations emitting 50% less GHGs than older construction. Then emissions are reduced by

60% in 2010, 70% in 2015, 80% in 2020, and 90% in 2025. The reductions in each year are calculated relative to the BAU baseline.

- New government space grows at 1.2% per year.
- Compliance with this policy is assumed to be 50% at the start of the program and rises to 75% by 2020 under the new compliance regime. For the portion of the new buildings (or retrofits) that don't comply, energy use in these structures is assumed to be 20% higher than the policy level.
- Building energy consumption is a function of Iowa's climate. According to the amount of HDD and CDD, Iowa is in the Residential Energy Consumption Survey climate zone 2 (RECS 2001).
- New commercial buildings in climate zone 2 have higher electric intensity relative to existing stock, so are adjusted upward by 24% (CBECS).
- This policy covers 74% of all electricity use. (Government appliances are covered under EEC-14.)
- Efficiency improvements result in differential efficiency gains for natural gas and electricity:
  - Assumes code or efficiency improvement affects gas and electricity according to fuel use.
  - Commercial/Government: Electricity efficiency improvement of 1% results in 0.63% gas improvement (CBECS 2006a).
- State and local governments consume 16.9% of all commercial electricity (CBECS 2006b).
- T&D losses for electricity are 7%.
- Wind and biomass are the types of renewable energy resources purchased by governments to meet the fossil fuel reduction targets, given their relevant abundance in Iowa. Purchases of renewables are assumed to be 80% wind and 20% biomass.
- Renewable electricity costs for wind and biomass in the analysis come from the levelized costs developed by the CRE SC.
- DSM/energy efficiency programs are assumed to displace marginal sources of generation (50% coal, 50% gas) through 2012. From 2013 on, the programs are assumed to displace the new-build mix of 78% coal, 21% renewables, and 1% gas.
- The annual real escalation rate for cost of energy efficiency programs is 0%.
- The value used for the real rate at which costs are discounted annually is 5%.
- NPV is calculated in 2005 dollars beginning in 2009.

Key Uncertainties

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased energy efficiency and DSM investments (the avoided CO_2 methodology).[24]

Additional Benefits and Costs

Energy efficiency investments should reduce the bills of utility customers who make the investments, but will probably not lead to absolute reductions in utility rates or bills for all customers. However, cost-effective energy efficiency improvements should reduce overall utility costs and average bills when compared to more expensive alternatives.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Super Majority (6 objections).

Barriers to Consensus

Unspecified.

[24] The Annex to this document defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses and provides several scenarios for the impacts of different mixes of avoided generation technologies.

EEC-14. More Stringent Appliance Efficiency Standards

Policy Description

Appliance efficiency standards reduce the market cost of energy efficiency improvements by incorporating technological advances into base appliance models, thereby creating economies of scale. Appliance efficiency standards can be implemented at the state level for appliances not covered by federal standards, or standards can be jointly developed by multiple states.

Policy Design

Goals: Achieve 5% reduction in energy consumption from residential, commercial, and industrial consumers via:

- 80% minimum efficiency standards by 2010 for appliances not covered by federal standards, as recommended by the Appliance Standards Awareness Project and the American Council for an Energy-Efficient Economy.[25]
- 100% market penetration of ENERGY STAR appliances in purchase transactions in which state funds are involved (state purchasing contracts, state grants or loans, etc.) by 2012.
- A doubling of market penetration of ENERGY STAR appliances in purchases made in the residential, commercial, and industrial sectors, where applicable, up to 100% by 2017.

Timing: As noted above.

Implementing Parties: As noted above.

Implementation Mechanisms

To ensure that appliances purchased in the state will maximize the cost-effective potential for energy efficiency and minimize GHG emissions, the following policy prescriptions should be considered:

- Create incentives for improving standards for appliances not regulated by federal standards, and consider working with other states to do so.
- More stringent appliance standards at the federal level. Require the preferential procurement of ENERGY STAR products if available (equipment, appliance, or technology), if state funds are involved (state purchasing contracts, state grants or loans, etc.).

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[25] See Appliance Standards Awareness Project and American Council for an Energy-Efficient Economy. *Energy Efficiency Standards Benefits—2006 Model Bill*. Available at: http://www.standardsasap.org/documents/a062_sc.pdf. The analysis recommends standards for the following products: bottle-type water dispensers; commercial boilers; commercial hot-food-holding containers; compact audio products; DVD players and recorders; liquid-immersion distribution transformers; medium-voltage, dry-type distribution transformers; metal halide lamp fixtures; pool heaters; portable electric spas; residential furnaces and boilers; residential pool pumps; single-voltage external AC-to-DC power supplies; state-regulated incandescent reflector lamps; and walk-in refrigerators and freezers.

- State sales tax exemptions, whether temporary or permanent, for ENERGY STAR-certified products.
- State income tax credits to reduce the incremental cost of ENERGY STAR appliances relative to standard appliances.

Related Policies/Programs in Place

There are existing federal standards for 17 residential products and 11 pieces of commercial equipment. Laws require the U.S. Department of Energy (DOE) to set minimum appliance efficiency standards that are technologically feasible and economically justified. However, state standards can play a role for many appliances not covered by federal standards.

ENERGY STAR is a joint EPA/DOE program designed to promote energy-efficient products in the marketplace. ENERGY STAR products and appliances surpass the minimum federal and state energy efficiency standards.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions. For direct fuel use, CO_2 from natural gas combustion and likely very small amounts of CH_4 from the transport of natural gas to end users are reduced.

Estimated GHG Reductions and Net Costs or Cost Savings

Table F-14-1. Estimated GHG reductions and net costs of or cost savings from EEC-14

Quantification Factors	2012	2020	Units
GHG emission reductions	0.94	2.20	$MMtCO_2e$
Net present value	–$110.4	–$708.1	$ Million
Cumulative GHG reductions	1.94	17.33	$MMtCO_2e$
Cost-effectiveness	–$56.95	–$40.85	$/tCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Energy consumption by sector (BBtu). See EEC-12.
- Power station electricity generation (GWh) and fuel use (BBtu). See EEC-12.
- ASAP 2006—Appliance Standards Awareness Project and American Council for an Energy-Efficient Economy. 2006. *Energy Efficiency Standards Benefits—2006 Model Bill*. Available at: http://www.standardsasap.org/documents/a062_sc.pdf.
- RECS 2001—U.S. Department of Energy, Energy Information Administration. 2001. "Residential Energy Consumption Survey 2001: Consumption and Expenditure Data Tables." Table CE1-1c: Total Energy Consumption in U.S. Households by Climate Zone. Available at: http://www.eia.doe.gov/emeu/recs/recs2001/detailcetbls.html#space.
- CBECS—U.S. Department of Energy, Energy Information Administration. "Commercial Buildings Energy Consumption Survey." Ratio of 1990–1999 buildings to all buildings total

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Quantification Methods:

- Heat rates (Btu/kWh). See EEC-12.
- GHG emissions associated with end-use consumption (by sector). See EEC-12.
- GHG emissions associated with electricity generation from different technologies and fuels. See EEC-12.

Key Assumptions:

- DSM/energy efficiency programs are assumed to displace marginal sources of generation (50% coal, 50% gas) through 2012. From 2013 on, the programs are assumed to displace the new-build mix of 78% coal, 21% renewables, and 1% gas.
- Improved appliance standards begin to take effect in 2010, with full implementation by 2017. The energy reduction due to improved appliance efficiency is calculated relative to the BAU baseline. For Iowa government operations, the assumed BAU penetration rate of ENERGY STAR appliances is 75% between 2010 and 2012. For the residential, commercial, and industrial sectors, the assumed BAU penetration rate is 50% in 2010 and rises to 75% in

2017. This is consistent with the 2005 penetration rates for various ENERGY STAR products in Nexus Market Research (2006).

- ENERGY STAR appliances are 30% more efficient than other appliance choices. There are some discrepancies about the relative efficiency of ENERGY STAR products. Webber et al. (2002) show efficiency gains ranging from 7% to 90%, but a recent *Consumer Reports* (2008) article highlights some of the problems with this voluntary program, which has a third-party verification system and sets efficiency benchmarks for products to qualify that are not realistic with everyday use. The 30% efficiency improvement is a rough estimate, given the uncertainties about the product brand.
- 39% of electricity is consumed by appliances in residential buildings, which assumes that refrigerators and one-half of other appliances and lighting apply to this option (RECS 2001).
- 26% of electricity is consumed by appliances (office equipment) in government and commercial buildings (CBECS 2006c).
- 8% of electricity is consumed by appliances in industrial buildings, which assumes one-half of HVAC and facilities support are covered by ENERGY STAR appliances, such as heat pumps and furnaces (MECS 2005).
- Appliance efficiency improvements result in differential efficiency gains for natural gas and electricity.
    - Residential: Electricity improvement of 1% results in 2.23% gas improvement (RECS 2001).
    - Commercial: Electricity improvement of 1% results in 0.63% gas improvement (CBECS).
    - Industrial: Electricity improvement of 1% results in 0.84% gas improvement. Source: Gas facility support divided by electricity facility support (in BBtu) in MECS 2005.
- The levelized cost (2005$) of appliance efficiency standards is $11.90/MWh and $3.49/BBtu (WGA 2005). Natural gas cost/BBtu is equivalent to MWh cost at the rate of 1 GWh/3.41BBtu. [Is this correct?]
- EISA developed standards, or instructed DOE to develop standards, for many of the products in the Appliance Standards Awareness Project (ASAP) 2006 model bill. EEC-14 applies only to the following products: bottle-type water dispensers, commercial hot-food-holding cabinets, hot tubs, residential furnace fuel efficiency (from 82% in the EISA to 90% annual fuel utilization efficiency [AFUE] in the ASAP model bill), pool heaters, and commercial boilers. GWh and BBtu reductions are from ASAP 2006.
- The annual real escalation rate for cost of energy efficiency programs is 0%.
- The rate at which costs are discounted annually is 5%.
- NPV is calculated in 2005 dollars beginning in 2009.

Key Uncertainties

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased energy efficiency and DSM investments (the avoided CO_2 methodology).[26]

Additional Benefits and Costs

Energy efficiency investments should reduce the bills of utility customers who make the investments, but will probably not lead to absolute reductions in utility rates or bills for all customers. However, cost-effective energy efficiency improvements should reduce overall utility costs and average bills when compared to more expensive alternatives.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Super Majority (2 objections).

Barriers to Consensus

One member was concerned about Iowa acting by itself in the Midwest to regulate appliance standards.

[26] The Annex to this document defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses and provides several scenarios for the impacts of different mixes of avoided generation technologies.

Annex A

Avoided Electricity Emissions for the Residential, Commercial, and Industrial Sectors

To estimate emission reductions from policy options that are expected to displace conventional grid-supplied electricity (i.e., energy efficiency and conservation) a simple, straightforward approach is used. Through 2012, we assume that these policy options would displace generation from a “marginal” mix of fuel-based electricity sources of 50% coal and 50% gas. (We assume that sources without significant fuel costs would not be displaced—e.g., hydro or other renewable generation.) After 2012, we assume that the policy options are likely to avoid a mix of new-build capacity additions. The new-build mix for the RCI sector is estimated to be 78% coal, 21% renewables, and 1% gas. This mix is what is proposed to be built as part of the Marshalltown (Sutherland) coal plant package, which includes wind generation and biomass co-firing requirements, as well as additional wind resources that the CRE SC perceived as being likely to be built as part of the reference case forecast.

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased energy efficiency and DSM. Table F-A-1 provides several scenarios for avoided generation mixes. The scenarios differ in that each scenario that includes less coal or more gas results in about 10% fewer tCO_2 reductions.

Recall that the NPV of options for the EEC sector is the difference between avoided costs and the levelized costs of the investments, and is unaffected by the CO_2 methodology. The changes in the $/ton (the last column of the table) are due to changes in total tons of CO_2 mitigated between the scenarios. The cost savings increase as CO_2 reductions decrease because the total cost savings number is constant, but is being spread out among fewer tons of CO_2. Table F-A-1 represents three different ways to look at what could happen under different scenarios. Note the 10% decrease in cumulative CO_2 reductions from scenario to scenario.

Table F-A-1. Potential outcomes of different mitigation scenarios

Scenarios	Avoided Generation Mix		EEC-12 Outcomes		
	2009–2012	2013–2020	Year 2020 Reductions ($MMtCO_2e$)	Cumulative 2009–2020 Reductions ($MMtCO_2e$)	2009–2020 ($/$tCO_2e$)
Reference: Marginal then New Build	50% coal, 50% gas	78% coal, 21% renewables, 1% gas	4.4	20.3	–$22
Marginal (More Coal Case)	50% coal, 50% gas	50% coal, 50% gas	4	18.9	–$24
Marginal (More Gas Case)	35% coal, 65% gas	35% coal, 65% gas	3.6	16.7	–$27

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

The reference approach described in the beginning of this annex provides a transparent way to estimate emission reductions and to avoid double counting (by ensuring that the same MWh from a fossil fuel source are not "avoided" more than once). The reference approach can be considered a "first-order" approach; it does not attempt to capture a number of factors, such as the distinction between peak, intermediate, and baseload generation; issues in system dispatch and control; impacts of nondispatchable and intermittent sources, such as wind and solar; or the dynamics of regional electricity markets. These relationships are complex and could mean that policy options affect generation and emissions (as well as costs) in a manner somewhat different from that estimated here. Nonetheless, this approach provides reasonable first-order approximations of emission impacts and offers the advantages of simplicity and transparency that are important for stakeholder processes.

Existing Energy Efficiency Actions In Iowa

IOU BAU incremental (new) electric efficiency investments equate to 0.8% of load in 2008. The assumed incremental statewide electric energy efficiency investments are equal to 0.69% of retail sales over the planning period (2009–2020). For natural gas, the assumed incremental statewide natural gas energy efficiency investments are equal to 0.82% of retail sales. These reductions are subtracted from EEC-12 and EEC-2, respectively.

Proposed energy efficiency plans, pending IUB determination, would achieve between 1.3% and 1.5% of retail sales by 2012. These proposals are not included in the analyses, as they have not been approved yet. Their inclusion would have simply changed the accounting for reductions from the policy options (e.g., EEC-12) to the recent actions line in the summary table at the beginning of this appendix.

The state government is also taking aggressive actions to reduce energy use. For example, Governor Culver's Executive Order #6 requires state buildings to reduce energy use by 15% by 2015,[27] and Governor Vilsack's Executive Order #41 requires that all state agencies reduce energy consumption per square foot per degree-day in all conditioned facilities (buildings) by an average of 15% by 2010 relative to 2000 levels.[28] The combined effects of these executive orders are shown in the recent actions line in the summary table. The calculations show that these orders save approximately 315 GWh of electricity and 680 BBtu of natural gas by 2015 with an accompanying GHG reduction of 0.29 $MMtCO_2e$ in 2015.

[27] State of Iowa, Executive Department. *Executive Order Number Six*. February 2008. Available at: http://publications.iowa.gov/6275/1/06-080221%5B1%5D.pdf.

[28] State of Iowa, Executive Department. *Executive Order Number Forty-One*. Available at: http://publications.iowa.gov/2619/1/EO_41.pdf.

Appendix G
Clean and Renewable Energy Policy Options

Summary List of Policy Options

No.	Policy Option	CO_2 Reduction 2012	CO_2 Reduction 2020	Total 2009–2020	Net Present Value 2009–2020 (Million $)	Cost/ton ($/$tCO_2e$)	Change in Generation Cost in 2020 $/MWh*	Level of Support
CRE-1	Education	*Not Quantified*						Unanimous
CRE-2	Technology Initiatives, Including Renewables	4.7	33.4	192.6	$5,653	$29.4	$25.7	Super Majority (3 Objections)
CRE-3	MGA Cap and Trade, Including Offsets To Promote Renewables	*Not Quantified*						Majority (5 Objections)
CRE-4	Decarbonization Fund	2.2	11.4	74.1	$316	$4.3	$3.1	Super Majority (2 Objections)
CRE-5	Performance Standards (50% Reduction by 2050)	4.9	11.4	95.4	$2,650.6	$27.8	$7.3	Super Majority (3 Objections, 1 Abstention)
CRE-6	Voluntary GHG Commitments	*Not Quantified*						Unanimous
CRE-7	Policies Related to Nuclear Power	0.0	9.7	9.7	$268	$27.6	$4.5	Majority (5 Objections)
CRE-8	Support for Grid-Based Renewable Energy & Development (MGA Target of 20% of retail sales by 2020)	0.0	2.3	4.3	$93.4	$21.8	$1.5	Unanimous
CRE-9	Transmission System Upgrading	*Not Quantified*						Unanimous
CRE-10	R&D for Emerging Technologies and Corresponding Incentives	*Not Quantified*						Unanimous
CRE-11	Distributed Generation/Co-Generation	0.0	0.1	0.5	$14	$29.1	$0.1	Super Majority (1 Objection)
CRE-12	Combined Heat and Power	0.3	2.1	13.6	–$564.3	–$41.4	$0.0	Unanimous
CRE-13	Pricing Strategies To Promote Renewable Energy and/or CHP	1.2	5.6	35	$1,128	$32.1	$4.7	Super Majority (3 Objections)
	Sector Total After Adjusting for Overlaps	**6**	**48**	**233**	**$5,921**	**$25**		
	Reductions From Recent Actions	**0**	**0**	**0**	**0**	**0**		
	Sector Total Plus Recent Actions	**6**	**48**	**233**	**$5,921**	**$25**		

CO_2 = carbon dioxide; Reduct. = Reduction; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; $/MWh = dollars per megawatt-hour; MGA = Midwestern Governors Association; GHG = greenhouse gas; 400k MWh/yr = 400,000 megawatt-hours per year; R&D = research and development; CHP = combined heat and power.

* Represents the change in the cost of generation in $/MWh in the Policy case from the No-Policy case to meet Iowa's electricity demand or for exports.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy options is for reference purposes only; it does not reflect prioritization among these important policy options.

Draft Overlap Discussion

The amount of carbon dioxide equivalents (CO_2e) emissions reduced in the policy options within the Energy Supply (ES) sector overlaps with some of the quantified benefits and costs of other policy options within the ES sector and in other sectors. Those overlaps were identified and adjusted to eliminate double counting. If a policy's impact by type of energy supplied was less than the impact from an overlapping policy for the same type of energy supplied, then it was excluded from the cumulative analysis. The ES sector totals were reduced accordingly, as shown in the summary table above.

The following text overview identifies specifically where those overlaps occurred and how they were resolved under the Clean and Renewable Energy (CRE) proposed policies:

CRE-2 (Renewables Technologies Initiative)—This option addresses actions that promote the use of renewable energy sources, while CRE-5 (Generation Performance Standard) and CRE-8 (Renewables Targets) are proposed as regulatory requirements for electric utilities and nonutilities. It is likely that the electricity generated by the new renewable energy sources that are developed pursuant to CRE-2 will be purchased by the large power producers that are required to comply with the clean energy targets of CRE-5. Therefore, the reductions of CRE-5 are subtracted from CRE-2.

CRE-5 (Generation Performance Standards)—A generation performance standard is a requirement that generators follow to reduce the CO_2 intensity of their generation portfolio, while providing regulatory flexibility in the compliance pathway. In the short term, a performance standard can reduce the incentives for new fossil fuel generation with high CO_2 intensity. In the long term, the generation portfolio can be considered similar to a renewable portfolio standard, but with a larger basket of compliance options. The renewable energy generated from this policy is assumed to overlap with CRE-2.

CRE-8 (Renewables Targets)—The renewables targets under this option are similar, but less aggressive than what is forecasted to occur under CRE-5. Similar generation mixes are expected under either approach. For that reason, CRE-8 is considered redundant to CRE-5, and electricity generation and associated CO_2 reductions from this option are eliminated through the overlap analysis.

CRE-13 (Pricing Strategies)—This option promotes the use of net metering to deploy clean energy technologies at the point of customer use. For renewables, there is very little overlap with other CRE policy options because the other options promote the deployment of large-scale renewable energy projects, like wind farms and co-firing biomass in pulverized coal boilers, while this option sites small-scale renewables. However, the combined heat and power (CHP) element of this option could overlap with CRE-12 (Combined Heat and Power) for industrial or commercial customers who might site microturbines or other CHP technologies at the point of use. For this reason, the electricity generation and associated CO_2 reductions from this option are reduced by 50%.

Overlaps With Other Sectors

The increased use of renewable energy from governments in Energy Efficiency and Conservation (EEC) policy option EEC-13 (Government Lead by Example) is not expected to overlap with CRE policies. EEC-13 has a goal of increasing renewable power generation among government end users. Voluntary green power purchasing typically does not count toward utility renewable portfolio standards, such as CRE-8b the Midwestern Governors Association (MGA) renewables target.

CRE-4 (Decarbonization Fund)—This policy option is a mechanism to fund renewable energy and energy efficiency, along with low-income weatherization and clean energy research and development (R&D). The renewables that are assumed to be deployed under the quantification of this option are expected to be redundant to CRE-8b (MGA renewable energy goals), and CO_2 reductions from this option are eliminated through the overlap analysis. The energy efficiency deployment that results from this option is expected to be completely redundant to energy efficiency under EEC-1.

CRE-2 also overlaps with Agriculture, Forestry, and Waste Management (AFW) policy options AFW-3 and AFW-9. The reductions from the AFW sector are assumed to completely overlap with CRE-2, and are subsumed under the CRE option.

The electricity energy efficiency investments from the suite of EEC policy options reduce electricity demand and thus make it possible to meet renewable energy mandates more cost-effectively. For example, under EEC-12, electricity demand in 2020 is reduced by almost 5,000 gigawatt-hours (GWh) versus the reference case. CRE-8b assumes a 20% goal by 2020, which is 4% more renewables (as a percentage of retail sales) than is forecasted under the reference case. Therefore, the implementation of EEC-12 would require 200 GWh fewer of renewable resources to meet the goal. Using the renewable energy cost assumptions for CRE-8b, the reduced spending on renewables that cost more than reference case generation in 2020 would result in savings of $.3 million in that year.

Finally, an additional feedback is that certain CRE policies will have the effect of reducing the GHG emissions associated with energy production, so that EEC policies that target electricity use will have a reduced impact on overall emissions. However, this impact is small and has not been reflected in the analysis beyond the avoided CO_2 methodology that assumes in the later years of the program that 21% new renewables are avoided by implementing the EEC options. (The CRE methodology does not include avoided renewables, because doing so would contradict the goals of the CRE options.) See Annex A for a discussion of the avoided CO_2 methodology.

CRE-1. Education

Policy Description

This option is directed at education and outreach for the purposes of nurturing public consciousness of climate change issues, as well as providing technical skills training for employment in positions that directly support greenhouse gas (GHG) emission reduction activities.

Broad awareness engages citizens of all ages to take direct action to reduce GHG emissions through personal and public means. It also builds grass-root support for government, industrial, and civil society actions with regard to GHG emission reduction programs, policies, or goals.

Technical instruction and training of citizens will provide the number of skilled employees needed to fill critical jobs in the new and growing industries that will provide emission reductions and clean energy.

Policy Design

Goals: The goals of this policy option are qualitative. They focus on developing, implementing, and executing a statewide climate change control awareness education and job-training program that:

- Provides a platform that, along with imparting knowledge, encourages a bias for action on the part of all Iowans.
- Provides a specified environmental education curriculum to primary, secondary, and post-secondary audiences within the state.
- Provides continuous public exposure through a variety of communications channels to educate and enhance the awareness of Iowans about environmental issues.
- Provides technical job training in support of the growing need by Iowa's renewable energy industries for skilled workers.
- Develops statewide environmental literacy. The outcome of a successful environmental education program is one in which the learner progresses to deeper knowledge, can apply it to address complex environmental issues, and makes wiser decisions based on that knowledge.

Timing: Begins with the 2010 academic year.

Implementing Parties: Elementary and secondary school districts, municipal governments, the three regents state universities, Iowa community colleges, community partners/associations.

Other: None identified.

Implementation Mechanisms

Unspecified.

Related Policies/Programs in Place

Junior Solar Sprint—This program for middle school children in Iowa engages students in miniature car races in which the cars are powered by small photovoltaic (PV) cells. The students build cars from kits provided to each participating class. The statewide program has grown to include 3,000–4,000 students per year. It is administered by the Center for Energy & Environmental Education at the University of Northern Iowa.

The Iowa Alliance for Wind Innovation and Novel Development—This newly formed organization aims to create a partnership among the educational community, government, associations, and private sector for the purpose of meeting the education, training, skills development, research, and testing needs of the state's expanding renewable energy industry.

Iowa Energy Center—The Energy Center awards scholarships to Iowa high school students at the State Science and Technology Fair of Iowa for exceptional energy-related projects.

Iowa Renewable Energy Association's Energy Learning Lab—"Make electricity from the sun and the wind, measure how much electricity is used by appliances, make hydrogen and use it to power a fuel cell model car, and use the sun to heat water. Your students will love using the Iowa Renewable Energy Association's energy education tools, available free of charge to teachers and schools for one week. In return, you will be asked to provide your name and contact information, a short paragraph describing how the tools were used in the classroom, and one or two digital pictures of students using the Energy Learning Lab materials."[1]

Maquoketa Valley Electric Cooperative's Renewable Energy Education in the Community (ReEC)—This new initiative showcases the residential application of two renewable energy technologies—wind and solar PV—recently installed at the cooperative's headquarters in Anamosa. These units are designed for installation in residential neighborhoods, and each will provide a portion of a home's electrical needs. ReEC will allow anyone to evaluate the real-time performance of these units and to use the data in a variety of education programs throughout Iowa.

Iowa Clean Cities Coalition (ICCC)—Based in Des Moines, Iowa's state capital and largest city, the ICCC coordinates educational activities, promotes renewable fuels and renewable fuel infrastructure, and collaborates with partners to promote emerging technologies in Iowa.

State Energy Council (SEC)—SEC brings together state agencies to communicate, collaborate, and coordinate efforts to meet the goal of advancing energy efficiency and renewable energy in Iowa. SEC seeks to capitalize on the skills, responsibilities, and resources of participating agencies through agency collaboration.

[1] Iowa Renewable Energy Association. Available at: http://www.irenew.org/learninglab.html.

Center on Energy and Environmental Education (CEEE)—Based at the University of Northern Iowa (UNI), CEEE's strategies include: Positive, Experiential Education: Helping children, youth and adults make sense of complex environmental and energy-related issues and participate in positive, solution-oriented responses. Facilitating Community Leadership: Bringing diverse stakeholders together to find common ground and work together to solve problems. Promoting Innovation: Bringing together the knowledge and tools needed to foster innovative sustainable energy and environmental practices. Engaging UNI Students and Faculty: Creating opportunities for UNI students and faculty to take a leadership role in creating more sustainable communities.

Iowa Electrathon—Sponsored by Alliant Energy, the Iowa Electrathon is an educational program that engages high school or college students in researching, designing, building, and racing Electrathon cars (small one-person electric vehicles with limited battery capacity).

www.bioediowa.org—This Web site informs Iowans about the public-sector education and training opportunities within the biorenewable energy industry.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions, primarily from carbon dioxide (CO_2) emissions, but also trace amounts of methane (CH_4) and nitrous oxide (N_2O) emissions.

Estimated GHG Reductions and Costs or Cost Savings

Qualitative.

Data Sources: Not applicable.

Quantification Methods: Not applicable.

Key Assumptions: Not applicable.

Key Uncertainties

None identified.

Additional Benefits and Costs

None identified.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

CRE-2. Technology Initiatives, Including Renewables

Policy Description

This policy option deals with the implementation of clean and renewable energy technologies that are currently commercially available, and their potential for implementation in Iowa. States can undertake initiatives focused on developing, promoting, and/or implementing one or more specific technologies that show promise for reducing GHG emissions. Technologies could include (among others) wind, biomass (including refuse-derived fuels), landfill gas to energy, hydropower, solar, and geothermal. This policy would support providing state government and other private and public parties with resources and incentives for analysis, targeted research and development (R&D), market development, and adoption of GHG-reducing technologies that are not covered by other CRE policies.

Policy Design

In 2008, the Iowa Legislature passed and the Governor signed a law that required the Iowa Utility Association, in consultation with the Iowa Association of Electric Cooperatives and the Iowa Association of Municipal Utilities, to conduct a technical study of the potential for cost-effective renewable energy generation by 2025. The study will be transmitted to the Iowa Office of Energy Independence by December 1, 2008, and included in the Iowa Energy Independence Plan required to be submitted to the Office of the Governor and the General Assembly by December 14, 2008.

Goals: Increase Iowa renewable electric production:

- From landfill gas-to-energy projects by 9,000 megawatt-hours (MWh) annually until the maximum feasible generation of approximately 90,000 MWh per year is developed.
- From waste-to-energy projects by 65,500 MWh annually until the maximum feasible generation of approximately 655,000 MWh per year is developed.
- From wind projects by up to 2.6 million MWh annually or until the feasible amount of wind generation that can be integrated into the grid is reached.
- From co-firing biomass agricultural residues in existing pulverized coal boilers at a rate of 10% of coal generation, or approximately 3,600 MWh annually.
- From biomass generation from dedicated energy crops up to 760,000 MWh annually until the maximum feasible generation is developed.
- From repowering hydroelectric facilities by up to 112,000 MWh annually until the maximum feasible generation is developed.

Initial specific targets for additional technologies listed in the policy description (such as wind) are to be determined upon review of best available data to characterize the maximum cost-effective potential of each of the major technology options until the study mentioned above is completed.

Timing: Beginning in 2011, continuing through 2020.

Implementing Parties: State government, private and public partners on a voluntary basis.

Implementation Mechanisms

Biomass co-firing can be a low-cost, near-term means of converting biomass to electricity and displacing coal use by adding up to 15% biomass in high-efficiency coal boilers. Biomass energy conversion factors and crop yield estimates will be used to determine the number of farm acres needed to reach specific percentage and MWh goals.

A standard interconnection rule will ensure that distributed power products meet minimum requirements for performance, safety, and maintenance and will significantly advance the commercialization of these new technologies. Standardized interconnection rules, which are generally developed and administered by a state's public utility commission, establish clear and uniform processes and technical requirements for connecting distributed generation (DG) systems to the electric utility grid. Interconnection standards will reduce barriers to connection of DG systems to the grid identified by other policy options. Connecting to the grid enables the facility to: (1) purchase power from the grid to supply supplemental power as needed, for example, during periods of planned system maintenance; (2) sell excess power to the utility; and (3) maintain grid frequency and voltage stability, as well as utility worker safety. This topic is of particular interest, as the Energy Policy Act of 2005 (EPAct 2005) directs states to consider upgrading their standards for interconnecting small generators within 1 year of enactment.[2]

Related Policies/Programs in Place

None identified.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions.

Estimated GHG Reductions and Costs or Cost Savings

Table G-2-1. Estimated GHG reductions and costs of or cost savings from CRE-2

Quantification Factors	2012	2020	Units
GHG emission savings	4.7	33.4	$MMtCO_2e$
Net present value (2008–2020)	$336	$5,653	$ Million
Cumulative reductions	7	193	$MMtCO_2e$
Cost-effectiveness	$45.6	$29.4	$/t$CO_2e$
Change in generation cost	$4.1	$25.7	$/MWh

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t$CO_2e$ = dollars per metric ton of carbon dioxide equivalent; $/MWh = dollars per megawatt-hour.

Data Sources:

- Spreadsheet Iowa Biomass to Displace Coal, sent by Jeff Myrom, June 23, 2008, shows biomass co-firing corn stover would utilize 5.5% of Iowa harvested cropland.

[2] U.S. Environmental Protection Agency. July 2, 2007. Interconnection Standards Fact Sheet. Available at: http://www.epa.gov/CHP/state-policy/interconnection_fs.html.

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- U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. 2008. *20% Wind Energy by 2030.* Available at: http://www1.eere.energy.gov/windandhydro/pdfs/41869.pdf.

Energy Consumption by Sector (Billions of British Thermal Units [BBtu])

- Historical energy consumption in the state, by sector, is from the U.S. Department of Energy (DOE) Energy Information Administration (EIA) State Energy Data System, available at http://www.eia.doe.gov/emeu/states/_seds.html. To calculate future projected energy consumption, growth factors were applied to the historical 2005 data to calculate projections through 2030. The growth factors are based on a combination of two parameters.
    - One accounts for growth within the RCI sectors, with growth factors for the residential sector based on projected population growth (from U.S. Bureau of the Census, Population Estimates Branch, and State Library of Iowa, State Data Center Program [http://data.iowadatacenter.org/datatables/State/stpopest19002007.xls] and State Library of Iowa, State Data Center Program, "Iowa Census Data Tables: Projections" http://data.iowadatacenter.org/browse/projections.html); growth in the commercial sector based on non-manufacturing employment growth projections; and industrial-sector growth based on manufacturing employment. Employment projections were taken from Iowa Workforce Development, Labor Market and Economic Research Bureau, "Iowa Statewide Projections (2004–2014)" (http://iwin.iwd.state.ia.us/pubs/statewide/indprojstatewide.pdf).
    - The other factor is growth in electricity sales, which was calculated based on historical retail sales from U.S. Department of Energy, Energy Information Administration, "Iowa Electricity Profile," Table 8: Retail Sales, Revenue, and Average Retail Price by Sector,

1990 Through 2006. Available at: http://www.eia.doe.gov/cneaf/electricity/st_profiles/iowa.html.

Power Station Electricity Generation (GWh) and Fuel Use (BBtu)

- Gross generation for 2005 was obtained from the EIA-906 and EIA-920 databases on fuel stocks at all electric power sector generating facilities, broken down by fuel type. (See U.S. Department of Energy, Energy Information Administration. "Form EIA-906 and EIA-920 Databases." Available at: (http://www.eia.doe.gov/cneaf/electricity/page/eia906_920.html.) Data for later years were projected from the 2005 figure based on projections of growth in generation for the Mid-Continent Area Power Pool (MAPP) region. The projected regional consumption and generation data are from the U.S. Department of Energy, Energy Information Administration, "Supplemental Tables to the Annual Energy Outlook 2008," Data Tables 62–91: Electricity Generation & Renewable Resource. Available at: http://www.eia.doe.gov/oiaf/aeo/supplement/index.html. On-site usage was subtracted from all generation figures.

Costs Associated With Electricity Generation

- The costs in the United States to produce electricity using different types of technologies are from the U.S. Department of Energy, Energy Information Administration, April 2007, "Electricity Market Module," Table 39, in *Assumptions to the Annual Energy Outlook 2007, With Projections Through 2030,* DOE/EIA-0554(2007). Available at: http://www.eia.doe.gov/oiaf/archive/aeo07/assumption/index.html. The costs are based on an analysis of U.S. energy supply, demand, and prices using the EIA National Energy Modeling System.

Energy Price Projections Through 2030

- Energy prices by region are from the U.S. Department of Energy, Energy Information Administration. June 2008. *Supplemental Tables to the Annual Energy Outlook 2008.* Data Tables 1–20: Consumption & Prices by Sector & Census Division. Available at: http://www.eia.doe.gov/oiaf/aeo/supplement/. Energy prices by region begin with Table 11.

Quantification Methods:

Heat Rates (Btu/kWh)

- Heat rates indicate how much fuel is used (British thermal units [Btu]) to generate a given amount of electricity (kilowatt-hour [kWh]), and they vary greatly depending on the type of power stations and the fuel used. Heat rates are used to convert figures for electricity into figures for fuel use so the fuel use can be converted into GHG emissions using GHG emission factors. Heat rates for 2005 for each type of generation and fuel were calculated from 2005 fuel use (in BBtu) divided by 2005 generation (GWh). Projections for 2006 and beyond are based on annual combustion efficiency growth rates for the MAPP region. Combustion efficiency for a given year is calculated for each fuel type as the fuel use (in quadrillion Btu) divided by the electricity generated (in billion kWh), and the combustion efficiency growth rate applied to this value is based on the change in combustion efficiency from the previous year.

GHG Emissions Associated With End-Use Consumption (by Sector)

- Historical CO_2 data by sector (and further broken down by fuel type) were calculated by two U.S. Environmental Protection Agency (EPA) State Greenhouse Gas Inventory Tool (SIT) software modules: the Fossil Fuel Combustion Module and—for emissions from industrial sources—the SIT module for industry. CH_4 and N_2O emissions were calculated by the Stationary Combustion Module and—for emissions from industrial sources—the SIT module for industry.
- Projected emissions through 2030 were based on the 2005 data, with growth factors compounded from year to year, as discussed above under Energy Consumption by Sector.

GHG Emissions Associated With Electricity Generation From Different Technologies and Fuels

- The projected data for each GHG were calculated for each fuel and generation type (e.g., nonlignite coal in a steam plant) as a direct product of the projected generation data (in GWh), described above under Power Station Electricity Generation and Fuel Use. Metric tons (t) of CO_2 are calculated from generation as:

  $$tCO_2 = GWh \times (Btu/kWh) \times (tCO_2/MMBtu) \times (\% \text{ of that fuel in the fuel mix})$$

  where (Btu/kWh) is the heat rate and (tCO_2/MMBtu) is the CO_2 emission factor. Calculations for CH_4 and N_2O are similar, =, which are then converted to CO_2 equivalents (CO_2e) using global warming potentials of 21 for CH_4 and 310 for N_2O. The emission factors used for each GHG were the same as those used in the EPA SIT software modules.

Key Assumptions:

- Renewables include landfill gas, waste-to-energy, wind, hydro repowering, 10% biomass co-firing, and biomass energy crops.
- The capacity factor for wind is 36%, which is the DOE 2015 class 3 capacity factor.
  - Iowa Energy Center's Wind Maps show nearly all of the state at or above an annual Class 3 wind resource (http://www.energy.iastate.edu/Renewable/wind/maps/annual.htm).
- The rate at which costs are discounted annually is 5%.
- Net present value (NPV) is calculated in 2005 dollars beginning in 2009.
- All electricity from coal-fired generation is coming from sources within Iowa (no imports).
- Renewables displace marginal sources of generation (50% coal, 50% natural gas) through 2012. From 2013 on, renewables displace the thermal new-build mix of 99% coal, 1% natural gas.

Key Uncertainties

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased renewables (the avoided CO_2 methodology).[3]

[3] Annex A defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses.

Additional Benefits and Costs

None identified.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Super Majority (3 objections).

Barriers to Consensus

Several members of the Iowa Climate Change Advisory Council (ICCAC) indicated that this policy does not adequately address the need for and cost of transmission upgrades.

CRE-3. MGA Cap-and-Trade, Including Offsets To Promote Renewable Energy

Policy Description

A cap-and-trade system is a constructed market-based compliance mechanism in which GHG emissions are limited to a specified amount (i.e., the cap), and entities subject to the cap can buy and sell (i.e., trade) emission allowances. In theory, a properly designed cap-and-trade system of sufficient market size can lower the cost of compliance of meeting the emissions cap to all entities involved. This is possible because participants with a lower cost of compliance can reduce emissions below their allocation and sell their additional allowances to a participant with a cost of compliance that is otherwise higher than the market allowance price.

Policy Design

Goals: The goals of this policy are assumed to be those adopted by the MGA cap-and-trade program. The ICCAC should revisit what action to take on this option once the MGA cap levels and model rule have been developed.

Timing: The policy would start in concert with other MGA actions.

Parties Involved: All sectors of the economy must be covered to ensure actual emission reductions. The electric generating sector is likely to cover all units emitting 10,000 tons of CO_2 or more per year. This policy would require adoption of a regional cap-and-trade system by the Iowa Legislature, and implementation by appropriate federal and state government agencies.

Implementation Mechanisms

Many variables can be incorporated into a cap-and-trade system, including the GHGs and sectors covered, upstream or downstream coverage, banking, safety valve prices, tie-ins with regional or international trading systems, offsets, early action credits, technology incentives, auctioning, triggers for on and off ramps, and the glide path of the cap. Each factor can have a significant influence on the market price of allowances, and thus the cost of compliance and impacts on ratepayers.

To encourage the development of biomass-based renewable energy, CO_2 emissions from the combustion of biomass (e.g., switchgrass, corn stover) or methane from the decomposition of organic matter (e.g., landfill gas, manure biogas) would not count against the cap.

Related Policies/Programs in Place

A possible federal cap and trade program could take the following steps:

- Realistically, the cap-and-trade program will need to follow a slow-stop-reverse glide path. An immediate or abrupt reversal of the current emissions growth path is unrealistic, given current technology options, and is more likely to cause undue economic hardship.
- In general, the larger the scope of a cap-and-trade program, the more likely the odds of lowering the cost of compliance for all participants. Thus, a federal cap-and-trade program is recommended as the first choice. A regional cap-and-trade program, such as the MGA

Accord, is the second-best choice and is also the minimum size recommended for a cap-and-trade program. A state-level program is not likely to be a cost-effective option; therefore, it is not recommended.

Assuming that cap-and-trade legislation is passed within the first year of a new presidential administration (2009), it will most likely take EPA 3 years to complete the rulemaking (2012). However, nearly all federal rulemakings are litigated, which could take another 2–3 years for a final rule to emerge (2015). For these reasons, a federal cap-and-trade program is unlikely to begin prior to 2015.

Type(s) of GHG Reductions

The cap-and-trade program includes emissions from all six GHGs—CO_2, CH_4, N_2O, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride—from the covered sectors.

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions.

Estimated GHG Reductions and Costs or Cost Savings

Not quantified: The GHG reductions and costs associated with this option have not been quantified because of current uncertainties about the stringency of the MGA cap, which sectors will be covered under the cap, as well as the degree of inclusion of flexibility mechanisms, such as offsets.

Key Uncertainties

A number of design variables and the quality of data for cost curves and emission projections can affect cap-and-trade simulation results, including permit prices, volume of permits traded, and cost distribution among trading participants.

Additional Benefits and Costs

In addition to direct cost savings of compliance and GHG emission reductions, other potential impacts are possible on labor, value added, income, market share of industries, energy independence, energy prices, air quality, and other environmental or economic outcomes.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Super Majority (5 objections).

Barriers to Consensus

One member was concerned that not enough Midwest states were full participants in the cap-and-trade program.

Several members of the ICCAC believe that federal policies to reduce GHG emissions are preferable to regional efforts like the MGA Energy Security and Climate Stewardship Platform.

CRE-4. Decarbonization Fund

Policy Description

A decarbonization fund is a fee on GHG emissions intended to transition society to a new, non-GHG-emitting state in the future. If multiple GHGs are covered, the global warming potentials of the covered gases are normalized into CO_2 equivalents prior to assessment of the fee. Thus, carbon fee proposals usually provide an annual fee levied on each ton of CO_2 or CO_2e.

A small portion of a decarbonization fee is to provide some market signal to consumers to reduce emissions. However, many GHG emissions result from necessities of life, such as heating and cooling and the preparation of food. Thus, given the current state of technology, there are practical and ethical limits to the assessment of a decarbonization fee for the purposes of a price signal. Therefore, the fee for this policy option is applied only to the electric utility sector.

The most important policy aspect of a decarbonization fee is that the revenue generation potential of even a small fee, feeding into a targeted decarbonization fund, can be significant. Given this, the monies derived from a decarbonization fee can provide a strong incentive toward GHG emission reductions. Thus, the most effective decarbonization fee design would include both the front-end variables (i.e., the covered GHGs, the amount levied per ton of emissions) and the back-end variables (i.e., where revenue is housed, how revenue is utilized).

Policy Design

Goals: The goals of this policy are:

- To help mitigate the potential impacts on the economy, the decarbonization fee should be phased in and capped at a reasonable rate, allowing for long-term planning by consumers. Therefore, as a starting point for the analysis, it is recommended that the decarbonization fee for electric generation begin at \$1/tCO_2 in 2010 and increase by \$1/year until a cap of \$10/tCO_2 is obtained in 2019. The funding in 2019 is estimated at \$320 million.
- To help mitigate potential impacts on low-income consumers, it is recommended that 10% of the funds derived from a decarbonization fee be directed toward targeted assistance (e.g., the Low-Income Home Energy Assistance Program [LIHEAP]) and energy efficiency programs. LIHEAP funding would be approximately \$32 million in 2019.
- To ensure the proper accounting and availability of decarbonization funds, the fees would be included in an adjustment clause, with costs passed directly to customers on a dollar-for-dollar basis and the resulting revenue placed into a dedicated fund. The decarbonization funds could only be utilized for programs and initiatives that transition the electric generating sector to a low-carbon future (e.g., new non-emitting or low-emission generation, energy efficiency, R&D of baseload renewables, and CCS). The Iowa Utilities Board (IUB) would have the authority to audit and review the use of the decarbonization funds.
- The decarbonization fee would be phased out, or reduced to a level that allows continued future system emissions performance, once a 50% or 90% reduction in emissions from 2005 is achieved by 2050.

Timing: The program begins in 2010 at \$1/ton CO_2, and the fee reaches \$10/ton in 2019.

Parties Involved: Potentially any entity, public or private, with a significant quantity of GHG emissions or emission offsets.

Implementation Mechanisms

This policy would require adoption of a decarbonization fee by the Iowa Legislature and implementation by appropriate state government agencies. It should be applied statewide, requiring a rate mechanism approved through the IUB for rate-regulated utilities, with legislative support, particularly for non-rate-regulated utilities.

Related Policies/Programs in Place

Iowa Energy Efficiency Fund.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2emissions, but also trace amounts of CH_4 and N_2O emissions.

Estimated GHG Reductions and Costs or Cost Savings

Table G-4-1. Estimated GHG reductions and costs of or cost savings from CRE-4a

Quantification Factors	2012	2020	Units
GHG emission savings	2.2	11.4	$MMtCO_2e$
Net present value (2008–2020)	\$144.7	\$315.6	\$ Million
Cumulative reductions	3.9	74.1	$MMtCO_2e$
Cost-effectiveness	\$36.8	\$4.3	\$/tCO_2e
Change in generation cost	\$0.1	\$3.1	\$/MWh

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; \$/tCO_2e = dollars per metric ton of carbon dioxide equivalent; \$/MWh = dollars per megawatt-hour.

The decarbonization fee could result in about 3,400 GWh of new renewable energy resources by 2020, which when combined with existing renewable resources results in a renewable energy equivalent of 22% of energy generation. The cost-effectiveness per tCO_2 is lower than the fee in 2020 for two reasons: (1) cost-effectiveness is measured as an average over the period, and (2) the benefits from energy efficiency reduce the impacts of renewable generation that cost more than existing thermal generation.

Data Sources: See CRE-2.

Quantification Methods: See CRE-2.

Key Assumptions:

- The decarbonization fee for electric generation begins at \$1/tCO_2 in 2010 and increases by \$1/year until a cap of \$10/tCO_2 is obtained in 2019, and is then kept constant through 2030.

- The new renewable generation that results from the decarbonization fee comes 95.8% from wind, 2% each from biomass and solar PV, and 0.2% from liquefied petroleum gas.
- Efficiency is capped as a percentage of generation at 20%.
- The funding goes 30% to efficiency, 40% to renewables, 10% to the Low-Income Weatherization Fund, and 20% to R&D.
- The levelized cost of energy efficiency measure is $37.13/MWh in 2009. The source for capital costs is Quantec, Summit Blue Consulting, Nexant, Inc., A-TEC Energy Corporation, and Britt/Makela Group (February 2008), *Assessment of Energy and Capacity Savings Potential in Iowa: Final Report,* vol. I. This figure includes all utility and participant costs. Utility fixed costs are assumed to be 24% of the capital cost, based on MidAmerican Energy Company EE [energy efficiency] Action Plan filing Docket # EEP-08-02, vol. II, p. A1-8.
- The avoided cost of electricity in 2009 is $72/MWh. The figure is from 2009–2013 Energy Efficiency Plan Interstate Power and Light Company Docket No. EEP-08-123-Apr-08, p. 33. The values base case is without an externality factor.
- The real rate at which costs are discounted annually is 5%.
- NPV is calculated in 2005 dollars beginning in 2009.
- All electricity from coal-fired generation is coming from sources within Iowa (no imports).
- Renewables displace marginal sources of generation (50% coal, 50% natural gas) through 2012. From 2013 on, renewables displace the thermal new-build mix of 99% coal, 1% natural gas.
- Energy efficiency measures are assumed to displace marginal sources of generation (50% coal, 50% natural gas) through 2012. From 2013 on, energy efficiency displaces the new-build mix of 78% coal, 21% renewables, and 1% natural gas.

Key Uncertainties

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased renewables (the avoided CO_2 methodology).[4]

Additional Benefits and Costs

- The quantification does not include the 10% of funds that go to low-income assistance and 20% that goes to "other." Thus, the emission reduction estimates are likely to be higher than estimated in the quantification process.
- A decarbonization fee has the potential for negative externalities, such as impacts on the economy, particularly low-income consumers, and the potential that the funds would be used for unrelated programs that do not directly assist the transition to a low-carbon future. Therefore, these issues must be addressed explicitly at the creation of the decarbonization fee policy.

[4] Annex A defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Super Majority (2 objections).

Barriers to Consensus

Unspecified.

CRE-5. Performance Standards

Policy Description

A generation performance standard (GPS) is an emissions rate hurdle that must be met for compliance by sources supplying electricity to consumers in Iowa. Typically, a GPS is expressed in pounds (lbs) of CO_2/MWh. An RPS is a type of performance standard, identifying a target percentage of a generator's supply mix that must be from sources that meet the RPS's definition of renewable. A GPS can be applied to new generation or can include the system-wide emissions rate of an entity's generating fleet.

In either scenario, the theory of a GPS is to lower the emissions rate over time to obtain a desired end point. Given this, a GPS can have many variables, including coverage of generating units or load-serving entities, offsets, the inclusion of energy efficiency programs, technology incentives, trading of renewable energy credits, penalty rates for noncompliance, emissions from purchased power, triggers for on and off ramps, and the rate of change to the emissions standard. Each factor can have a significant influence on the cost of compliance and thus on ratepayers.

Policy Design

Goals: The goals of this policy are to:

- Identify the likely reasonable cost regulatory structures for a GPS to comply with the scenarios modeled.
- Analyze the costs and benefits of GPS scenarios to reach the:
    - 5(a): 50% reduction goal from 2005 emissions levels by 2050, and
    - 5(b): 90% reduction goal from 2005 emissions levels by 2050.

Timing: This policy would require adoption of a GPS by the Iowa Legislature and implementation by the IUB.

Parties Involved: The Iowa Legislature, IUB, and entities covered by the GPS.

Other: Various forms of GPS have been utilized by many states and countries to encourage zero- and low-emitting generation, while providing regulatory flexibility in the compliance pathway.

Implementation Mechanisms

To accomplish this policy option's goals, an initial draft policy outline for a GPS is as follows:

- The simplest approach to model the 50% and 90% reduction scenarios, from a 2005 emissions baseline, is a system-wide emissions rate from an entity's generating fleet.
- In 2005, the average emissions rate for electrical generating fleets in Iowa was approximately 1,800 lb CO_2/MWh. By 2050, demand for electricity is expected to approximately double. Therefore, the draft GPS path begins at 1,800 lb CO_2/MWh in the year 2010. The end points

for the performance standards in 2050 are 450 lb CO_2/MWh for the 50% reduction scenario, and 90 lb CO_2/MWh for the 90% reduction scenario. Nonetheless, it is important to note that these end points are theoretical and will need to be amended according to real-world growth in the demand for electricity.

- The success of an emissions performance standard depends upon the reasonable cost technologies available. Consistent with CRE-10, baseload renewable energy and CCS technologies are not expected to be commercialized until the 2020–2025 time frame. Therefore, the GPS must provide incentives for developing these technologies in Iowa.
- The emissions performance standard for both goals begins in 2010 at 1,800 lb CO_2/MWh for an entity's generating fleet. For the 50% scenario, the standard will be reduced by approximately 33.75 lb CO_2/MWh per year through 2050. For the 90% scenario, the standard will be reduced by approximately 42.75 lb CO_2/MWh per year through 2050.
- Electric generating entities employing baseload renewable energy and CCS technology prior to 2025 would receive a bonus multiplication factor for such MWh to stimulate technology development. Between 2025 and 2030, the bonus multiplication factor would continue to be granted for baseload renewable energy and CCS projects, but at a lower reward rate than used between 2015 and 2025.
- To encourage the development of biomass-based renewable energy, CO_2 emissions from the combustion of biomass (e.g., switchgrass, corn stover) or methane from the decomposition of organic matter (e.g., landfill gas, manure biogas) would not count against the emissions performance standard.

Related Policies/Programs in Place

None identified.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions.

Estimated GHG Reductions and Costs or Cost Savings

The target in 5a (Table G-5-1) results in 16,000 GWh of renewables by 2020, or 30% of net generation; 2008 renewables generation (including hydropower and municipal solid waste) is estimated at 9.8%.

Table G-5-1. 5a—For the 50% reduction by 2050 option (14.3% by 2020)

Quantification Factors	2012	2020	Units
GHG emission savings	4.9	11.4	$MMtCO_2e$
Net present value (2008–2020)	$722.5	$2,650.6	$ Million
Cumulative reductions	18.1	95.4	$MMtCO_2e$
Cost-effectiveness	$40.0	$27.8	$/t$CO_2$e
Change in generation cost	$3.3	$7.3	$/MWh

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t$CO_2$e = dollars per metric ton of carbon dioxide equivalent; $/MWh = dollars per megawatt-hour.

The target in 5b (Table G-5-2) results in 21,300 GWh of renewables by 2020, or 40% of net generation; 2008 renewables generation (including hydropower and municipal solid waste) is estimated at 9.8%.

Table G-5-2. 5b—For the 90% reduction by 2050 option (25.7% by 2020)

Quantification Factors	2012	2020	Units
GHG emission savings	5.7	16.1	$MMtCO_2e$
Net present value (2008–2020)	$892.9	$3,480.1	$ Million
Cumulative reductions	20.1	124.3	$MMtCO_2e$
Cost-effectiveness	$44.5	$28.0	$\$/tCO_2e$
Change in generation cost	$4.2	$10.3	$/MWh

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; $/MWh = dollars per megawatt-hour.

Data Sources: See CRE-2.

Quantification Methods: See CRE-2.

Key Assumptions:

- The program begins in 2009 and runs through 2020.
- The generation performance standard deploys new resources equal to 90% from wind, 10% from biomass.
- The real interest rate used to discount cash flows is 5%.
- NPV is calculated in 2005 dollars beginning in 2009.
- All electricity from coal-fired generation is from sources within Iowa (no imports).
- Renewables displace marginal sources of generation (50% coal, 50% natural gas) through 2012. From 2013 on, renewables displace the thermal new-build mix of 99% coal, 1% natural gas.

Key Uncertainties

Compliance penalties for nonperformance need to be addressed in future iterations of this policy option.

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased renewables (the avoided CO_2 methodology).[5]

Additional Benefits and Costs

None identified.

[5] Annex A defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses.

Feasibility Issues

Regulated actors ability to reduce emissions by 26% by 2020 is an issue for concern.

Status of Group Approval

Approved.

Level of Group Support

Super Majority (3 objections, 1 abstention).

Barriers to Consensus

Unspecified.

CRE-6. Voluntary GHG Commitments

Policy Description

Numerous U.S. companies and organizations, including many utilities, have taken on voluntary GHG reduction commitments. Some of these are organized through EPA's Climate Leaders program. Others include participation in Power Partners and the EIA 1605(b) Voluntary GHG Emission Reduction Program. Forty two companies, including some of the world's largest—e.g., GE, Dupont, IBM, and Duke Energy—have joined together as the Business Environmental Leadership Council (BELC) of the Pew Center on Global Climate Change. These companies are voluntarily addressing global climate change through proactive and innovative measures, including setting targets for GHG emission reductions, implementing innovative energy supply and demand solutions, improving waste management practices, participating in emissions trading, and investing in carbon sequestration opportunities and research. Thirty-seven of these BELC companies have established GHG reduction targets. Some of these companies have achieved their targets and are currently evaluating new goals, while others are considering first-time targets.

These commitments can be based on total GHG emissions in a given year or specific voluntary projects, or can be defined on an intensity basis (tCO_2e/MWh generated or delivered.) Some entities with voluntary commitments also transact through the Chicago Climate Exchange (CCX), a pilot program for reducing and trading GHG emissions in North America. Currently more than 350 entities are participating in the CCX, including the University of Iowa and Iowa Farm Bureau.

Policy Design

Goals: The goals for an Iowa Voluntary GHG program include:

- Encourage Iowa businesses and citizens to voluntarily begin reducing GHG emissions immediately, without waiting for mandatory Iowa or national GHG reduction program measures. A goal of this program is to obtain voluntary commitments from each of Iowa's investor-owned utilities (IOUs) to reduce GHG emissions by at least 6% below the baseline year 2005 emissions by 2010, and to obtain similar commitments from 25% of Iowa's GHG-emitting private businesses.
- Provide a means for Iowa voluntary GHG emission reductions to be quantified and recognized by applying Iowa-approved GHG quantification methods.
- Allow rate-regulated utilities assurance of cost recovery for voluntary GHG reduction measures that are reviewed and approved as prudent and reasonable by the IUB. The rates charged by some utilities in Iowa are regulated and must be approved by the IUB. The rate-regulated utilities in Iowa are MidAmerican Energy Company, Interstate Power and Light Company, Aquila, Inc., Atmos Energy Corporation, and Linn County REC. The rates of the rural electric cooperatives and the municipal utilities are not regulated or approved by the IUB, except that Linn County REC has voluntarily asked that its rates be regulated. Rate-regulated utilities would have to propose actions they would take to reduce their GHG

emissions for approval by the IUB. If the IUB approved those measures, cost recovery means that the IUB would allow the rate-regulated utility to recover the cost of the approved GHG reduction measures in rates the utility charges its customers.

- Provide documentation that supports voluntary measures receiving full credit under a future Iowa or national mandatory or voluntary GHG reduction program (e.g., credit for early action).
- Enable Iowa voluntary GHG emission reduction measures to receive credit as certifiable CO_2 offsets for use inside and outside of the United States.

Timing: Upon promulgation of CRE-6.

Parties Involved: All sectors and sources that wish to provide for voluntary GHG reductions or offsets, including government, utilities, industry, business, commercial building owners, and homeowners.

Implementation Mechanisms

Legislation will provide for voluntary GHG emission reductions to be registered and for costs-recovery mechanisms. The Iowa Department of Natural Resources (IDNR) will be authorized to provide voluntary measure recordkeeping and provide for review for public interest. The IUB will be authorized to review and approve any costs for rate-regulated utilities.

Related Policies/Programs in Place

None identified.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions.

Estimated GHG Reductions and Costs or Cost Savings

Not quantifiable.

Data Sources: Not applicable.

Quantification Methods: Not applicable.

Key Assumptions: Not applicable.

Key Uncertainties

None identified.

Additional Benefits and Costs

None identified.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

CRE-7. Policies Related to Nuclear Power

Policy Description

Nuclear power has potential as an alternative source of electricity for meeting GHG reduction goals. During operation, nuclear plants generate no GHGs, although, as with any new structure, GHG emissions are associated with the construction of the facility. Nuclear power generation is classified as baseload generation and is designed to operate at high-capacity factors. It is also the largest single source of non-carbon-emitting electric generation. As a result, it is a potential energy supply alternative, in large scale, to meet Iowa's growing electric needs and for possible long-term replacement of baseload coal-fired generation.

As of the end of the 2007, 104 commercial nuclear generating units were licensed by the U.S. Nuclear Regulatory Commission (NRC), with an electric capability of 97,400 MW. The most recent reactor came on line in 2007. The current administration has been supportive of nuclear expansion, emphasizing its importance in maintaining a diverse energy supply and its potential for producing electricity with negligible GHG emissions during operation.

Other means of incorporating nuclear generation include license renewal and uprating for existing plants. Nuclear license renewal allows a nuclear power plant to extend the life of the facility for 20 years past its original 40-year license term. The NRC considers the license renewal program one of its major cornerstones of current regulatory activity. A nuclear power plant uprating is a technical review process whereby a licensee may receive approval from the NRC to operate a plant at a higher power level than the level authorized in the original license. License renewal and power uprates typically require some capital investment for upgrades and rebuilding of plant subsystems.

Iowa's only nuclear plant is the Duane Arnold Energy Center, which is owned by the FPL Group, through its subsidiary FPL Energy (70% ownership), Central Iowa Power Cooperative (20% ownership), and Corn Belt Power Cooperative (10% ownership). Duane Arnold received approval for a power uprate in 2001, and currently has a license from the NRC to operate until 2014. In acquiring its ownership share in 2005, FPL committed to seek license renewal for an additional 20 years, until 2034. MidAmerican Energy Company is a 25% owner of the Quad Cities Nuclear Power Station near Cordova, Illinois, which also completed a power uprate, and has received license renewal from the NRC to operate until 2032.

It is currently estimated that it would take approximately 10–12 years to design, permit, and construct a new nuclear power plant. Therefore, steps should be taken today if Iowa chooses to employ nuclear power as part of a balanced and diversified energy portfolio[6] that achieves Iowa's long-term carbon emission reduction goals.

Policy Design

Goal: If deemed feasible, consider building one new 1200-MW nuclear power plant in Iowa. The focus of this particular policy is to determine the economic feasibility of nuclear power in a

[6] Including, among others, renewable energy, conservation, and energy efficiency measures.

carbon-constrained environment, and to define specific state legislative and regulatory actions to facilitate licensing, financing, and construction of new nuclear power plants in Iowa.

Timing: To have the plant operational by January 1, 2020.

Parties Involved: This policy would become effective with action by the Iowa Legislature and implementation by the IUB, IDNR, and other state agencies. IOUs, generation and transmission electric cooperatives, municipalities, Iowa Department of Public Health, environmental advocacy groups, state legislators, county government and economic development leaders, business advocacy groups, the Office of Energy Independence, and the Office of Consumer Advocate.

Other: None identified.

Implementation Mechanisms

Unspecified.

Related Policies/Programs in Place

As a starting point, the analysis should assume that the NRC approves the license renewal application for the Duane Arnold Energy Center.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4, and N_2O emissions.

Estimated GHG Reductions and Costs or Cost Savings

Table G-7-1. GHG reductions and costs of or cost savings from CRE-7

Quantification Factors	2012	2020	Units
GHG emission savings	0.0	9.7	$MMtCO_2e$
Net present value (2008–2020)	N/A	$267.7	$ Million
Cumulative reductions	N/A	9.7	$MMtCO_2e$
Cost-effectiveness	N/A	$27.6*	$/tCO_2e$
Change in generation cost	N/A	$4.5*	$/MWh

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; $/MWh = dollars per megawatt-hour; N/A = not applicable.

* See the Key Uncertainties section on the estimated costs of new nuclear power.

Data Sources: See CRE-2.

- Moody's Investors Service. October 2007. "New Nuclear Generation in the United States: Keeping Options Open vs. Addressing An Inevitable Necessity." Available at: http://www.moodys.com.

Quantification Methods: See CRE-2.

Key Assumptions:

- That one new nuclear plant with a capacity of 1200 MW is operating in Iowa by 2020.
- The existing Duane Arnold Energy Center is operating with a new license until 2034.
- A 90% capacity factor for new nuclear units.
- The real interest rate used to discount cash flows is 5%.
- NPV is calculated in 2005 dollars beginning in 2009.
- All electricity from coal-fired generation is coming from sources within Iowa (no imports).

Key Uncertainties

There are considerable uncertainties about the cost characteristics of new nuclear power. EIA's cost estimates for new nuclear are employed in this analysis, but are much lower than other recent reports, such as Moody's, that estimate installed costs of $5,700/kW.

As with other CRE modeling assumptions (e.g., natural gas, wind), the cost of nuclear power is higher today than previously modeled. The latest numbers for nuclear power, based on an average of data prepared by Progress Energy Florida and Florida Power and Light, estimate the total levelized unit cost of nuclear power is $100/MWh ($2006 dollars) generated.[7] This is nearly double the $52/MWh used in the quantification for CRE-7 in Iowa.

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased renewables (the avoided CO_2 methodology).[8]

Additional Benefits and Costs

None identified.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Majority (5 objections).

[7] Assumes a useful life (and life for calculation of annualized capital costs) of 40 years, a capacity factor of 91%, an average installed capital cost of $7,091/kW, $79/kW-yr fixed O&M costs, $3.1/MWh variable O&M costs, $15/MWh fuel costs, and a 8.5%/yr weighted-average cost of capital. See: http://www.flclimatechange.us/ewebeditpro/items/O12F19875.pdf.

[8] Annex A defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses.

Barriers to Consensus

Objections were raised that the costs of nuclear power are underestimated, and that significant GHGs are associated with the extraction, refining, and disposal of nuclear waste.

Objections were also raised that many of the liabilities associated with nuclear power are not reflected in the cost analysis of the ICCAC process. For example, its economics require investments now that will not receive returns for 1–12 years, and it is unlikely that investors will be will to capitalize such a project given the current crisis. Commercial nuclear wastes (spent fuel rods) do not have a viable storage/disposal option at this time and require diligence for 40,000 years for the longest-lived isotopes to decay. Yucca Mountain, Nevada, is the proposed repository, but it is not a popular option among people in Nevada or among the citizens of states like Iowa through which the nuclear waste will need to be transported to reach its ultimate destination. Terrorism and nuclear proliferation are additional concerns regarding the transportation of high-level nuclear wastes. Also, reprocessing the wastes is currently not an option in the United States. Considering all these liabilities, some ICCAC members felt that this option did not merit being a part of the ICCAC's portfolio of options, and it is not necessary to utilize this option to achieve the scenario targets.

CRE-8. Support for Grid-Based Renewable Energy and Development

Policy Description

This policy option reflects financial incentives to encourage investment in renewable energy resources by businesses and individuals that sell power commercially. Grid-based renewable energy facilities are assumed to be those that interconnect directly with the transmission system.

Policies can be developed to help overcome financial barriers and increase incentives for renewable energy development. Institutional barriers, such as low market prices, the inability of the market to assign values to the public benefits of renewables and the social costs of fossil fuel technologies, high transaction costs relative to smaller project sizes, and high financing costs because of lender unfamiliarity and perceived risk, can be overcome through a suite of financial and regulatory incentives for renewable energy development. These policies and incentives can include:

- Direct subsidies for buying or selling renewable generation equipment.
- Tax credits or exemptions for buying or selling renewable generation equipment.
- Government-sponsored or -facilitated loan programs for buying renewable generation equipment.
- Tax credits or direct subsidies for each kWh generated or sold from renewable generation facilities.
- Government-sponsored or -facilitated loan programs supporting the manufacture of renewable generation equipment.
- Direct subsidies supporting the manufacture of renewable generation equipment.
- Tax credits or exemptions supporting the manufacture of renewable generation equipment.
- Regulatory policies that provide incentives and/or assurance of cost recovery for utilities that invest in renewable energy systems.
- Regulatory policies that streamline certification requirements for renewable generation plants.
- Iowa regulatory support for federal transmission cost-allocation policies that are equitable and promote the cost-efficient siting of renewable generation resources.

The reference case scenario predicts that renewables generation will rise from approximately 6% of retail sales in 2005 to 11% in 2009, and will rise to 16% of retail sales by 2020.

Policy Design

Goals: This option includes two different pathways for promoting renewable energy development: 8a more aggressive and 8b is less aggressive. For the purpose of quantification, 8b is used for calculations and in the summary table.

- 8a (More aggressive case): Increase grid-based renewable electric production in Iowa by 400,000 MWh (400 GWh) of generation in the first year and growing by 1% of retail MWh sales each year thereafter. This policy adds an average of 521 GWh of new renewable resources per year over 2012–2020 and results in incremental renewables generation equal to 3.7% of retail sales by 2015, and 8.2% of retail sales by 2020. Including assumed reference case renewables deployment, CRE-8a results in approximately 24.2% of renewables as a percentage of retail sales by 2020, and 32.2% by 2030.
- 8b (Less aggressive case): The MGA renewable energy goal for the Midwest region equivalent to 10% of retail MWh sales by 2015, 20% by 2020, and 30% by 2030. Iowa's reference case renewable generation exceeds the linear MGA target until approximately 2018, and then adds an average of 767 GWh of new renewable resources per year over 2018–2020. CRE-8b results in new renewables generation equal to 4% of retail sales by 2020, and additional increments equal to 1% of retail sales each year thereafter. Including assumed reference case renewables deployment, CRE-8b results in the MGA target of 20% of renewables as a percentage of retail sales by 2020, and 30% by 2030.

Timing:

- Beginning in 2012, continuing through 2020.
- As specified in the MGA renewable energy goal.

Parties Involved: Grid-based renewable generation developers.

Implementation Mechanisms

- Identify barriers to grid-based renewable generation development.
- Quantify barriers in dollar terms.
- Determine specific incentive levels and durations needed to overcome barriers.
- Set incentive levels and program limits to achieve grid-based renewable generation development goals.
- Provide federal production tax credit.

Related Policies/Programs in Place

Current policies and programs include:

- Tax exemptions for buying or selling renewable generation equipment:
  - The property tax exemption for methane gas conversion available under Iowa Code § 427.1(29);
  - The property tax exemption for renewable energy facilities available under Iowa Code § 441.21;

- The local option special assessment for wind generation facilities available under Iowa Code § 427B.26;
- The replacement generation tax exemption for renewable energy facilities available under Iowa Code § 437A.6; and
- The sales tax exemption for wind and solar generation equipment available under Iowa Code §§ 423.3(54) and 423.3(90).

- Government-sponsored or -facilitated loan programs for buying renewable generation equipment:
  - The alternate energy revolving loan program under Iowa Code § 476.46; and
  - The Iowa Energy Bank loan program under Iowa Code § 473.19.
- Tax credits for each kWh generated or sold from renewable generation facilities:
  - The wind and renewable energy tax credits available for kWh sold under Iowa Code chapters 476B and 476C; and
  - The wind energy tax credits available for kWh generated and consumed on site under Iowa Code chapter 476B.
- Regulatory policies that provide incentives and/or assurance of cost recovery for utilities that invest in renewable energy systems:
  - Advance ratemaking principles available for utility-owned renewable generation facilities under Iowa Code § 476.53, which are determined in advance of plant construction and before the utility's next rate case.
- Regulatory policies that streamline certification requirements for renewable generation plants:
  - The IUB chapter 24 rules for "Location and Construction of Electric Power Generating Facilities" (199 IAC 24), and the "25 MW per gathering line" exemption for wind-generating facilities described in IUB Docket No. DRU-03-2.

The DOE report *20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply* (http://www.20percentwind.org/20p.aspx?page=Report) describes an expansion of U.S. wind-generation capacity from 11.6 GW in 2006 to 305 GW by 2030, with more than 10 GW located by 2030. This 10 GW of wind capacity in Iowa would be equivalent to an Iowa goal of 40%–50%, based on estimated Iowa retail sales of 67,651 GWh in 2030 (i.e., 40% goal if the combined wind capacity generates at a 31% capacity factor, and 50% goal if it generates at a 39% capacity factor).

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions.

Estimated GHG Reductions and Costs or Cost Savings

Table G-8-1. Estimated GHG reductions and costs of or cost savings from CRE-8a (More aggressive case)

Quantification Factors	2012	2020	Units
GHG emission savings	0.3	4.8	$MMtCO_2e$
Net present value (2008–2020)	$16.2	$557.6	$ Million
Cumulative reductions	0.3	22.9	$MMtCO_2e$
Cost-effectiveness	$54.4	$24.4	$\$/tCO_2e$
Change in generation cost	$0.2	$3.0	$/MWh

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; $/MWh = dollars per megawatt-hour.

Table G-8-2. Estimated GHG reductions and costs of or cost savings from CRE-8b (Less aggressive case used in the summary table at the beginning of this appendix)

Quantification Factors	2012	2020	Units
GHG emission savings	0.0	2.3	$MMtCO_2e$
Net present value (2008-2020)	$0.0	$93.4	$ Million
Cumulative reductions	0.0	4.3	$MMtCO_2e$
Cost-effectiveness	$0.0	$21.8	$\$/tCO_2e$
Change in generation cost	$0.0	$1.5	$/MWh

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; $/MWh = dollars per megawatt-hour.

Data Sources:

Midwestern Governors Association. 2007. *Energy Security and Climate Stewardship Platform for the Midwest*. Midwestern Energy Security & Climate Stewardship Summit. Available at: http://www.midwesterngovernors.org/Publications/MGA_Platform2WebVersion.pdf.

Quantification Methods: See CRE-2.

Key Assumptions:

- The program runs from 2012 through 2020. For CRE-8b, the gap between the MGA target and the policy goal in 2015 and 2020 is met in a linear deployment of new renewables.
- Coal is the fossil fuel displaced, and it is replaced by grid-based renewable electric production: wind (95%), solar PV (2%), and biomass (3%).
- The real interest rate used to discount cash flows is 5%.
- NPV is calculated in 2005 dollars beginning in 2009.
- All electricity from coal-fired generation is coming from sources within Iowa (no imports).
- Renewables displace marginal sources of generation (50% coal, 50% natural gas) through 2012. From 2013 on, renewables displace the thermal new-build mix of 99% coal, 1% natural gas.

Key Uncertainties

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased renewables (the avoided CO_2 methodology).[9]

As a sensitivity analysis, the assumption of avoiding 50% coal, 50% gas generation for the entire planning period (2009–2020) instead of 2009–2012 in CRE-8a results in the year 2020 CO_2 reductions decreasing from 4.8 to 3.5 $MMtCO_2$, the cumulative 2009–2020 reductions decreasing from 22.9 to 16.7 $MMtCO_2$, and the cumulative 2009–2020 cost increasing from \$24.40 to \$43.20/tCO_2.

Additional Benefits and Costs

None identified.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

[9] Annex A defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses.

CRE-9. Transmission System Upgrading

Policy Description

Developing policies to address the long-term demand for electricity requires not only consideration for enhancing the generating portfolio mix and demand-side and energy efficiency programs, but also measures to improve both the regional and the local distribution systems in order to diminish bottlenecks, enhance throughput, and reduce transmission line losses.

Opportunity exists to significantly increase transmission line carrying through the implementation of new construction methods and retrofit activities on the transmission grid, including incorporating advanced composite conductor technologies, reactive compensation technologies, and grid management software. Siting new transmission lines can be a difficult process, given their cost and perceived impacts on health, the environment, and the use, enjoyment, and value of property. Future development of renewable energy facilities will require the addition of new or the upgrade of currently existing transmission lines, which must be integrated into the regional transmission grid. Policy measures in support of this option could provide incentives to utilities and transmission owners to upgrade transmission systems and reduce barriers to siting new transmission lines.

This policy assumes that all existing state and federal laws regarding the siting of transmission will be followed as this policy is implemented. Reduction of barriers to the siting of new transmission lines does not mean the protections afforded by currently applicable environmental laws should be reduced. This policy option could also include reductions in the use and leakage of sulfur hexafluoride from electrical equipment, plus use of efficient transformers and other advanced materials and equipment. Given the long lead time (between 4 and 7 years) for large transmission line planning, permitting, and construction, current distribution line capacity should be evaluated immediately as a "quick start" measure to get carbon-free distributed generation on the grid.

Policy Design

Goals: The goals of this policy are to:

- Research how implementing modern grid technologies would enable a more efficient and intelligent transmission system.
- Identify specific legislative and regulatory actions that would be needed to support long-term, cost-effective alternatives that increase transmission system capabilities.
- Commission a study that would identify areas in Iowa's transmission system where upgrading and/or expanding transmission would enable the state's wind resources to be developed for Iowa users and for potential exports to other states. The study would focus on identifying both areas where large expansions are necessary to catapult Iowa's wind production, as well as areas where smaller upgrades would enable wind installations for local area purposes. The study would seek to quantify the incremental costs and identify the benefits and implementation time frames for alternatives that yield additional increases to

transmission and distribution (T&D) system capabilities, beyond normal planned expansion. The analysis should take into account reductions in GHG emissions that would result from energy saved due to lower line losses.

Timing: This policy would become effective with action by the Iowa Legislature and implementation by the IUB and other state agencies.

Parties Involved: IUB, IOUs, generation and transmission electric cooperatives, municipalities, representatives of environmental and economic development organizations, and the Office of Consumer Advocate, the Federal Energy Regulatory Commission (FERC), Midwest ISO, and transmission owners (such as ITC Midwest).

Other: Fully utilize the existing grid by balancing the congestion points in the grid by identifying and maximizing "sweet spots" that can match modest transmission capacity with good renewable resources.

Implementation Mechanisms

Several energy efficiency measures can be implemented to reduce the T&D line losses of electricity. Utilities use a variety of components throughout the T&D system to reduce losses. Increasing the efficiency of these components can further reduce losses. Vermont, for example, offers a rebate to encourage users to install energy-efficient transformers. Regulations, incentives, and/or support programs can be applied to achieve greater efficiency of T&D system components.

Related Policies/Programs in Place

None in Iowa

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions.

Estimated GHG Reductions and Costs or Cost Savings

Not quantified.

Data Sources: Midwest Ag Energy Network. 2006. *Where Agriculture Meets Energy: Policy Options From the Midwest Ag Energy Summit*. (No Web link available.)

Quantification Methods: Not applicable.

Key Assumptions: Not applicable.

Key Uncertainties

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased renewables (the avoided CO_2 methodology).[10]

Additional Benefits and Costs

None identified.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

[10] Annex A defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses.

CRE-10. R&D for Emerging Technologies and Corresponding Incentives

Policy Description

R&D of emerging technologies to develop demonstration projects and eventual commercialization of reasonable-cost generation technologies with low or zero GHG emissions is critical to solving the global climate change challenge. Technology areas often cited as requiring such reasonable-cost developments are CCS (e.g., in deep saline aquifers or coal seams) for fossil fuel facilities, and large-scale baseload renewable energy or technologies that can transform intermittent renewables into baseload generation (e.g., batteries, compressed air storage).

Given the magnitude of the task, an Apollo-like research program to create and field test such technologies that are commercially viable is needed. At present, such funding is not a significant portion of a rate-regulated utility's budget or the budgets of federal and state government agencies. Nonetheless, even a small fee per kWh of electricity could generate significant funding. However, funding is only half of the equation; strategies to use such funds to implement a focused program to commercialize generation technologies with low or zero GHG emissions must also be developed.

Policy Design

Goals: The goals of this policy, though unquantifiable in terms of emissions, are:

- By 2009, identify the likely funding mechanisms and policy tools that would provide further stimulus for the development of new, reasonable-cost, low- and zero-GHG-emitting electricity generation in Iowa.
- By 2009, analyze the costs and benefits of R&D program scenarios to help reach the 50% and 90% reductions targets from 2005 emission levels by 2050.
- By 2010, begin to implement the R&D funding mechanisms.
- By 2015, identify and begin characterizing areas within and near Iowa that are likely candidates for CCS, and begin larger-scale field studies of baseload renewable energy and technologies that can transform intermittent renewables into baseload generation.
- By 2020, complete larger-scale field studies and demonstrations of baseload renewable energy and technologies that can transform intermittent renewables into baseload generation. Prior to 2020, verify small-scale CCS test projects within suitable formations, and initiate larger-scale projects.
- By 2025, fully commercialize baseload renewable energy and technologies that can transform intermittent renewables into baseload generation, and fully integrate CCS into new coal-fueled power plants.
- By 2030, commercialize reasonable-cost CCS technology for coal-fueled power plants that were not originally designed for sequestration. Baseload renewable energy and technologies

that can transform intermittent renewables into baseload generation will be cost competitive without subsidies or incentives.

Timing: See above.

Parties Involved: Iowa Legislature, IUB, electric utilities, and potentially other appropriate state government entities, such as the Office of Energy Independence, Iowa Power Fund, Iowa Department of Economic Development, and State Regents Institutions.

Other: The Iowa Power Fund is an example of a new state government board designed to help stimulate the research, development, and commercialization of new clean energy sources in Iowa.

Implementation Mechanisms

This policy may require the adoption of incentives by the Iowa Legislature, IUB, and potentially other appropriate state government entities.

Related Policies/Programs in Place

CRE-4 could provide a source of funding for this option.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions.

Estimated GHG Reductions and Costs or Cost Savings

Not quantified.

Data Sources: Not applicable.

Quantification Methods: Not applicable.

Key Assumptions: Not applicable.

Key Uncertainties

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased renewables (the avoided CO_2 methodology).[11]

Additional Benefits and Costs

None identified.

Feasibility Issues

None identified.

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[11] Annex A defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

CRE-11. Distributed Generation/Co-Generation

Policy Description

This policy option focuses on encouraging investment in small-scale distributed generation (DG) through incentives or subsidies and the prevention of barriers for both utility and consumer investment.

Policy Design

Goal: 7500 MWh per year of new distributed renewable generation.

Timing: New distributed renewable generation beginning in 2010 and continuing each year thereafter.

Parties Involved: All utilities serving customers in Iowa, state agencies with jurisdiction, other interested stakeholders.

Other: A funding source to cover any financial incentives would need to be determined. The level of credit or funding should be consistent for all utilities (IOUs, municipals, and cooperatives). The cost of the incentive should be shared among all end users so that no one is overly burdened.

Implementation Mechanisms

DG can be encouraged by ensuring access to the grid under uniform technical and contractual terms and charges for interconnection, including mandatory insurance coverage and amounts, that are based on economic costs, so that owners know in advance the requirements for parallel interconnection, and manufacturers can design standard packages to meet technical requirements. Changes that generally facilitate the integration of customer-owned DG with the grid could encourage the adoption of specific renewable energy and high-efficiency technologies, including small wind farms, solar PV systems, fuel cells, and microturbines. In addition, prices should be established that owners of distributed generators both pay and receive for electricity at levels consistent with utilities' costs. Uniform requirements for emissions, land use, and building codes should be established that are based on the technology of electricity generation, so that manufacturers can design suitable units and owners of distributed generators are not restricted in their siting and operating decisions relative to other new sources of generation.

Incentives for distributed renewables should include (1) direct subsidies for purchasing/selling renewable technologies; (2) tax credits or exemptions for purchasing/selling renewable technologies; (3) tax credits for each kWh generated from a qualifying renewable facility; (4) rebates to the customer from utilities for the installation of a residential renewable energy system similar to rebates for energy-efficient appliances; (5) state assistance for Iowa's utilities to implement a Smart Grid, which would more easily enable utility customers to be both users and producers; and (6) hiring a DG point person who would work within the Office of Energy Independence to assist utilities and customers to implement this policy, its incentives, and regulatory requirements in order to fully utilize the benefits from DG and reach the ICCAC's goal of 90% reduction of GHG emissions by 2050.

DG can be encouraged by ensuring access to the grid under uniform technical and contractual terms for interconnection that are based on best practices, so that owners know in advance the requirements for parallel interconnection and manufacturers can design standard packages to meet technical requirements. Changes that generally facilitate the integration of customer-owned DG with the grid could encourage the adoption of specific renewable energy and high-efficiency technologies, including solar PV systems, fuel cells, and microturbines. Uniform requirements for emissions, land use, and building codes should be established that are based on the technology of electricity generation, so that manufacturers can design suitable units and owners of distributed generators are not restricted in their siting and operating decisions relative to other new sources of generation.

Other implementation mechanisms include funding mechanisms and incentives, and regulatory policies that support utility investments in small-scale distributed renewable energy. CRE-13 addresses feed-in tariffs and net metering to help facilitate investments in DG.

Related Policies/Programs in Place

Wind production tax credits, and tax exemptions on residential wind, solar (PV) panels, and solar hot water systems.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions.

Estimated GHG Reductions and Costs (or Cost Savings)

Table G-11-1. Estimated GHG reductions and costs of or cost savings from CRE-11

Quantification Factors	2012	2020	Units
GHG emission savings	0.0	0.1	$MMtCO_2e$
Net present value (2008–2020)	$2.0	$14.3	$ Million
Cumulative reductions	0.0	0.5	$MMtCO_2e$
Cost-effectiveness	$59.1	$29.1	$/tCO_2e
Change in generation cost	$0.0	$0.1	$/MWh

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO₂e = dollars per metric ton of carbon dioxide equivalent; $/MWh = dollars per megawatt-hour.

Data Sources:

- Energy consumption by sector (BBtu). See CRE-1.
- Power station electricity generation (GWh) and fuel use (BBtu). See CRE-1.

Quantification Methods:

- Heat rates (Btu/kWh). See CRE-1.

- GHG emissions associated with end-use consumption (by sector). See CRE-1.
- GHG emissions associated with electricity generation from different technologies and fuels. See CRE-1.

Key Assumptions:

- The program begins in 2010 and continues annually.
- The new renewable DG will come from wind (95%) and solar PV (5%).
- The real interest rate used to discount cash flows is 5%.
- NPV is calculated in 2005 dollars beginning in 2009.
- Renewables displace marginal sources of generation (50% coal, 50% gas) through 2012. From 2013 on, renewables displace the thermal new-build mix of 99% coal, 1% natural gas.

Key Uncertainties

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased renewables (the avoided CO_2 methodology).[12]

Additional Benefits and Costs

None identified.

Feasibility Issues

Self-generation and displacing part or all of one's own energy demand is more likely cost-effective than interconnecting for small (i.e., less than 1 MW) generation sources.

Status of Group Approval

Approved.

Level of Group Support

Super Majority (1 objection).

Barriers to Consensus

Unspecified.

[12] Annex A defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses.

CRE 12. Combined Heat & Power

Policy Description

Combined heat and power (CHP) is a term used to describe scenarios in which waste heat from energy production is recovered for productive use. CHP scenarios most commonly occur at baseload generating stations, so that a reliable source of thermal energy can be provided to the users of the reclaimed thermal energy. The reclaimed thermal energy, while sometimes not of significant energy value for the baseload generating station, can be used by other nearby entities (e.g., within an industrial park or district steam loop) for productive purposes.

The theory of CHP is to maximize the energy use from fuel consumed and to avoid additional GHG emissions from entities near a baseload generating station via additional fossil fuel combustion. Generating stations in more rural areas will most likely require the co-location of new industry, thereby avoiding new emissions from development. However, generating stations in urban areas may have existing opportunities or may require the co-location of new industry. Thus, this goal may be more effective at slowing and stopping emission increases by targeting industrial development near baseload generating stations, rather than reversing current emissions from existing industry.

The key to implementing CHP systems is to provide adequate incentives for the development of infrastructure to capture and utilize the waste heat. Such incentives could come in many forms, such as recruiting suitable end users to the area, tax credits, grants, zoning, and offset credits for avoided emissions.

Policy Design

Goals: The goals of this policy are:

- Biomass, ethanol, and wind sectors will grow and develop facilities that might use CHP.
- To identify the likely policy tools that would provide significant stimulus for CHP developments in Iowa by 2009.
- To implement significant incentives for CHP development by 2010.
- To quantify the maximum cost-effective contribution of CHP scenarios to help reach the 50% and 90% reduction targets from 2005 emission levels by 2050.
- To provide sufficient stimulus to implement 50% of cost-effective CHP opportunities by 2025.
- To provide sufficient stimulus to implement 90% of cost-effective CHP opportunities by 2035.

Timing: This policy may require the adoption of incentives by the Iowa Legislature and appropriate state and local government agencies.

Parties Involved: Iowa Legislature, Iowa Department of Economic Development, electric generating stations, city and county governments, and other agencies as appropriate.

Implementation Mechanisms

This policy may assist the transportation group and any renewable fuels goal that would require an expansion of biofuel plants in Iowa. Such new plants could be given incentives to locate where CHP opportunities exist.

Related Policies/Programs in Place

Renewable Fuels Standards (U.S. and Iowa)

Iowa's renewable fuel standard (RFS) is the most progressive standard in the country. The standard will be implemented beginning in calendar year 2009, with incentives eligible in 2010. The Iowa standard, in cooperation with the federal RFS, guides production and sets the following goals for renewable fuel use over a span of 14 years:

- 25% biofuel sales in Iowa by 2019.
- 36 billion gallons produced in the United States by 2022.
- 50% reduction in GHG emissions from biomass-based diesel and advanced biofuels.
- 20% reduction in GHG emissions from renewable fuels.
- 60% reduction in GHG emissions from cellulosic biofuels.

(Goals defined in Iowa RFS and the 2007 Energy Independence and Security Act.)

Timing: Achieve by 2022 under the federal RFS and by 2019 under the Iowa RFS.

Parties Involved: Federal government, state government, producers, marketers, blenders, consumers, and refiners.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from CO_2 emissions, but also trace amounts of CH_4 and N_2O emissions.

Estimated GHG Reductions and Costs or Cost Savings

Table G-12-1, on the following page, shows the estimated greenhouse gas reductions and cost savings resulting from the combined heat and power policy option.

Table G-12-1. Estimated GHG reductions and costs of or cost savings from CRE-12

Quantification Factors	2012	2020	Units
GHG emission savings	0.3	2.1	$MMtCO_2e$
Net present value (2008–2020)	–$61.6	–$564.3	$ Million
Cumulative reductions	0.6	13.6	$MMtCO_2e$
Cost-effectiveness	–$104.5	–$41.4	$/$tCO_2e$
Change in generation cost	5.4	0.0	$/MWh

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; $/MWh = dollars per megawatt-hour.

Note: The costs are relative to the avoided cost of electricity, which does not include avoided T&D costs or capacity charges to end users. Negative numbers indicate cost savings.

Data Sources:

- NREL/FEMP 2004—"Biomass Cofiring in Coal-Fired Boilers." June 2004. Federal Energy Management Program (FEMP) Federal Technology Alert. DOE/EE-0288. Available at: http://www1.eere.energy.gov/femp/pdfs/fta_biomass_cofiring.pdf.
- Onsite Sycom Energy. January 2000. *The Market and Technical Potential for Combined Heat and Power in the Commercial/Institutional Sector*. Available at: http://www.chpcentermw.org/pdfs/eiacom.pdf.
- DOE/Office of Renewable Energy and Energy Efficiency. (ND). *Net Energy Balance for Bioethanol Production and Use*. Available at: http://klprocess.com/Facts_Legends/USDOE_Energy_Bal.pdf.
- Estimates for Iowa biofuels consumption are derived from Iowa_transportation_CO2.xls file. from TLU sector. (No Web link available.)

Quantification Methods:

Includes avoided T&D charges and thermal costs for commercial, industrial, and biomass CHP.

Key Assumptions:

- The program begins in 2010 and runs through 2019.
- The real interest rate used to discount cash flows is 5%.
- NPV is calculated in 2005 dollars beginning in 2009.
- All electricity from coal-fired generation is coming from sources within Iowa (no imports).
- T&D losses are 7%.
- Avoided electricity emissions are Iowa average emissions over the period at 7%.
- The fuel for new commercial CHP is 100% natural gas; for new industrial and biomass refineries, it is 50% coal and 50% natural gas.
- The program deploys only 30% of estimated achievable CHP potential in the state over the life of the program.

- Avoided cost of electricity in 2009–2018 from: 2009–2013 Energy Efficiency Plan Interstate Power and Light Company Docket No. EEP-08-1, April 23, 2008, p. 33. Values base case without externality factor. The 2009 avoided cost is $.72/MWh.
- Avoided capacity charges for commercial CHP are: Ancillary Service Charge of $0.28/kW/month, Facility Capacity—Distribution $1.65/kW/month, On-Peak Demand Charge $1.90/kW/month, System Usage Charge $0.35/kWh. Avoided capacity charges for industrial and biomass are 50% of commercial. Fixed and variable operation and maintenance for displaced thermal are assumed to be $0.07 MMBtu each.
- Displaced boiler efficiency is 80%.
- Renewables displace marginal sources of generation (50% coal, 50% natural gas) through 2012. From 2013 on, renewables displace the thermal new-build mix of 99% coal, 1% natural gas.

Key Uncertainties

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased renewables (the avoided CO_2 methodology).[13]

Additional Benefits and Costs

None identified.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

[13] Annex A defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses.

CRE 13. Pricing Strategies To Promote Renewable Energy and/or CHP

Policy Description

This policy option focuses on creating pricing and metering strategies that can encourage consumers to implement CHP, renewable energy, and overall reductions in GHG emissions. Pricing strategies, such as feed-in tariffs, provide minimum utility purchase rates for DG. Net metering is a policy that allows owners of DG (generating units on the customer side of the meter, often limited to some maximum kW level) to generate excess electricity and effectively sell it back to the utility by "turning the meter backward."

Policy Design

Goal: Achieve a 10% shift to renewable energy sources, as a percentage of retail sales, through implementation of various pricing strategies.

Timing: 1% shift achieved in 2010, with linear growth through 2019.

Parties Involved: All industrial, commercial, and residential electricity customers in Iowa; utilities; representatives of environmental and economic development organizations; IUB, Office of Consumer Advocate, Office of Energy Independence.

Implementation Mechanisms

Encourage net metering of renewable energy systems by:

- Creating a centralized net metering program that is a one-stop shop for net metering. Staff would work with customers and utilities to assist the process of net metering.
- Providing incentives to utilities to net meter with their customers.
- Providing incentives to customers to net meter with their utilities.
- Establishing uniform standards and requirements for utilities and customers.
- Requiring all Iowa's utilities to net meter with interested customers who meet the minimum requirements.
- Rewarding utilities that show leadership in net metering measured by the number of customers who are net metering and the amount of energy net metered.

Implementation of pricing strategies, such as feed-in tariffs, must be considered in light of existing rules, such as the FERC's avoided cost standard.

Related Policies/Programs in Place

- IUB net metering rule for rate-regulated utilities (199 IAC 15.11(5)).
- Rate-regulated utility net metering tariffs.

- According to current FERC rules, states may not require utilities to pay more than the utility's avoided cost of electricity. This potentially limits state application of feed-in tariffs. Passage of a federal feed-in tariff law would supersede the FERC avoided cost standard.

Type(s) of GHG Reductions

Avoiding electricity generation from fossil fuel sources results in GHG reductions primarily from carbon dioxide emissions (CO_2), but also trace amounts of methane (CH_4), and nitrous oxide (N_2O) emissions.

Estimated GHG Reductions and Costs or Cost Savings

Table G-13-1. Estimated GHG reductions and costs of or cost savings from CRE-13

Quantification Factors	2012	2020	Units
GHG emission savings	1.2	5.6	$MMtCO_2e$
Net present value (2008–2020)	$90.4	$1,128.0	$ Million
Cumulative reductions	2.4	35.2	$MMtCO_2e$
Cost-effectiveness	$38.0	$32.1	$\$/tCO_2e$
Change in generation cost	$0.97	$4.67	$/MWh

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; $/MWh = dollars per megawatt-hour.

Data Sources:

- Energy consumption by sector (BBtu). See CRE-1.
- Power station electricity generation (GWh) and fuel use (BBtu). See CRE-1.

Quantification Methods:

- Heat rates (Btu/kWh). See CRE-1.
- GHG emissions associated with end-use consumption (by sector). See CRE-1.
- GHG emissions associated with electricity generation from different technologies and fuels. See CRE-1.

Key Assumptions:

- The program begins in 2010 and runs through 2019.
- The reduced GHG emissions come from reduced use of thermal resources, replaced by 80% wind, 15% biomass energy crops, 3% solar PV, and 2% fuel cells.
- The real discount rate is 5% per year.
- NPV is calculated in 2005 dollars beginning in 2009.
- All electricity from coal-fired generation is coming from sources within Iowa (no imports).
- Renewables displace marginal sources of generation (50% coal, 50% natural gas) through 2012. From 2013 on, renewables displace the thermal new-build mix of 99% coal, 1% natural gas.

Key Uncertainties

None identified.

Additional Benefits and Costs

None identified.

Feasibility Issues

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased renewables (the avoided CO_2 methodology).[14]

Status of Group Approval

Approved.

Level of Group Support

Super Majority (3 objections).

Barriers to Consensus

Self-generation and displacing part or all of one's own energy demand is more likely to be cost-effective than interconnecting for small (i.e., less than 1 MW) generation sources. However, this policy gives the impression that interconnection for small sources is technically and economically feasible, and does not adequately address potential safety concerns to distribution system electrical workers.

[14] Annex A defines the rationale behind the assumption used for the avoided CO_2 methodology in these analyses.

ANNEX A

Avoided Electricity Emissions for the Energy Supply Sector

To estimate emission reductions from policy options that are expected to displace conventional grid-supplied electricity (i.e., renewable energy and CHP), a simple, straightforward approach is used. Through 2012, we assume that these policy options would displace generation from the a "marginal" mix of fuel-based electricity sources of 50% coal and 50% gas. (We assume that sources without significant fuel costs would not be displaced—e.g., hydro or other renewable generation.) After 2012, we assume that the policy options are likely to avoid a mix of new fossil fuel-based capacity additions. The thermal new-build mix is estimated to be 99% coal and 1% gas.

There is a risk that GHG reductions are overstated and the costs per ton of CO_2e reductions are understated, if high-CO_2-intensity resources are assumed to be redispatched or not built due to increased renewables (the avoided CO_2 methodology).

As a sensitivity analysis, the assumption of avoiding 50% coal, 50% gas generation for the entire planning period (2009–2020) instead of 2009–2012 in CRE-8a results in the year 2020 CO_2 reductions decreasing from 4.8 to 3.5 $MMtCO_2$, cumulative 2009–2020 reductions decreasing from 22.9 to 16.7 $MMtCO_2$, and the cumulative 2020 cost increasing from \$24.40 to \$43.20/tCO_2.

The reference approach described in the beginning of this annex provides a transparent way to estimate emission reductions and to avoid double counting (by ensuring that the same MWh from a fossil fuel source is not "avoided" more than once). It can be considered a "first-order" approach; it does not attempt to capture a number of factors, such as the distinction between peak, intermediate, and baseload generation; issues in system dispatch and control; impacts of nondispatchable and intermittent sources, such as wind and solar; or the dynamics of regional electricity markets. These relationships are complex and could mean that policy options affect generation and emissions (as well as costs) in a manner somewhat different from that estimated here. Nonetheless, this approach provides reasonable first-order approximations of emission impacts and offers the advantages of simplicity and transparency that are important for stakeholder processes.

ANNEX B

Generation Modeling Assumptions

Generation Modeling Assumptions	2020						
	Fuel Cost $/MMBtu	Capital Cost $/kW	Capacity Factor	Renewables Tax Credits	Integration Cost	Generation Cost MWh	Assumed CO_2 Emissions Intensity (t/MWh)
Coal (existing pulverized)	$1.32	$479	75%	—	—	$23.84	1.03
Nuclear	$0.50	$2,631	90%	—	—	$52.40	0.00
Natural gas	$5.50	$751	75%	—	—	$49.23	0.46
Oil	$10.30	$751	35%	—	—	$58.09	1.05
MSW	$0.50	$2,016	90%	—	—	$50.33	0.48
Biomass—energy crops	$7.47	$2,363	75%	–$10.00	—	$120.12	0.00
Biomass—ag. residues	$7.47	$459	75%	–$10.00	—	$67.85	0.00
Landfill gas	$0.50	$2,016	90%	—	—	$50.33	0.67
Wind	—	$1,703	36%	–$20.00)	$4.00	$56.51	0.00
Hydro	—	$1,896	75%	–$10.00	—	$32.88	0.00
Solar	—	$6,006	30%	–$10.00	—	$254.60	0.00

$/MMBtu = dollars per million British thermal units; $/kW = dollars per kilowatt; MSW = municipal solid waste; MWh = megawatt-hour; t/MWh = metric tons per megawatt-hour.
Note: Negative numbers indicate cost reductions/cost savings.

Capital costs and capacity factors come from the Assumptions to the Annual Energy Outlook 2007. Capital costs from that report have been adjusted for real inflation in the sector. Fuel costs come from the *Assumptions to the Annual Energy Outlook 2008*, with the exception of the two biomass fuel sources and landfill gas, which were developed by the AFW and CRE subcommittees.

Appendix H
Transportation and Land Use Sectors
Policy Options

Summary List of Policy Options

No.	Policy Option	GHG Reductions ($MMtCO_2e$) 2012	2020	Total 2009–2020	Net Present Value 2009–2020 (Million $)	Cost-Effective-ness ($\$/tCO_2e$)	Level of Support
TLU-1	Smart Growth Bundle with Transit	0.076	0.242	1.53	–$377	–$245	Unanimous
TLU-1a	Expand and Improve Transit Infrastructure	0.004	0.026	0.127	$7.2	+$57	Supermajority (5 objections)
TLU-2	GHG Impacts for State and Local Capital Funding	*Quantified as part of TLU-1 and TLU-1a*					Unanimous
TLU-4	Support Passenger Rail Service in Iowa	N/A	0.008	0.026	$15	+$597	Majority (7 objections)
TLU-5a	Adopt Best Workplaces for Commuters in Iowa	0.02	0.02	0.21	$18	$84	Supermajority (6 objections)
TLU-5b	Distributed Workplace Models	*Non-quantified, qualitative option*					Unanimous
TLU-6	Light Duty Vehicles Fuel Efficiency Incentives	0.44	3.65	17.70	NQ	NQ	Supermajority (3 objections)
TLU-7	Fuel Efficient Operations for Light Duty Vehicles-LRR Tires	0.11	0.65	3.41	–$306.9	–$90	Unanimous
TLU-8	New Vehicle Standards (Tailpipe GHG and Fuel Economy)	N/A	0.8	4.1	–$246	–$60	Unanimous
TLU-9	Freight Strategies (Truck and Rail)	0.39	0.63	5.9	$30	+$5	Supermajority (1 objection)
TLU-10	Fuel Strategies (20% Low Carbon Fuel Standard)	0.60	5.11	22.03	–$1,359	–$62	Unanimous
	Sector Total After Adjusting for Overlaps and Synergies	**1.64**	**11.14**	**55.03***	**-$2,218.50**	**-$59**	
	Reductions From Recent Actions (Federal CAFE Requirements)	**0.26**	**1.93**	**9.39**	***Not Quantified***		
	Sector Total Plus Recent Actions	**1.9 (8.3)**	**13.07 (48)**	**64.42**	**N/A**	**N/A**	

CAFE = corporate average fuel economy; GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; NQ= not quantified; N/A = not applicable BAU = business as usual (i.e., no new curbs on GHG emissions)

The numbering used to denote the above policy options is for reference purposes only; it does not reflect prioritization among these important policy options.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

* Deduct total TLU-6 2009–2020 reductions [17.7 MMt] from 55.03 total = 37.3, before calculating cost/ton for TLU options.

Overlap Discussion:

The amount of greenhouse gas (GHG) emissions reduced and the costs of a policy option within the Transportation and Land Use (TLU) sectors overlap with some of the quantified benefits and costs of policy options within other sectors. Where this overlap has been determined to exist, the sector totals have been adjusted and each instance is outlined below. Overlaps between options within TLU have been accounted for within the goal-setting process.

TLU-10 (Fuel Strategies) overlaps with AFW-6 (Cellulosic Biofuels). TLU-10 promotes the development of a Low-Carbon Fuel Standard (LCFS), which could potentially include cellulosic biofuels already accounted for in AFW-6. To adjust for the overlap between these two Subcommittees, the AFW sector total emission reductions and costs were reduced by the proportion determined to be included under the TLU-10 analysis.

TLU-1 (Smart Growth Bundle with Transit) and TLU-1a (Expand and Improve Transit Infrastructure) are also very closely related and complementary or each other. Creating higher density, mixed-use developments works best when transit can be incorporated into the developments. Conversely, transit works best when it is located in higher density populations to achieve the necessary ridership to allow transit to be feasible. Although these policy options are closely related, the complementary nature of these policies did not, however, impact their quantification. Each of these policies has been independently quantified for both emissions reductions and costs.

TLU-5a (Adopt Best Workplaces for Commuters in Iowa) and TLU-5b (Distributed Workplace Models) both focus on reducing vehicle miles traveled (VMT) by adjusting commuter patterns. TLU-5a focuses on telecommuting as well as utilizing alternative modes of transportation for commuting to work, while TLU-5b focuses on the development of workplace clusters being placed within communities thereby minimizing the VMT associated with workplace commuting. While complementary of one another, the subcommittee did not see these policies as overlapping. TLU-5a was quantified, but due to the planning required to determine how the distributed workplace model would function most effectively in a given community this policy option (TLU-5b) was not quantified.

No reductions from recent actions as identified in the policy options have been made to the TLU sector totals.

TLU-1. Smart Growth Bundle

Policy Description

The Smart Growth Bundle includes policies that will align growth and development in Iowa with GHG reduction goals. Developing statewide policies to implement smart growth will have significant economic, social, and ecological benefits for communities across Iowa. This bundle of policies includes the following elements:

- Downtown revitalization, infill and brownfields* redevelopment
- Transit-oriented development
- Smart growth planning, modeling, and tools
- Bicycle and pedestrian infrastructure
- Growth management planning
- Technical and financial support to local and regional agencies
- Reforms of local zoning, tax, and building codes

Smart growth policies that affect land use and transportation patterns are proven to reduce vehicle miles traveled (VMT). This will enable more Iowans to conveniently travel on foot, by bicycle or transit, or with shorter driving trips. Improving planning tools and software applied in Iowa will enable accurate quantification of VMT reduction of various smart growth policies. The combination of these policies will ensure maximum impact.

Achieving reductions in VMT through smart growth policies will occur through:

- *Strategic Growth and Development*—Enable local governments to improve community design and direct growth to locations that will result in reduced VMT. The state will establish and maintain a land use policy framework that ensures that local land use planning satisfies both state goals and local interests. This framework will include: greater coordination amongst local governments and state agencies, strategic development areas where metropolitan growth boundaries support reduction of VMT, and focused redevelopment strategies that ensure efficient use of land and existing infrastructure.
- *Education and Technical Assistance*—Communities will be given flexibility and choices to achieve VMT reduction goals through their growth and development. Local governments and other stakeholders, such as developers and private lending institutions, will be provided technical assistance that will include diverse strategies for communities to consider using in reaching VMT reduction goals. (i.e., model zoning code provisions, local tax code reform to achieve smart growth, etc.) Education will be provided to parties involved with

* Brownfields are abandoned or under-utilized commercial and industrial areas, often within or close to the urban core.

implementation, as well as to the general public in order to overcome barriers to accepting smart growth and to encourage sustainable lifestyles like biking and walking.

- *Incentives and Funding Programs*—Existing incentives, funding, and loan programs administered by the state that are applicable to growth and development will be assessed and realigned to support the elements of this smart growth bundle of policies. Rating systems and prioritization of funding will be reviewed and improved to meet smart growth objectives. New programs will be developed and existing programs will be revised to fill in gaps where no program exists to meet needs that can't be achieved, or are far less likely to be achieved, without funding assistance. (i.e., improved brownfields and greyfields* incentives increased technical assistance funding for Iowa Downtown Resource Center.)

Details of specific policies and programs that fall under the above three categories will be outlined in the Implementation Mechanisms category of this document.

Policy Design

Goals:

- Achieve quantifiable/measurable VMT reduction goals of 10% per capita off the baseline projection for 2020 in urban areas through smart growth. The state of Iowa will enable growth and development to achieve VMT reduction goals through a series of policies, including implementation mechanisms identified below. Scientific research shows that VMT reduction in urban areas is quantifiable through improved planning software. Iowa agencies will assist local and/or regional governments in using the latest planning technology that measures VMT impacts to assist with decision-making on future growth and development. The more aggressively the policies are pursued, the greater the potential reduction in VMT that would be achievable.

Additional goals:

- VMT reduction goals of 20% per capita reduction off baseline forecast for 2030
- VMT reduction goals of 30% per capita reduction off baseline forecast for 2050
- *Incorporate unique rural VMT reduction strategies*—although rural areas of the state will have more limited opportunities to reduce reliance on the automobile, smart growth policies will still be implemented to reduce auto dependence within small communities and reduce the need to drive far away for employment, retail goods, or services.
- *Integrate with Transit Policy When Applicable*—Land use practices are a key component of reducing VMT with expanded and improved transit infrastructure. The implementation of the Smart Growth Bundle, with Transit Infrastructure policy (TLU-4), will be coordinated whenever applicable to achieve maximum reduction of greenhouse gases through efficient implementation.
- *Integrate GHG Reductions from Other Sectors When Applicable*—Policies intended to reduce GHG through other sectors besides transportation, such as generation or consumption of electricity will be tied together when implementation mechanisms present an opportunity to

* Greyfields are old, obsolete and abandoned retail and commercial sites, usually malls.

achieve maximum GHG emissions from multiple sectors. (i.e., incentives for downtown revitalization will also be tied to green building standards when applicable)

Timing:
2009—Development of metropolitan growth boundaries and involvement of utility and service providers (water, wastewater).

2009—Administrative policies or actions that do not require new funding sources will begin.

2009—Policies that require state legislation should be considered during the legislative session.

2009–2010—Use of planning tools and software to analyze transit and land use scenarios for VMT reduction.

2009–2012—Adoption of metropolitan growth boundaries, and revisions to those boundaries every three years that will include VMT reduction measurements and goals.

2009–2012—Municipalities will develop and implement policies that support and promote high quality, dense developments at hubs and nodes along identified rapid transit routes. Other local policies will be adopted to reduce VMT through community design. State technical assistance will be provided, where needed, in order to relieve barriers to local implementation.

2012—State funding will be fully realigned to support VMT reduction.

2020—Full implementation with evident VMT reduction results achieved through this policy.

Parties Involved: Cities, counties, Iowa State University Extension, University of Iowa, Metropolitan Planning Organizations and Councils of Governments, transit service providers and transit agencies, utility providers, water and sewer service providers, Environmental Protection Agency, Iowa Department of Natural Resources, Department of Transportation, Department of Economic Development, Department of Public Health, Iowa Finance Authority, Office of Energy Independence, USDA Rural Development, non-profit organizations with development-related interests (environment, economic development, human services, etc), developers, planners, lenders, school districts, contractors, homebuilders, employers.

Implementation Mechanisms

Establish and adopt a statewide "complete streets" policy that incorporates transit, bicycle and pedestrian facilities in state, or state-facilitated and federally funded transportation projects as appropriate. The policy will require documentation of the consideration and decision-making process of transit, bicycle and pedestrian facilities for all roadway projects.

A Governor's Executive Order will create a Community Investment cabinet to guide state planning and investments to local communities. This cabinet-level position and office is essential in coordinating a new framework for state agencies and state funding streams. The Office of Community Investment *(or similar name)* will work with the Iowa legislature and the directors of state agencies. Other states across the country have created similar cabinet-level offices to spearhead new land use and development initiatives, to ensure that state dollars are spent efficiently to meet state goals, and that state agencies are operating in a cohesive manner to reach state goals for community development. This cabinet will be responsible for monitoring and ensuring that investments are tied to communities who are successfully reducing VMT and making progress on policies that will lead toward VMT reduction. This will happen in a variety of state investments such as transportation dollars, sewer and water funding, housing funding, and redevelopment incentives.

Performance measures such as the following will be established in coordination with the parties involved in the implementation of this policy:

- Utilize new planning software to produce land use scenarios in Iowa communities, showing their impact on Vehicle miles traveled. Measure local and regional land use plans with VMT software. Use this technology to guide local decision-making and incent climate-friendly development patterns.
- Develop land use inventories to track the underutilized or undeveloped property within existing city limits and the conversion rate of greenfields (i.e., farmland, natural areas) to development. Use these periodic inventories to measure how development patterns are shifting to compact development, and whether smart growth strategies are having the desired statewide impact.

Strategic Growth and Development

Greater coordination of local governments and state agencies, and planning for growth to support the reduction of VMT, will require:

- **Metropolitan Growth Boundaries** will be established in the nine largest urban areas, in cooperation with service providers and local governments. The boundaries will show a 20-year projection for growth and development. Boundaries will be based on regional population projections, which utilize county-level population projections provided by the state (such as Regional Economic Models, Inc.), and increased densities with compact development to support VMT reduction goals.
- **Urban Service Areas** will address the growth of a given city, in an agreement with county governments within Iowa's nine metropolitan areas and other areas projecting rapid growth. These are cooperative agreements to control rural large lot development; address where a city has the capacity to improve infrastructure in order to accommodate growth and development; and inform local and state decision-making on annexation requests.
- **Priority Growth Areas** will be designated in every county of the state, including cities within rural counties. Priority Growth Areas include town centers, downtowns, neighborhood centers and commercial districts, transit corridors, and transit station areas. Encourage higher density housing and employment growth, mixed-use and mixed-income development, and bicycle, pedestrian, and transit-friendly development within these areas.

Redevelopment strategies that ensure efficient use of land and existing infrastructure will entail the establishment of the above three tools in order to tie state goals to funding of local communities. Decision making on aligning state incentives and goals with local interests must include

- An extensive inventory of state-level funding, incentives and programs that guide growth and development. This inventory, which may take up to a year to complete, will include information on programs such as the Clean Water State Revolving Fund, the Road Use Tax Fund, Community Development Block Grants, business development programs such as the Iowa Values Fund, Tax Increment Financing, and other areas of the state's role in local development. This inventory will detail how existing programs are helping increase vehicle miles traveled and what their potential role is in meeting state VMT goals. It will also identify the decisions the state makes about growth and development that are not necessarily tied to funding streams. (i.e., the state-level City Development Board). This inventory will be administered out of the Office of Community Investment.
- Guiding state decisions to align with VMT goals may occur through a variety of implementation mechanisms, depending on the source and the decision-making process. (i.e., state legislation, administrative rule-making, changing scoring systems on funding applications, creating simple check lists to inform state-level boards on decision-making.)
- State boards and commissions who make quasi-judicial, funding, or regulatory decisions on growth and development will use new criteria in their decision-making processes. (i.e. Iowa Finance Authority Board, City Development Board, Environmental Protection Commission) These criteria will include indicators of VMT-reducing practices such as increased densities of 7 DU/acre or more, complete pedestrian infrastructure, and mixed use development.

Education and Technical Assistance

State agencies will expand education and technical assistance to Iowa communities about meeting greenhouse gas reduction goals, including smart growth strategies. This education and technical assistance will be developed with the advice of local governments, academics, and other stakeholders. State agencies will share responsibility in implementing cooperative strategies, where deemed appropriate. VMT reduction can occur through such a wide range of activities, such as changes in consumer behavior, development and land use decisions, increasing transit ridership, and others. Not every community will be expected to use the exact same tools to reach a common statewide VMT goal. Funding and technical assistance will be provided from state agencies to help local communities update comprehensive plans, zoning, and other local regulation to help encourage VMT reduction. State agencies may contract with non-profit organizations or private entities, with expertise and experience in these areas, to work with communities on behalf of state agencies.

One learning curve to receive a lot of attention will be the use of new planning software that measures VMT growth associated with community development scenarios. Different ways of utilizing this information can be found in places like Denver, Colorado and Sacramento, California. Because of advances in technology, the state of Iowa can be a leader in planning climate-friendly communities by capturing this opportunity at the forefront. Funding for software technology could be provided by the state, or through cap-and-trade auctioning revenues.

State Agency Involvement in Education and Technical Assistance

Department of Economic Development

- Strengthen and increase funding for the Iowa Downtown Resource Center and Main Street Iowa program to provide technical assistance to cities engaged in repositioning and revitalizing their downtown areas and urban neighborhood commercial districts.
- Fund a cooperative study between the Iowa DOT and the Iowa Downtown Resource Center to help identify specific travel habits in rural areas. This study would identify areas of business and community development, where viable, that could reduce trips taken for needs like entertainment, groceries, health care services, etc.
- Continue the newly established Iowa Green Communities Program. Use that program to convene other state agencies to advance green community principles and criteria. Conduct workshops for cities, developers, and stakeholders about how to design community development projects to fit smart growth criteria. Develop a public information program promoting the acceptance of infill and higher densities in exiting neighborhoods.
- Engage the Business Development Division in assisting private investments associated with transit-oriented development. (i.e., streetcars, trolleys, commuter rail, and the commercial development process around transit stations/stops). Develop educational materials about how businesses can attract new customers who use transit, foot, or bicycle.
- The City Development Board and agency staff will provide communities with education about implementing smart growth principles in existing and new neighborhoods, as well as improving practices for public participation in development decisions.

Department of Natural Resources

- Increase funding for the Iowa Brownfield Redevelopment Program. Assist cities in working through regulatory requirements to allow brownfield reuse and redevelopment. Work with cities to develop or update inventories of qualifying brownfield and greyfield sites.
- The Water Quality Division, and any appropriate offices in the division, will cooperate with other agencies that provide funding for sewer and water infrastructure, such as the Iowa Finance Authority and Iowa Department of Economic Development to prioritize improvements needed within the existing city limits of cities which both meet the state's water quality goals and are located within the identified Priority Growth Areas. The Water Quality Division will also provide technical assistance to communities regarding the processes of updating their infrastructure and the funding that is available to do this for communities located within targeted Priority Growth Areas.

Department of Public Health

- Create an education campaign to educate bicyclists, motorist and pedestrians about the health benefits of bicycling and walking. Create pilot communities and showcase those who do more to embrace and design for walking and biking.

Department of Cultural Affairs

- Expand technical assistance for historic preservation projects, especially those located in Priority Growth Areas and/or serving a public purpose such as libraries and city halls.

Department of Transportation

- Establish a program within DOT administrative planning processes that will help communities integrate land use and transportation planning. A model for this can be found in Pennsylvania with Penn DOT's Sound Land Use Implementation Plan. http://www.dot.state.pa.us/Internet/Bureaus/CPDM.nsf/LandUseHomepage?OpenFrameset
- Share responsibility and cooperate with the Iowa Department of Economic Development in the study to help identify specific travel habits in rural areas.
- Cooperate with Iowa State University's Center for Transportation Research and Education. Update the Iowa Statewide Urban Design and Specifications Manual to incorporate new and improved standards for appropriate bicycle, pedestrian, and transit accommodation in transportation and development projects. Iowa State University (ISU) and DOT will cooperate with state agencies, transit providers, and other interested parties in the update of the manual.

Incentives and Funding Programs

The inventory of state-level incentives and funding programs that guide growth and development will assist in identifying the realignment of programs needed to support state VMT reduction goals. State agencies will assist in evening the cost differentials between greenfield development and brownfield sites by giving priority to infill projects and/or designated Priority Growth Areas. Require state government agencies to consider local land use comprehensive plans, zoning ordinances, Metropolitan Growth Boundaries, and Urban Service Areas in making certain permit and funding decisions. Public investments would only be made when the existing infrastructure systems are at capacity or all available land is developed.

Strategies To Realign State Funding

- Extend and expand the new Iowa Brownfields/Greyfields Tax Credit Program. Expand eligible costs to include site assessments.
- Incorporate preferential rating of brownfield and greyfield sites into a point system for receiving federal transportation funds, acknowledging the negative impacts of continuing to develop new interchanges and greenfield sites.
- Develop new criteria for sewer loans, bonding and funding. Projects can only qualify for state funding for new capacity when available land is developed and existing sewer system is either in a state of good repair, or has a plan in place for improving it within five years.
- Limit Tax Increment Financing districts in greenfields.
- Adopt a new "complete streets" policy for state Department of Transportation (DOT)-funded roadway projects. The policy will require consideration of transit, bicycle and pedestrian facilities for all roadway projects and documenting their consideration and the decision-making process. The policy will incorporate public input on its effectiveness in serving all users—pedestrians, cyclists transit riders and motorists. Apply new criteria to road funding programs, such as the Revitalize Iowa's Sound Economy (RISE) program, to ensure that new roads/improvement projects are designed create access to employment centers and to create transportation choices for workers.

- Extend and expand the Historic Preservation Tax Credit Program; remove the artificial cap.
- Give infrastructure funding priority to areas that have concurring sewer, water, and road planning that does not induce demand or catalyze sprawling development on the urban fringe. This would be identified in the Metropolitan Growth Boundary and Urban Service Area agreements.

Related Policies/Program in Place

None noted.

Estimated GHG Reductions and Net Costs or Cost Savings

Quantification Factors	2012	2020	Units
GHG emission savings	0.076	0.242	$MMtCO_2e$
Net present value (2009–2020)		–$377	$ Million
Cumulative reductions (2009–2020)		1.53	$MMtCO_2e$
Cost-effectiveness		–$245	$/t$CO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t$CO_2e$ = dollars per metric ton of carbon dioxide equivalent. Note: Negative numbers indicate cost savings.

This analysis considers potential GHG reductions from reductions in VMT for personal (non-commercial) travel, as a result of a shift towards more compact development patterns. The analysis relies on estimates of per-capita VMT by U.S. Census tract population density range, as developed by Polzin, et al. for the Center for Urban Transportation Research (CUTR) VMT forecasting model. The CUTR model is based on analysis of 2001 Nationwide Household Travel Survey data. The model provides estimates of per-capita VMT by state for five density ranges. The model is currently set up for years 2005, 2035, and 2055; for this analysis, results were interpolated for Center for Climate Strategies (CCS) analysis years 2012 and 2020.

The observed relationship between per-capita VMT and population density is a rough proxy for the effects of Smart Growth development as described above. Higher levels of population density are associated with overall shorter trips because destinations are closer together. In addition, areas with higher population densities are more likely to have pedestrian-friendly design (walkability, mixed-use, etc.) and to support transit service. It is difficult to separate out the individual effects of the various Smart Growth strategies at this aggregate level of analysis, but the analysis should provide an indicator of what can be achieved through a combined set of Smart Growth policies.

There are strong linkages and interdependencies between transit and land use. Hence, their effects and costs, as they specifically relate to areas which are engaged in smart growth development, were jointly estimated here. Although there are significant synergies between transit and land use, outside of areas which are engaged in smart growth development, those synergies were already accounted for in the separate stand alone analyses of transit and land use. Hence, they were not included here to avoid double-counting. In particular, the transit analysis assumes a greater VMT reduction than that from transit ridership alone due to induced land use effects. Similarly, the CUTR VMT rates used for the land use analysis presume the provision of sufficient transit service.

Data Sources:

- Total population and population density by Census tract, 1990 and 2000.
- Per-capita VMT by Census tract population density in Iowa, from CUTR VMT forecasting model.
- Forecast statewide population growth

Quantification Methods:

The specific method used to estimate GHG benefits of Smart Growth strategies is as follows:

- Total population in 2000 is identified by five U.S. Census tract density ranges as identified in the CUTR model (<500, 500–1,999, 2000–3,999, 4,000–9,999, and 10,000 or more persons per square mile).
- The change in population from 1990 to 2000, and associated share of change by density range, is identified from Census data.
- For the Baseline scenario, new population growth between 2000 and 2020 (as determined from CCS baseline assumptions) is allocated to U.S. Census tract density ranges based on the share of growth in the 1990–2000 timeframe.
- The proportion of existing housing stock (population) that would be redeveloped over this timeframe is estimated at 15%, of which two-thirds is redeveloped in place and one-third is redeveloped elsewhere, with this redevelopment allocated to census tract density ranges based on the 1990-2000 share of population growth. (The 15% and two-thirds figures come from the 2007 Growing Cooler report Section 1.7.3, citing analysis of Census data by Nelson (2006)).
- The Climate Action scenario assumes a significant shift in the proportion of new development and relocated redevelopment takes place, with higher-density tracts (>4,000 persons per square mile) receiving 60% of new development under this scenario compared to effectively no growth under the Baseline scenario. Total population by tract density under this scenario is then calculated.
- Total personal-travel VMT is calculated under the Baseline and Climate Action scenarios based on VMT per capita (from the CUTR model) and total 2025 population by tract density range, and the percent reduction in personal-travel VMT is calculated.
- Costs were estimated for implementing regional vision processes in large, medium and small cities ($22 million over 12 years), State Policy/Code Revision and Implementation ($2.2 million over 12 years), and municipal policy/code/zoning revisions ($12 million over 12 years). Savings were estimated for avoided infrastructure costs (highway, water and sewer) and fuel savings.
- The costs of providing additional transit services were estimated as described below in TLU-1-a. The operating and capital costs of providing additional services, offset by the federal cost share and the savings from reduced personal vehicle operating costs, were calculated. As

described above, the cost of avoided infrastructure construction and the tons of CO_2 reduced by transit were not included in these totals to avoid double-counting.

Key Assumptions:

- Fraction of new population growth and redevelopment by U.S. Census tract density, under baseline scenario.
- Assumed shift in fraction of new population growth and redevelopment from lower-density to higher-density Census tracts, under Climate Action vs. baseline scenario.
- Percent of residential building stock redeveloped (off-site) over the analysis timeframe.

Key Uncertainties

Smart Growth scenario analysis depends upon patterns of development that involve decisions of many individual property owners and private capital investors. As a result, the scenarios show what is possible under smart growth development, but should not be considered as predicted outcomes.

The estimates developed using this methodology are consistent with results found in meta-analysis in the published literature, such as the recent Urban Land Institute (ULI) report *Growing Cooler*.

Additional Benefits and Costs

Smart growth generally has very low direct costs to implement, comprised of the governmental costs of altering regulations and zoning and providing education and technical assistance. Tax incentives are an income transfer that results in public sector costs but offsetting developer revenues. As most smart growth policies (e.g., allowing higher density and mixed use, reducing parking requirements) are deregulatory in nature, they are opening up the development market and have significant indirect benefits. An exception is growth boundaries, which restrict the land use market and have an indirect cost.

Alternative patterns of development have a large number of additional impacts, which may both provide benefits and costs. Smart growth provides a range of co-benefits that are well documented in other places. Prominent among these is the reduced cost of providing utilities and infrastructure, as smart growth makes better use of existing facilities and infrastructure. Improved air quality, public health (e.g., due to reduced air pollution and to walking), and quality of life are also notable co-benefits.

Transit services have a large number of additional impacts which provide additional benefits. Transit service provides mobility, accessibility, and safety benefits that are not included in the analysis above. Important other co-benefits are similar to those noted above: improved air quality, public health, and quality of life. Transit benefits in reducing congestion and facilitating land use patterns such as transit-oriented development and smart growth are very significant and as noted are partially reflected in the analysis above.

Feasibility Issues

Smart growth policies are being considered and implemented around the country in a wide range of communities. Because most policies are deregulatory in nature, this significantly lowers political barriers.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None noted.

TLU-1a. Expand & Improve Transit Infrastructure

Policy Description

Improvements and expansion of existing transit service and implementation of new, innovative transit services can shift more passenger transportation to public transit, thereby reducing Vehicle miles traveled (VMT). Public transportation improvements are critical to support Smart Growth initiatives (as referenced in TLU-1) and are essential to an ongoing effort to reduce VMT. This policy includes four components of change that are needed on the state level to expand and improve transit infrastructure.

- *Funding*—Current levels and allocation formulas of state funding for transit are inadequate to substantially expand and improve transit infrastructure to reduce VMT. This proposal outlines several funding levels and potential sources to meet these needs, although other funding sources not listed in this proposal will also be considered in the years to come.
- *Studies and Planning*—While a few local metropolitan areas have completed rapid transit (i.e., Bus Rapid Transit, commuter rail) studies, the state will provide the technical assistance and leadership needed to assist or help initiate future studies with local and regional governments. Transit projects and local transit agency goals will be reflected in the State Transportation Plan and will be considered in any inventory of funding needs for traffic mitigation and studies of specific roadway capacity. Currently, travel demand models in Iowa are not able to directly consider the impacts of additional or expanded transit service on total VMT in an area. This ability needs to be researched further and implemented along with other tools that can provide quantifiable estimates of VMT reduction due to additional or expanded transit service along with land use patterns.
- *Technical Assistance*—The state will provide technical assistance, where needed, to promote transit-oriented development around transit nodes or hubs. Land use and transportation coordination will be improved to increase ridership through land use changes that support transit use in urban areas.
- *Transit Marketing and Promotion*—Incentives and marketing strategies aimed at increasing transit use will be pursued as a means to shift more passenger transportation from cars to the existing transit systems and increase demand for transit.

Policy Design

Goals:

The state will expand and improve transit infrastructure to reduce VMT and achieve an annual ridership increase of 100% by the year 2020. This will be measured on a per capita basis in order to prevent population demographics from affecting the transit ridership goal. The goal of this set of activities is for the state to provide the leadership and resources necessary to help create expanded transit and ridesharing networks throughout the state that will provide Iowans with choices and will reduce VMT.

Funding Goals—Current state transportation financing policy emphasizes maintenance and capacity improvements to the road network to meet projected future VMT increases. The state will adopt revised transportation financing policies that meet the state's emission and greenhouse gas reduction goals by reducing VMT through support of public transit operating and capital investment. Goals for funding include:

- Direct more funding to help cover a significant percentage of annual operating costs for transit systems.
- Support transit capital investments.
- Designate state funding specifically for the purposes of transit services designed to reduce VMT.
- Sources of this funding will be dedicated, reliable, predictable, and able to grow despite inflation.

Funding, studies/ planning, technical assistance, and transit marketing/promotion will address the needs to:

- Improve service frequency on selected existing transit routes.
- Offer more forms of transit services and infrastructure (e.g. commuter rail, urban streetcars, bus, bus rapid transit (BRT), passenger stations, facilities, suburban park-and-ride lots).
- Reduce travel times on selected existing transit routes (signal prioritization, exclusive lanes, technology improvements, etc.).
- Improve service quality on selected transit routes (safety, cleanliness, enhanced bus stops/shelters, and real-time schedule communications).
- Expand longer distance ridesharing activities by promoting carpool and vanpool services throughout the state.
- Reduce or eliminate transit fares paid by riders that hinder ridership growth, by implementing other funding strategies (e.g. employer subsidies, state incentive funds, etc.).

Timing:
2009: Administrative policies or actions that do not require new funding sources will begin.

2009: Policies that require state legislation will be considered during the legislative session.

2009–2010: Use of planning tools and software to analyze transit and land use scenarios for VMT reduction.

2010–2020: Full Implementation.

Implementation Mechanisms

The rising cost of fuel will cause more Iowans to rely on public transit for travel needs. However, it will also increase pressure on the operating costs of local and regional transit agencies. This dynamic points to the need for implementing transit infrastructure strategies that create dependable services, while enabling performance measures to target funding for efficient, VMT-reducing services that reduce greenhouse gas emissions from the transportation sector.

Iowa must address existing shortfalls of annual state funding, identify methods to provide the required state matching funds to federal transit funding programs, and allocate transportation funding based on VMT performance measures.

Funding

Regional Transit Authorities and Enabling New Local Funding:

- Most urban areas in Iowa are currently at a disadvantage to expand transit infrastructure due to a limitation in the Iowa Code about Regional Transit Authorities (RTA). Currently, only the two largest urban areas, Des Moines and Cedar Rapids, are eligible to create RTAs. The Iowa General Assembly will pass legislation to expand RTA eligibility to all transit systems in Iowa. This will enable those areas to utilize property tax levies to enhance transit planning and services on a multi-jurisdictional, regional scale.
- Property taxes are currently the only funding source that transit systems, including RTA's can use to generate revenue for annual operating expenses. State legislation will enable new transportation-related fees, generated solely by users in a regional area, to be allocated directly to RTAs for VMT-reducing services. The RTAs will use that revenue to pay for their highest ridership routes, pay for expansion to routes with increasing ridership, and/or offer more forms of transit services and infrastructure.

State Transportation Funding

- Currently, annual State funding for public transit operations average 14 percent of total operations costs, ranging from a low of 5% in Des Moines to 37% in certain rural transit operations. State funding should be increased to cover a higher percentage, at least 25%, for transit systems with increasing ridership or ability to document VMT-reducing strategies. However, these increased state funds should be added to, not displace local support (property taxes). This will help transit agencies experiencing both an increase of riders and of higher fuel and operating costs to serve the new riders.
- The State of Iowa will be a funding partner to community-sponsored investments in transit infrastructure improvements (commuter rail or other rapid transit, major passenger facility, streetcars). The state will work with applicants of federal programs, such as the Small Starts program, to identify sources of state matching funds well in advance of the federal funding application submittal, in order to enhance the proposed transit project's application within the federal government's competitive award process. The competitive federal process for Small Starts and New Starts programs, the programs most often used for projects like rapid transit or streetcars, gives favorable ratings to projects with solid non-federal support. This encourages diversification of non-federal financial resources, such as state and local support.
- Some federal and state transportation funding programs will be examined to identify their potential role in helping to meet state VMT reduction and transit ridership goals. Applicable

programs will be modified to reward communities that are successfully reducing VMT and making progress on policies that will lead towards VMT reduction.

Studies and Planning

The state will support studies and planning for new, efficient forms of transit to assist to achieve an annual ridership increase of 100% by the year 2020. Expanding transit capacity will primarily enhance, and not replace, the effectiveness of current transit services.

Bus Rapid Transit

- Bus Rapid Transit (BRT) is an enhanced bus system that operates on exclusive transitways, High Occupancy Vehicles (HOV) lanes, expressways, or ordinary streets in order to combine the flexibility of buses with the efficiency of rail. By doing so, BRT operates at faster speeds, provides greater service reliability and increases customer convenience. It also utilizes a combination of advanced technologies, infrastructure, operational investments and land use integration to provide significantly better service than traditional bus service.
- Research indicates we could hit the target of doubling ridership and achieve it at a lower total cost through conversion of existing transit services to enhanced Bus Rapid Transit lines versus simply increasing service levels of the existing bus systems. 50-75% of the increase in ridership could be achieved via Bus Rapid Transit with the balance coming from increases in traditional fixed route bus services or other technologies as listed below.
- BRT would be implemented in the four largest existing transit agencies—Iowa City, Des Moines, Ames, and Cedar Rapids. Implementation of these studies and plans would involve participation by the following entities:
    - *The Iowa Department of Transportation* will provide assistance to transit operators to coordinate the development of possible rapid transit corridors.
    - *Transit providers* such as, the Des Moines Area Regional Transit Authority (or similar regional body), will identify corridors that can accommodate rapid transit.
    - *Municipalities* will develop and implement policies that support and promote high quality, dense developments at hubs and nodes along the identified rapid transit routes. Bicycle and pedestrian infrastructure will be planned surrounding these hubs, along with feeder bus routes that enable BRT riders to conveniently access the service.
- Other new transit services will be studied and planned for inclusion in the 25%–50% increase in transit ridership, not attributed to Bus Rapid Transit. Streetcars, trolleys, increased vanpools, and commuter rail. These will be studied with cooperative participation of cities, the Iowa DOT, transit providers, the Iowa Office of Energy Independence, and other stakeholders.

Technical Assistance

Supplemental DOT staff resources will be approved to manage, evaluate, and provide technical assistance associated with this new Transit Investment & VMT Reduction Strategy. Transit agencies in Iowa's nine urban areas shall be responsible for measuring and evaluating their success at implementing these VMT reduction policy goals in cooperation with their Metropolitan Planning Organization & DOT Office of Public Transit staff.

Transit providers will report to the Iowa DOT about progress on studies and planning activities on at least an annual basis. This will enable DOT to provide technical assistance to other areas about best practices, lessons learned, and possible funding strategies to advance new transit projects.

Transit Marketing and Promotion

Transit agencies will be required to evaluate their marketing strategies for public transit and report to the Iowa DOT about the effectiveness of current programs. The Iowa DOT will provide advice and technical assistance on transit marketing and promotion.

A State of Iowa Transit Promotional Tax Credit Fund shall be established. The fund will award tax credits to employers and other private sector interests who rely on the expansion of public transit. This fund will provide grants to transit agencies to improve websites, signage, advertisements, and other programs to encourage the use of public transit.

The state will support new fare pricing and marketing strategies that increase accessibility and ridership for transit systems. Fare pricing strategies may include a supplemental appropriation divided up to support transit agencies experiencing increased ridership growth and to reward the agencies most successfully reducing Vehicle miles traveled. Three possible policies for fare pricing are: 1) prevent agencies from increasing fares to cover their increasing operating costs. 2) transition the agency to a reduced fare to enable ridership growth, and 3) upgrade systems to allow people to more conveniently purchase bus passes to meet their needs.

Marketing strategies may include direct mail programs to targeted areas with convenient transit service. These programs will illustrate the benefits of using transit, improve the image of the transit agencies, give directions on how to use transit in that neighborhood, and how to use it for daily needs.

Related Policies/Program in Place

None noted.

Estimated GHG Reductions and Net Costs or Cost Savings

Quantification Factors	2012	2020	Units
GHG emission savings	0.004	0.026	$MMtCO_2e$
Net present value (2008–2050)		$7.2	$ Million
Cumulative reductions (2008–2050)		0.127	$MMtCO_2e$
Cost-effectiveness		$57	$/tCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

This analysis examines the reductions in GHGs possible through a shift from personal motor vehicles to transit, which emits fewer GHGs per passenger mile. The calculation of GHG reductions must account both for the reduction in the number of private vehicle miles, but also the partially offsetting increase in transit vehicle miles traveled. In addition to these direct reductions from individuals' shift of modes, two more long-term, indirect effects are estimated. The shifting of trips from personal vehicles to transit can reduce the number of vehicles on the road, and thus the amount of congestion in urban areas. Reducing congestion improves traffic flow and can improve actual average vehicle fuel economy achieved. Studies also demonstrate that increased transit service can help shape land-use patterns, enabling densities and proximity to the center of urban areas. This results in reduced VMT by those living in transit corridors, even if they never use transit.

Data Sources:

- Making Transit Work: Insight From Western Europe, Canada, and the United States—Special Report 257. Transportation Research Board: Washington, DC, 2001.
- Current and historical transit ridership, by mode type (urban/rural, bus, or paratransit) from National Transit Database. (http://www.ntdprogram.gov/ntdprogram/)
- Operating cost per passenger and per passenger-mile, by mode type (urban/rural, bus, or paratransit) from National Transit Database. (http://www.ntdprogram.gov/ntdprogram/)
- Annual Energy Outlook, Energy Information Agency, US DOE, 2008.
- Revenue per passenger and per passenger-mile, by mode type (urban/rural, bus, or paratransit) from National Transit Database.
- Transit elasticities from Improving Travel Choices, Natural Resources Defense Council, 2007. All data was collected for the transit agencies in the following Iowa cities: Ames, Bettendorf, Cedar Rapids, Coralville, Davenport, Des Moines, Dubuque, Iowa City, Sioux City, and Waterloo.

Quantification Methods:

As noted above, this analysis examines direct and indirect reductions in GHGs resulting from shifting people from personal motor vehicles to transit, which emits fewer GHGs per passenger-mile. The calculation of GHG reductions accounts for reduced private VMT and for the partially offsetting increase in transit VMT., In addition to these direct VMT and emissions reductions from individuals' shifting modes, two more long-term, indirect effects are estimated: (1) the shifting of trips from personal vehicles to transit can reduce the number of vehicles on the road, and thus the amount of congestion in urban areas, and (2) reducing congestion improves traffic flow and can reduce emissions and improve actual average fuel economy for all vehicles. As also stated above, studies show that increased transit service can help shape land-use patterns, allowing higher densities and proximity to the urban core. This results in reduced VMT even by those who never use transit.

Direct quantification was undertaken for improvements in service frequency, reductions in travel time, and the introduction of new and expansion of existing routes and services for bus, BRT, commuter rail, and vanpools. Indirectly, the effects of a fare buy down and increased marketing were reflected by selecting the highest elasticity from the literature.

Travel time improvements provide a well-documented means of improving transit service and ridership. There is a direct benefit to riders because the improved service reduces the "generalized cost" (time cost plus financial cost) of their trip. In addition to co-benefits in improving service frequency, there is about a –0.4 elasticity for transit travel time

Service frequency increases ridership by existing riders and attracts new riders. Studies show reductions in waiting time between vehicles are valued about two times more strongly on average than actual travel time, so this mechanism can prove very effective. There is a reported 0.5 elasticity for service frequency alone (time between buses), while the aggregate impacts for service improvements in time between vehicles and travel time have shown an elasticity of between 0.6 and 1.0, incorporating the time and frequency impacts of aggregate increases in service miles provided. The aggregate elasticity, using a value of 1.0, was applied to the total increase in vehicle revenue service miles (the number of miles the vehicle was scheduled to travel while operating and available to the public) to capture both factors together along with the effects of a fare buy down and increased marketing efforts.

For service expansions and introduction, both the literature and a first-order statistical analysis show a long-run elasticity for service expansion of between 0.6 and 1.0. An elasticity of 1.0 was applied to service increases.

The costs of providing service were compiled for operating and capital costs from the National Transit Database, subtracting out the Federal share of funding for these expenditures.

Savings to new riders for reducing the mileage driven in their vehicle were calculated using the Internal Revenue Service mileage reimbursement rate (58.5 cents per mile), which accounts for fuel costs, routine maintenance, repairs and depreciation. Savings from avoided infrastructure costs were calculated for highways based on the VMT reduction from transit ridership.

Key Assumptions:

- Transit services can be expanded and introduced at the same average operating cost as current services. A mix in transit modes provided—to include greater bus rapid transit, commuter rail, and van pools—decreases the average net operating cost from the existing almost purely bus service being offered.
- New or improved services will be able to attract ridership in a manner consistent with service improvements in other similar areas of the country (i.e., the Iowa transit market is not at saturation). Recent fuel price increases provide a strong argument for this assumption.

Key Uncertainties

Funding availability for the provision of additional transit service.

Additional Benefits and Costs

The provision of transit service provides other more direct benefits and cost impacts. Most importantly are travel time benefits that accrue to transit users, reduced air pollution, and congestion relief that affect road users on parallel routes.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Supermajority (Vote: 11–5).

Barriers to Consensus

None noted.

TLU-2. GHG Impacts for State and Local Capital Funding (to be a model for climate-friendly development patterns)

Policy Description

The state of Iowa will be a leader in ensuring that the development of state facilities and that state capital funding programs are helping to meet GHG-reduction goals. This includes encouraging growth and development that reduces vehicle miles traveled (VMT).

State and local government buildings will be location-efficient with compact development design, allowing easy access by multiple transportation modes and reducing reliance on the automobile. This includes city halls, schools, libraries, community-sponsored attractions, recreational centers, fire stations, police stations, and state agency offices. These location-efficient buildings will be in central business districts, established core business areas, or in neighborhood commercial areas to be efficiently accessible.

Any state of Iowa office that serves the public in an urban area will be accessible by public transportation within ¼ mile at a frequency rate that supports the needs of Iowans who visit and need that facility. New buildings for state offices located in downtowns will be high density and consider first floor retail to encourage mixed use and pedestrian orientation in downtowns. If these locations are not possible, suburban locations will have good access for bicyclists, pedestrians, and public transit.

Capital funding that Iowa administers will be a model for climate-friendly development. Some of this funding is administered in the form of grants and loans; other capital funding goes directly to local governments. This policy would improve coordination between state agencies, local and regional governments to provide the technical assistance, incentives, and tools needed to reduce VMT through smart growth implementation and linking infrastructure planning to land use planning.

Existing infrastructure and community development funding sources will be reviewed to assess their potential to facilitate smart growth and new funding programs will be developed to fill in needed funding gaps. Comprehensive planning and site planning information from local and regional governments will be submitted to the state to review specific state funding applications. The state will significantly reduce capital investments that result in VMT increase. Technical assistance and planning tools will be developed and disseminated in conjunction with the realignment of state funding assistance and approval processes.

Capital funding that can enable GHG reductions from other sectors than transportation, such as encouraging energy efficient buildings, will be included in this policy as well.

Policy Design

Goals:

- Establish and adopt a statewide “complete streets” policy that incorporates transit, bicycle and pedestrian facilities in state, or state-facilitated and federally-funded transportation projects as appropriate. The policy will require documentation of the consideration and decision-making process of transit, bicycle and pedestrian components for all roadway projects.

- Establish a reliable source of capital funding for public transportation within the Iowa DOT that is able to serve increased demands and opportunities for transit infrastructure.
- Pass a state administrative policy regarding the location and accessibility of state offices and agencies.
- Transportation, water, and sewer funding will be targeted toward maintenance needs in central locations and areas with the ability to reduce VMT through community design.
- Development projects that are designed to serve higher density, more compact, pedestrian-friendly development will be prioritized for state capital funding.
- The DOT will actively monitor and implement anticipated federal legislation regarding the consideration of GHG impacts of transportation projects. The DOT will evaluate tools and processes to evaluate GHG impacts and implement in the transportation planning process.

Timing:
2009: Adopt complete streets policy, compilation of maintenance needs of infrastructure in central locations and areas with the ability to reduce VMT through community design, compile data on existing state capital funding programs, begin technical assistance and education to stakeholders and applicants for state funding.

2010: New infrastructure policy applied to selected state capital funding, create a state-level source of capital funding for public transportation, state NEPA policy development, pass state administrative policy on location of state facilities, begin applying community design principles to state or state-administered federal capital funding.

2010–2020: Full Implementation

Parties Involved: Department of Transportation, Department of Management, Department of Administrative Services, Iowa Finance Authority, the Department of Economic Development, the Department of Natural Resources, transit agencies, and local governments. Every state agency will be complying with the policy relating to the location of offices.

Implementation Mechanisms

Locating and Expanding State Facilities—For purposes of this policy, state facilities will be defined as any property owned or leased by the state or used primarily pursuant to a written agreement on behalf of the state that derives at least 50% of its annual funding from the state. The state will develop a new approach to siting and expanding state facilities. A State Facilities Plan will be created to project short-term and long-term needs of state facilities. The plan will emphasize principles of location-efficient buildings, and designation to Priority Growth Areas as referenced in the Smart Growth Policy. An existing state facility that meets the principles of this policy will not be closed or moved outside of the Priority Growth Area.

Locating or Expanding other Public/Civic Buildings—Upon consideration of expanding public services or needing an improved building, local governments will be encouraged to redevelop and use any surrounding under-utilized property as a priority. State incentives and technical assistance will be provided to assist in preservation of historically significant public buildings. The state will enact low-interest rates on bonds to support utilization of existing buildings, infill sites, historic structures, and location-efficient developments to serve the public.

Schools—For school districts proposing new school sites, a standard lot size based on needs per pupil will be evaluated and recommended by the Department of Education and Office of Community Investment to prevent sprawling consumption of land and auto-dependence. Schools will be rewarded for re-using and redeveloping existing school sites.

Alternative Financing Mechanisms—Many local governments are overly reliant on the property tax and seeking new revenue streams for capital expenses. Any new local revenue streams authorized by state legislation will require that capital funding for infrastructure or development will primarily be used for efficient land use patterns, infill, and transportation projects that support VMT reduction. Impact fees will be authorized by the General Assembly, directed to improve the already developed areas and fund climate-friendly development patterns.

Related Policies/Program in Place

None identified.

Estimated GHG Reductions and Net Costs or Cost Savings

To be quantified as part of TLU-1 and TLU-1a

This strategy was considered as one of the key implementation mechanisms for TLU-1 and TLU-1a; it both facilitates and initiates activities that are described within those strategies. As such, the potential greenhouse gas impacts were not estimated separated, but instead can be considered as being incorporated into the other two.

Key Uncertainties

None identified.

Additional Benefits and Costs

Many of the same benefits and costs that are considered as part of the TLU-1 and TLU-1a analysis apply here as well.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None noted.

TLU-4. Support Passenger Rail Service in Iowa

Policy Description

Increasing passenger rail will reduce single occupant vehicle travel which reduces emissions of pollutants and greenhouse gases (GHG). The following is from the report "Vision for the Future—U.S. Intercity Passenger Rail Network Through 2050" prepared by the Passenger Rail Working Group:

> "Traveling by public transportation is less carbon intensive than traveling in a single occupant vehicle. Partially or fully loaded rail coaches are more environmentally friendly than lower occupancy single vehicles. The average intercity passenger train produces 60 percent fewer CO_2 emissions per passenger-mile than the average auto and half the GHG emissions of an airplane."[1]

Iowa is currently served by two Amtrak long distance routes. The California Zephyr runs east-west through southern Iowa from Omaha to Burlington and the Southwest Chief cuts across the southeastern tip of Iowa through Fort Madison. Total ridership on these routes in FY 2006 was 61,377 which is a 33% increase from FY 2002. These long-distance routes are important to connect Iowa with the rest of the nation and should continue.

As part of this policy option, the expansion of rail between the Quad Cities and Iowa City should also be supported along with the Midwest Regional Rail Initiative

The Iowa Department of Transportation (DOT) has participated in a study of the development of a Midwest Regional Rail System which would provide high-speed service (up to 79 mph) across Iowa from Omaha to the Quad-Cities ultimately connecting with Chicago. This service would provide an estimated user benefit to Iowa of $500 to $700 million. This system would require a significant investment to upgrade track and an operational subsidy for the first few years of service.

The DOT is now partnering with Amtrak to study regional passenger service in Iowa. Initial feasibility studies have been completed for service from Chicago to Dubuque and Chicago to the Quad Cities. Studies are underway to look at extending the Chicago to Quad Cities service on to Iowa City and then on to Des Moines. Estimated ridership for the Chicago to Dubuque service is 74,500 and would require capital upgrades (primarily in Illinois) and an annual operating subsidy of $2.9 million. Estimated ridership for the Chicago to Quad Cities service is 102,700 and would require capital upgrades (primarily in Illinois) and an annual operating subsidy of $6 million.

The DOT, along with other interested partners and agencies, will develop and implement a statewide passenger rail system in Iowa. This will involve identifying and implementing funding to support capital and operating costs. The plan will identify a phased implementation of service and appropriate funding support based on type of service provided (i.e. long-distance vs. regional vs. commuter service). In the short-term this effort should result in regional passenger rail

[1] *Vision for the Future—U.S. intercity passenger rail network through 2050*, a report prepared for the Surface Transportation Revenue and Study Commission by the Passenger Rail Working Group, December 2007, p.15. See: www.sehsr.org/reports/visionfuturerpt07dec06.pdf.

service from Chicago to Dubuque and from Chicago to the Quad Cities to Iowa City. In the long-term, this will result in statewide passenger rail service consistent with yet to be developed long-range passenger rail plans.

Policy Design

Goal Levels: Establish a statewide passenger rail system in Iowa to supplement existing long-distance service and that provides connections to other modes of transportation.

Timing:

By 2010, the Iowa Department of Transportation and other interested parties and agencies will:

- Support the initiation and development of passenger rail feasibility studies.
- Develop and implement education, marketing, and promotion activities that support passenger rail service.
- Develop a Passenger Rail Advisory Committee.
- Identify and seek state funding for passenger rail capital and operating assistance.
- Seek federal funding to support passenger rail service.
- Develop a long-range passenger rail plan that identifies both short-term and long-term passenger rail service in Iowa along with an implementation strategy.

By 2012, the Iowa Department of Transportation and other interested parties and agencies will:

- Support implementation of regional rail service from Chicago to Dubuque and Chicago to the Quad Cities and on to Iowa City/Cedar Rapids and Des Moines by 2012.
- Work with local governments through the planning process to link passenger rail service with other modes of transportation including public transit, intercity bus service, bicycle, pedestrian, and aviation.
- Support implementation of other regional service including service extending from Des Moines to Omaha as deemed feasible and consistent with the passenger rail plan.

By 2015, the Iowa Department of Transportation and other interested parties and agencies will:

- Support implementation of other regional service including service extending from Des Moines to Omaha as deemed feasible and consistent with the passenger rail plan.

By 2030, the Iowa Department of Transportation, in coordination with other interested parties, will:

- Support full implementation of passenger rail service as envisioned in the passenger rail plan, and connect all metropolitan areas of the state by 2030.
- Support higher-speed service that results in significant ridership.

Parties Involved: Iowa Department of Transportation, Passenger Rail Advisory Committee (yet to be created), Iowa Legislature, Amtrak, Midwest Interstate Passenger Rail Commission, Illinois Department of Transportation, local governments, and regional/metropolitan planning organizations, Iowa Department of Economic Development, Iowa League of Cities, Iowa Chamber Alliance, railroads, Congressional delegation and environmental organizations.

Implementation Mechanisms

None noted beyond what is identified in the "Policy Design" section of this policy option.

Related Policies/Program in Place

None identified

Estimated GHG Reductions and Net Costs or Cost Savings

Quantification Factors	2012	2020	Units
GHG emission savings	N/A	0.008	$MMtCO_2e$
Net present value (NPV) 2008–2020		$15.3*	$ Million
Cumulative reductions 2008–2020)		0.026	$MMtCO_2e$
Cost-effectiveness		$597*	$/tCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; N/A = not applicable; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent. * Longer-term (after 2024) NPV and cost-effectiveness for these measures represent a cost savings.

It should be strongly noted that the high cost (cost-effectiveness) of this strategy for the 2010-2020 period is largely driven by the large up-front capital costs. By 2024 the cumulative ridership benefits will outstrip these costs and the strategy will have a negative cost per ton looking at all periods of cumulative effects from 2010-2024 or further onwards. Additionally, federal funding which has recently been made available through the Rail Safety Improvement Act of 2008 and the Passenger Rail Investment and Improvement Act could cover up to 80 percent of the cost of developing this passenger rail line.

Data Sources:

- Feasibility Report on Proposed Amtrak Service Chicago-Rockford-Galena-Dubuque (http://www.dot.state.il.us/amtrak/RCK_Feasibility.pdf)
- Feasibility Report on Proposed Amtrak Service Quad Cities-Chicago (http://www.dot.il.gov/amtrak/pdf/quadcitiesreport.pdf)
- The Midwest Regional Rail Study, utilizing the same ridership numbers from the Quad Cities to Iowa City rail study. (http://www.midwesthsr.org/pdfs/railmidwest.pdf)
- National Household Travel Survey, Bureau of Transportation Statistics. (http://www.bts.gov/programs/nationao_household_travel_survey/)

Quantification Methods:

Potential GHG reductions are calculated from reductions in modal shift from auto to inter-city rail due to the installation of new inter-city passenger rail services: Chicago- Quad Cities, Quad Cities-Iowa City, Iowa City-Des Moines, Des Moines-Omaha, and Chicago–Dubuque service. Rail ridership generated is considered to be shifted from personal vehicles, with an assumed vehicle occupancy of 1.78 in personal vehicles for diverted trips. The increase in ridership after the initial feasibility results is assumed to be growing at the same rate as population increase.

Annual costs were calculated using operating and capital expenses as given in the above sources, with capital costs evenly distributed over the investment phase. The savings from avoided personal vehicle costs were calculated on a $0.505/mile average mileage cost based on current U.S. Internal Revenue Service reimbursement guidance adjusted for improving fuel economy, and assumed an average auto occupancy of 1.78 (NHTS 2001). Locomotive emissions were calculated based on 772 passenger-miles/gallon.[2]

Key Assumptions:

Vehicles occupancy was assumed to be 1.78 for personal vehicles. This number was taken from 2000 U.S. Census for average vehicle occupancy and based upon the National Personal Transportation Survey.[3]

The savings from avoided personal vehicle costs were calculated on a $0.505/mile average mileage cost. This number was based upon the Internal Revenue Service's standard mileage rates for the use of a car.[4]

Key Uncertainties

Funding availability for the provision of additional passenger rail service is a significant uncertainty.

Initial implementation of regional rail service in Iowa is dependent on the state of Illinois and their funding of passenger rail service to Iowa's border. At this time, Illinois has not funded this service and there is some uncertainty that this will happen within the assumed schedule of this strategy.

Implementation of expanded passenger rail service is dependent on a significantly expanded federal funding program (and Iowa successfully securing federal funding) and the establishment of sustainable state funding in Iowa.

Additional Benefits and Costs

Passenger rail service provides additional benefits and cost impacts, by improving the mobility of the local populations, reducing emissions and thereby increasing health benefits, and by

[2] Calculations based on *Railroad Facts,* Association of American Railroads, 1999; cited in "North American Trade and Transportation Corridors: Environmental Impacts and Mitigation Strategies," North American Commission for Environmental Cooperation, 2001."

[3] http://www.allcountries.org/uscensus/1033_national_personal_transportation_survey_npts_summary.html

[4] http://www.irs.gov/newsroom/article/0,,id=176030,00.html

reducing the population's dependency upon automobile ownership and thereby saving people, particularly lower income people money.

Feasibility Issues

Additional passenger rail service is still in the study and planning phase and as a result it is expected that additional feasibility issues will be assessed as planning proceeds.

Status of Group Approval

Approved.

Level of Group Support

Majority (Vote: 9–7).

Barriers to Consensus

There was some concern raised over the high cost per ton of reduction and the low GHG reduction potential, particularly during the period of analysis through 2020. This concern was addressed by including in the text the following to indicate that in the long-term this policy option would have cost benefits: "By 2024 the cumulative ridership benefits will outstrip these costs and the strategy will have a negative cost per ton."

TLU-5a. Adopt Best Workplaces for Commuters in Iowa

Policy Description

According to the 2001 National Household Travel Survey, 27% of total vehicle miles traveled (VMT) to and from work are equivalent to 734 billion miles nationally. Assuming that same percentage applies to Iowa, more than 8.5 billion miles of travel in 2006 was from Iowans going to and from work. Of those trips, 78% were done by single occupant vehicles (2000 U.S. Census).

Many actions can be taken to reduce single-occupant vehicle commuting. These include increasing the number of employees that telework, carpool, vanpool, ride transit, ride bicycles, and walk. In May, 2001, a new government-industry partnership was created and sponsored by the United States Environmental Protection Agency (EPA) and the United States Department of Transportation (DOT)titled “Best Workplaces for Commuters.” This program recognizes employers and districts (e.g. downtown districts, malls, business parks) that subsidize employee transit/vanpool use, implement telework programs, and/or other activities that reduce traffic and air pollution. Benefits of designation include public recognition, training, access to Web-based tools, one-on-one technical assistance, and networking opportunities. A 2005 survey of program participants found that programs that included a comprehensive benefits package (i.e. guaranteed ride home, on-site services, financial incentives, etc.) resulted in a 15% reduction of trips, pollutants, and fuel consumption. More information is available at www.bestworkplaces.org.

The state of Iowa and interested organizations should take action to reduce single-occupant vehicle commuting by encouraging and incentivizing participation in activities such as Best Workplaces for Commuters.

Policy Design

Goal Levels: Major employers and districts in all nine of Iowa’s metropolitan areas will be designated as ‘Best Workplaces for Commuters.’

Timing:
By 2012, the state of Iowa and other interested parties will:

- Educate, inform, and market to employers and communities in Iowa’s metropolitan areas regarding the Best Workplaces for Commuters program.
- Identify existing funding programs and make funding available to assist employers and commuters to take actions that will assist qualifying for designation (i.e. funding for van pools, subsidization of transit fees, etc.).
- Identify and implement public incentives (e.g., tax credits, deductions, etc.) to support actions that will assist qualifying for designation (i.e., funding for van pools, subsidizing transit fees, etc.).

- Evaluate opportunities to expand the goal level beyond Iowa's metropolitan areas into smaller communities and rural areas.

Parties Involved: Local governments, state agencies, environmental organizations, United States EPA, United States DOT, metropolitan planning organizations, local governments, chambers, Iowa Chamber Alliance, Iowa League of Cities, transit providers, Transportation Management Associations, major employers, downtown development groups, etc.

Implementation Mechanisms

Enact legislation to require, if feasible, all employers in the counties listed in the quantification methods section to, below, offer commuter benefits programs if they have more than 100 employees at an individual work site and normally begin office hours between 6:00 and 9:00 am. Compliance with this requirement could be coordinated through the Iowa Department of Transportation or other agency as appropriate. Information, training and outreach should be provided to major employers to assist them in developing commuter benefits programs.

A growing number of Iowa's citizens are employed in knowledge-based work. Most of these individuals are daily commuters relying primarily on single-occupied vehicles as the primary method of getting to work. By focusing on the commuting patterns of these knowledge workers, Iowa will examine the opportunity to implement advanced applications of telecommunications infrastructure to connect its communities to reduce vehicle miles traveled and predictably alter traffic patterns. More details on this method of reducing VMT are provided in the policy option TLU-5b, Distributed Workplace Model.

Related Policies/Program in Place

Vanpooling and ridesharing programs are offered in various locations throughout the state, such as through Des Moines Area Rapid Transit (DART) rideshare.

Estimated GHG Reductions and Net Costs or Cost Savings

Quantification Factors	2012	2020	Units
GHG emission savings	0.023	0.024	$MMtCO_2e$
Net present value (2008–2050)	$1.96	$17.9	$ Million
Cumulative reductions (2008–2050)	0.023	.214	$MMtCO_2e$
Cost-effectiveness	$84	$84	$/t$CO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t$CO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- National Household Transportation Survey data (trip length to work) for Des Moines area (http://www.trb.org/conferences/nhts/Kane.pdf)
- Iowa County Business Patterns 2004 (U.S Census Bureau)
- Worksite Trip Reduction Model and Manual (http://www.nctr.usf.edu/worksite/)

- Iowa Population Forecast to 2030 (U.S. Census Bureau)
- Iowa GHG Inventory and Projections (http://www.iaclimatechange.us/Inventory_Forecast_Report.cfm)
- Best Workplaces for Commuters Program and Benefits Calculator (http://www.bestworkplaces.org/resource/calc.htm)

Quantification Methods:

Estimated number of effected employees by tabulating number of employers with more than 100 employees in the following counties:

Benton County
Black Hawk County
Bremer County
Dallas County
Dubuque County
Grundy County
Guthrie County
Harrison County
Johnson County
Jones County
Linn County
Madison County
Mills County
Polk County
Pottawattamie County
Scott County
Story County
Warren County
Washington County
Woodbury County

From Iowa County Business Patterns 2004 include the number of employers from the following business sectors (as these are more likely to begin work day between 6 and 9 a.m.):

No. of Employers:	Business Sectors:
22	Utilities
31–33	Manufacturing
42	Wholesale Trade
51	Information
52	Finance and Insurance
53	Real Estate and Rental and Leasing
54	Professional, Scientific, and Technical Services
55	Management of Companies and Enterprises
56	Administrative and Support and Waste Management and Remediation Services

61	Educational Services

It is assumed that the "best workplaces for commuters" programs are put in place with employers with 100 more employees. This represents about 235,000 employees statewide, in 17 counties. (Note that 3 of the original 20 counties included in the analysis had no qualifying employers). Using data from the Worksite Trip Reduction Model and Manual, it was estimated that commute trip programs would reduce vehicle work trips by about 5% for effected employers. Based on feedback from the TLU Subcommittee, these estimates were adjusted to an assumed reduction in work trip VMT by 2% in Polk, Dallas, and Warren Counties, and by 5% in the other counties.

For 2004/2005 total annual VMT reduced by these programs was about 45 million miles (off of a total VMT baseline of about 31,570 million miles). From 2004/2005, the forecast of affected employees increased at the same rate as population. These mile reductions were all from light duty vehicle miles listed in the Iowa GHG Inventory and Projections, and emissions reductions were calculated based on the Iowa GHG Inventory and Projections.

Key Assumptions:

Assumes the programs are in place beginning in 2012. Assumes these programs are put in place with employers with 100 or more employees by 2012. This represents about 235,000 employees statewide working for 671 employers in 17 counties. Assumes programs reduce employee trip to/from work VMT by 2% in Polk, Dallas, and Warren Counties, and by 5% in the other counties. Assumes the number of effected employees increases at the same rate as population is forecast to increase. Assumes 240 commute days per year at an average one-way commute distance of 10.7 miles. Assumes annual program administration cost of $2,600 per employer, plus commute benefits of $30 per month per employee who commutes to work using an alternative mode, based on Best Workplaces For Commuters website (www.bestworkplaces.org/). Benefits to employers include reduced parking costs. The analysis did not consider any foregone state and federal tax revenue.

Key Uncertainties

None noted.

Additional Benefits and Costs

None noted.

Feasibility Issues

None noted.

Status of Group Approval

Approved.

Level of Group Support

Supermajority (Vote: 14–6).

Barriers to Consensus

None noted.

TLU-5b. Distributed Workplace Model

Policy Description

A growing number of Iowa's citizens are employed in knowledge-based work. Most of these individuals are daily commuters relying primarily on single occupied vehicles as the primary method of getting to work. By focusing on the commuting patterns of these knowledge workers, Iowa will examine the opportunity to implement advanced telecommunications applications and infrastructure to connect its communities reducing vehicle miles traveled and predictably altering traffic patterns. Workforce deployment is an initial focus of this initiative, seeking to develop more community-located employment opportunities. Additionally, this approach will further enhance the viability of the TLU-1, Smart Growth Bundle.

Distributed workplace is a community work model. Moving beyond “work from home” as the primary methodology of remotely supporting employees, networks of community-based multi-location work centers will enhance access for both employers and employees. It is anticipated that each work center will accommodate a cluster of employees (200 to 1000) working for multiple employers, such as local state and federal governments, as well as private employers such as financial and insurance companies. A typical employer will have 15 to more than 100 employees in any given work center based upon their geographic hiring patterns. Further study of the potential for these issues to benefit the State of Iowa should be considered.

A network of work centers is a progression in the use of telecommunications infrastructure. It will more effectively reduce vehicle miles traveled and gasoline consumed than current approaches. In addition, there are economic reasons to develop distributed work centers such as extending employment opportunities to part-time working parents, students and individuals with disabilities. Locating work centers in local communities will improve employee productivity and employers' abilities to attract and retain quality employees.

The multi-location, distributed workplace model takes advantage of the changing nature of work and balances workforce deployment with security and management oversight while enabling employees to access a greater number of jobs from “within” their local communities without long commutes.

The falling costs of converged services networks (voice, data and video) and enhanced collaborative and interactive systems permit a greater number of knowledge-based employees to work from work centers located closer to their place of residence.

By using networked offices to reduce commuting distances for some, the overall reduction in vehicle miles traveled (VMT) mitigates congestion for the benefit the rest of the highway users.

The distributed multi-location work centers can reduce the impact of emergency evacuations and vastly improve emergency preparedness and continuity of operations, by providing for a more dispersed workforce and an expanded web of the telecommunications infrastructure, lessening the impact if any one facility is incapacitated or needs to be evacuated.

These distributed workplace networks will achieve economies of scale and create a secure, scalable platform for rapid geographic expansion. Focus on telecommunications resources will establish the 21st century building blocks for ongoing distance learning and acceleration in the use of telemedicine.

Every center will be unique based upon each community's individual requirements.

The initial focus on workforce deployment:

- Reduces vehicle miles traveled, emissions, consumption of gasoline, and transportation congestion.
- Converts gasoline dollars into local economy dollars.
- Engages the knowledge-based workforce with a greater number of potential employers, improving employment opportunities by lowering the cost of access.

The distributed workplace model is a network of work centers supporting a cluster of employees working for multiple employers. Each employer in the work center will have dedicated offices for their employees. All work centers will be networked together and to each employer's primary facilities. A technical staff will provide support for the network and services at each work center.

Communities and employers will work together to examine optimal commercial real estate recommendations. This will include re-use of employers' underutilized space and available commercial real estate opportunities based upon capacity and location requirements.

The target client groups are identified as follows:

- Local, state, and federal employers in selected major metropolitan statistical areas (MSA): Defined as a U.S. Government classification for a free-standing urban population center with a population of at least 50,000 and a total MSA population of 100,000 or more.)
- Enterprise employers (non-retail, non-manufacturing) i.e. law firms, financial services, insurance and technology companies, etc.
- Interactive, web-enabled call center services.
- Distributed interactive seminars, training, and distance education.

Policy Design

Goal Levels: Based on a survey of major employers in Iowa's nine metropolitan statistical areas, findings on their geographic hiring patterns and their interests in this approach, density distribution models will be constructed to identify the optimal number and locations for networked work centers. One or more pilot project initiative(s) will be developed with an objective of 10 to 20 % deployment for each participating employer.

Each pilot project initiative will apply for state and government financial support from a variety of funding sectors, including transportation mitigation, environment improvement, energy conservation and emergency preparedness. Iowa's leadership and pro-active actions in this area will improve the opportunity for funding subsidies for pilot initiatives. Initial business proposals will examine the feasibility of public-private partnerships.

Timing:

- By 2009 all nine metropolitan statistical areas will be surveyed and potential multi-location networks identified.
- By 2010 applicable funding programs will be identified and grants proposal will be submitted.
- By 2011 the first pilot initiative(s) will commence with transition and build out completed by 2013.
- By 2012 legislative and economic incentives will be drafted for continuation of pilot initiatives and expansion to include development in the most feasible rural communities.
- By 2013 academic and medical organizations will be approached to examine the feasibility of incorporating and coordinating distance learning and telemedicine services.

Parties Involved: Major employers, including state government, local governments, chambers of commerce, economic development groups, commercial developers, technology companies, Iowa DOT, USDOT, EPA, USDA, and Homeland Security all represent potential stakeholders.

Implementation Mechanisms

Establish a core-planning group to develop and/or acquire the necessary analytic tools while beginning presentations and conducting surveys in target metropolitan communities to determine public opinion on the utilization of these work centers.

The key areas to succeed in creating and testing the viability of a multi-location metropolitan network of work centers are policy, partners, and projects.

Policy—Develop support from Federal, State and Local Legislative and Administrative groups to fund and/or create incentives for initial pilot projects.

Partners—Solicit technology, real estate and service providers as potential public-private partners:

- To develop technology solution proposals for communities and tenant organizations.
- To plan, implement and maintain initial pilot project networks.
- To provide a source of operating capital for start up operations.

Projects—Work with federal, regional and local stakeholders on the formation of core stakeholder groups for specific pilot projects. Investigate requirements and procedures for establishing public-private partnerships.

Related Policies/Program in Place

None noted.

Estimated GHG Reductions and Net Costs or Cost Savings

No quantitative analysis was undertaken to estimate GHG reductions or costs/savings for this option.

Data Sources: None noted.

Quantification Methods: None, since this option was not quantified.

Key Assumptions: None noted.

Key Uncertainties

None noted.

Additional Benefits and Costs

None noted.

Feasibility Issues

None noted.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None noted.

TLU-6. Light-Duty Vehicle Fuel Efficiency Incentives

Policy Description

Iowa can reduce its greenhouse gas emissions by improving the fuel economy of the light duty vehicle fleet. The first step is to charge a state agency with tracking the fuel economy of Iowa's entire fleet. Once a baseline for Iowa's fuel economy is established, the state could then establish goals for improving the fuel economy of the entire fleet as a basis for reducing GHG emissions. For example, if the current fuel economy is 20 miles per gallon (mpg), goals of 21 mpg by 2012 and 25 mpg by 2020 could be adopted. All other things being equal, increasing fuel economy from 20 mpg to 25 mpg would reduce fuel consumption and the resulting greenhouse gases by 20%. Further reductions beyond 2020 are also likely. Iowa could establish a goal of 40 to 200 mpg by 2050, reflecting the climate council's goals of reducing GHG emissions by 50% to 90%.

Policy options to meet a goal of higher fuel economy include consumer education about vehicle purchases, monetary incentives through a feebate system or tax credits, investments in a plug-in hybrid infrastructure, and a state policy for scrapping older vehicles that do not have good fuel economy. Information about vehicle fuel economy and consumer benefits of higher fuel economy are available at www.fueleconomy.gov. As the federal agencies responsible for that Web site explain, "The difference between a car that gets 20 mpg and one that gets 30 mpg amounts to $775/year (assuming 15,000 miles of driving annually and a fuel cost of $3.10)."

This option includes several policies and programs to encourage the purchase of low GHG emission vehicles through monetary and convenience rewards and incentives throughout the state.

- *Feebates*—This is a study option rather than an implementation option. The state would participate in a multi-state study of the feasibility and effectiveness of a regional feebate system with other midwestern states.
- *Tax Credits for Low-GHG Vehicles*—Amend the current federal income tax credit program for hybrid, alternative fuel, and low-emission vehicles so that it continues in its present form beyond 2010. The state will initiate an income tax program to encourage consumer purchases of fuel efficient vehicles. For example, within a year of a low GHG vehicle coming onto the market, a consumer could purchase that vehicle and receive a $1,000 tax credit. *The incentives should keep pace with the market. The state will develop the standards for which the tax credits will be given to low emission vehicles. Establishing a state standard will insure that the performance of the vehicle is the basis for the incentive, not individual vehicle models. The program needs to be responsive to changing market conditions and product development.*
- *Operating Incentives for Low-GHG Vehicles*—Provide for preferential access and infrastructure for alternative fuel vehicles (E10, E85, natural gas, propane, 100% electric, others) such as state-controlled highways and local-government controlled parking.

- Vehicle Registration Fees —Add a new criteria in the collection of annual vehicle registration fees that applies increased fees for high emitting vehicles and a reduced fee for low emitting vehicles. Overall the results of the revenue collection amount would be the same.

Policy Design

Goals/Timing: Reduce GHG emissions by improving the fuel economy of the light duty vehicle fleet in the State of Iowa by 20% by 2012, 100% by 2020, and 250% or more by 2050. Implementation to start on January 1, 2010.

Parties Involved: Iowa Department of Transportation, Iowa Department of Revenue, County Treasurers, Iowa Automobile Dealers Association, and Iowa Independent Automobile Dealers Association.

Implementation Mechanisms

The proposed policies and programs in this option will need to be passed through the legislative process and implemented by state and local government agencies in partnership with affected parties.

Related Policies/Program in Place

While feebates are set as a new proposal, they are not completely unlike the application of existing taxes such as vehicle sales tax and gas guzzler tax. The difference is the method of calculation. In the case of feebates, the calculation will be on vehicle 'green rating' drawing on the greenhouse gas scores for vehicles as determined by the U.S. EPA (http://www.epa.gov/greenvehicle/).

Some European countries have implemented feebate programs, and other U.S. states are considering both the rebate portion and the "gas guzzler tax" elements of feebate type programs. In 2007, Canada introduced the "Vehicle Efficiency Incentive (VEI) program, which took effect in March 2007. The program includes both a rebate and a tax component.

Recently, the State of North Carolina Climate Action Policy Advisory Group (CAPAG) recommended that the state charge a sliding scale of fees and rebates for new light duty vehicles based on their emissions of greenhouse gases and/or other measures of a vehicle's efficiency technologies. In addition, the State of South Carolina Climate, Energy, and Commerce Advisory Committee (CECAC) decided that a reduced or free vehicle registration would not provide an effective incentive because of the low level of existing fees. The CECAC also evaluated the option of a feebate, and decided not to pursue such a policy. The CECAC did call for the state of South Carolina to maintain and enhance the already existing state tax rebates and state income tax credits for low-GHG emission vehicles.

Estimated GHG Reductions and Net Costs or Cost Savings

Data Sources:

The Center for Climate Strategies (CCS) conducted a review of the most relevant research and analysis on feebate proposals with the following three findings:

1. There has been significant conceptual development of the feebate idea, especially at the national level;

2. There is a need for a greater understanding of potential benefits and costs of state-level and multi-state coordinated feebate programs; and

3. There has not been sufficient pilot testing of feebate programs in the United States to provide implementation experience.

CCS assessed recent studies of potential GHG emission reductions from a national feebate program based on modeling work conducted by the U.S. Department of Energy's Oak Ridge National Laboratory (ORNL). CCS also reviewed other relevant recent studies and analyses of feebates conducted by the Canadian government, the State of California, and the Public Interest Research Group (PIRG). The ORNL and other studies assume a national feebate rate high enough to produce responses from both consumers and manufacturers. ORNL's estimate of the national potential for reduction in carbon dioxide emissions is approximately 11 $MMtCO_2e$ in 2010 and 66 $MMtCO_2e$ in 2020.

Some attempts have recently been made to estimate the GHG emissions reduction potential from individual state feebate programs, including programs proposed for the states of Arizona and California. For example, a recent PIRG analysis suggests that a single state feebate program for Arizona would result in an estimated 0.1 $MMtCO_2e$ GHG emissions reductions in 2020.

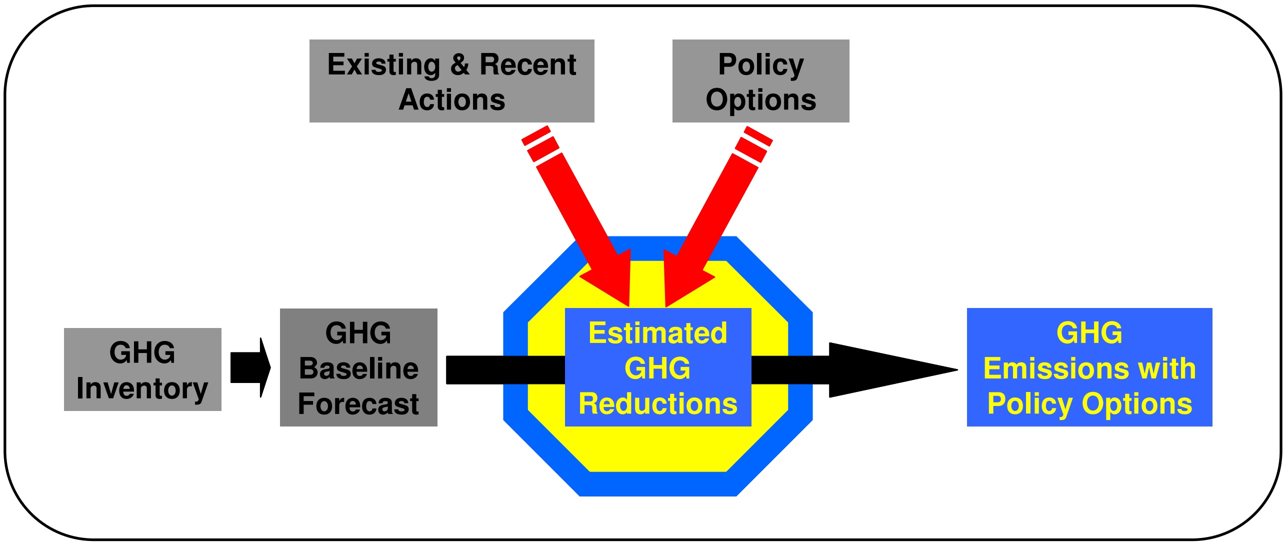
These recent estimates of the potential impacts of individual state programs are contingent upon assumptions and analytical methods that have not undergone thorough peer review. Therefore, the results of these analyses are preliminary and should be interpreted with some caution. Further analysis and study of the potential benefits and costs of individual state and multi-state feebate programs would greatly increase confidence in projected results.

Quantification Methods:

In order to quantify the GHG reductions and fuel savings that would result from implementation of TLU-6 for the State of Iowa, CCS used the Vehicle Energy and Greenhouse Gas Assessment Tool (VEGA Tool). The VEGA Tool was developed by the CCS team to support its role in the Iowa Climate Change Advisory Council process in conducting analysis of various policies affecting GHG emissions from the on-road transportation sector.

Figure H-1 illustrates schematically how the VEGA Tool operates. The grey boxes represent the inputs required: state GHG Inventory and Forecast data, existing actions, recent actions, and the policy options to be analyzed.

Figure H-1. VEGA Tool overview

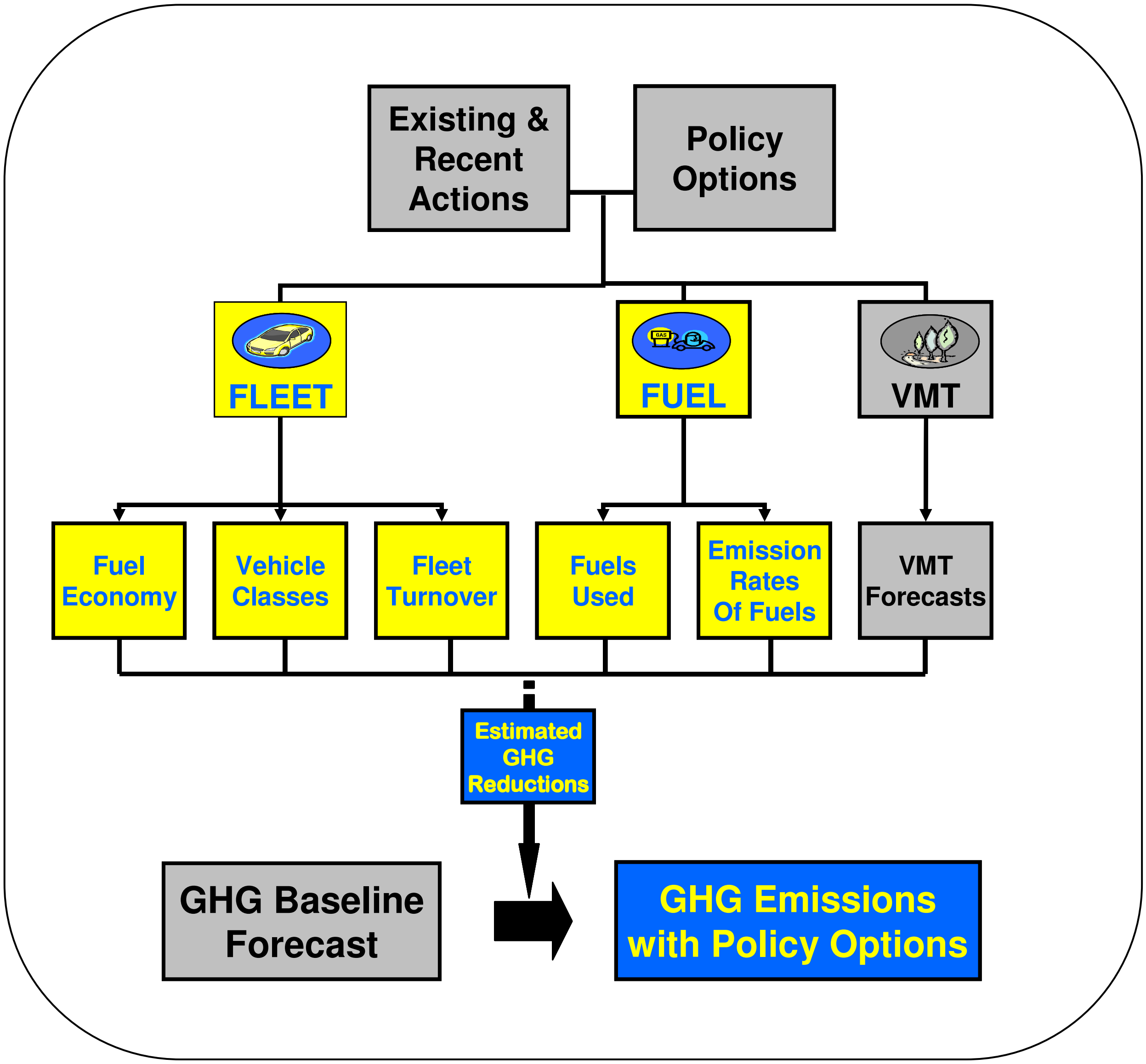


The tool helps the analyst quantify the existing actions, recent actions, and policy options by translating them into three aspects of on-road transport that affect on-road vehicle emissions of greenhouse gases:

- Fleet Characteristics: What types of vehicles are being driven
  - Fuel Economy: The average miles per gallon for each model year and vehicle class
  - Vehicle Class Distribution: The portion of the vehicle fleet falling into each of the 28 vehicle classes defined by the Mobile6 model (light-duty gas vehicles, light-duty gas trucks – type 1)
  - Fleet Turnover Rate: The rate at which new cars are introduced and older cars are retired from the vehicle fleet
- Fuel Characteristics: What types of fuel are these vehicles using
  - Fuels Used
  - Emission Rates of Fuels: How much greenhouse gas is emitted per unit of fuel
- Travel Habits (VMT): How much are the vehicles being driven

The above parameters, also illustrated in Figure H-2 can be adjusted by the analyst to best reflect a given action or policy option. The VEGA Tool then combines these parameters to estimate what the greenhouse gas emissions would be if the policy option is implemented.

Figure H-2. VEGA Tool analysis parameters



Policy TLU-6 affected the fuel economy parameter. It was assumed that this improvement would be phased in linearly starting with Model Year (MY) 2010 and reaching intermediate targets of 20% improvement for MY 2012 vehicles, 100% improvement for MY 2020 vehicles, and at least 250% improvement for MY 2050 vehicles. In other words, it was assumed that the average fuel economy of MY 2020 vehicles would be 100% higher than what they would have been had TLU-6 not been implemented. Table H-1 shows specifically the percent improvement to average fuel economy of the light-duty fleet per Model Year which was assumed to result from implementation of TLU-6. Fuel economy improvements were calculated for each vehicle class and model year affected by the policy.

Table H-1. Assumed TLU-6 fuel economy improvement

Model Year	% Improvement to MPG of Light-Duty Fleet
2009	0%
2010	7%
2011	13%
2012	20%
2013	30%
2014	40%
2015	50%
2016	60%
2017	70%
2018	80%
2019	90%
2020	100%
2021	105%
2022	110%
2023	115%
2024	120%
2025	125%

Once all of the parameters have been defined, the tool uses the following general methodology to estimate fuel savings and GHG reductions. The vehicle miles traveled (VMT) and fuel economy (mpg) are combined to estimate fuel consumption (gallons). The difference between fuel consumption under baseline and policy option conditions is the estimated change in fuel consumption that would result from implementation of the policy option. The estimated change in fuel consumption is translated into an estimated change in greenhouse gas emissions.

Key Assumptions:

The following key assumptions were made in quantification of TLU-6:

- The baseline fuel consumption assumed that the new federal CAFE standards were in effect.
- It was assumed that the policy would affect all light-duty vehicles and trucks.
- It was assumed that the policy would not change the vehicle class distribution (i.e. the relative number of gas vehicles, diesel vehicles, gas trucks, and diesel trucks), but would rather change the specific makes and models purchased within each class.
- It was assumed during this analysis that the fuels used (predominantly gasoline and diesel) remained consistent with Iowa's Inventory and Forecast of GHG Emissions, Chapter 2.
- The carbon content for the fuels used in this analysis (predominantly gasoline and diesel) remained consistent with Iowa's Inventory and Forecast of GHG emissions (Chapter 2), and

was assumed to be consistent with the EPA estimate for CO_2 emissions of 19.4 pounds/gallon for gasoline and 22.2 pounds/gallon for diesel.[5]

Key Uncertainties

Consumer reaction to incentive programs varies.

Additional Benefits and Costs

Incentive programs that significantly reduce GHG emissions through vehicle fuel efficiency also have the potential to significantly reduce the amount of transportation fuel consumed from imported sources, thus reducing the dependency of the United States on foreign sources.

Feasibility Issues

Vehicle efficiency incentive programs may be affected by the availability of vehicles in the marketplace by the limited number of automobile manufacturing firms.

Status of Group Approval

Approved.

Level of Group Support

Supermajority (Vote: 13–3).

Barriers to Consensus

Concerns were raised surrounding vehicle registration fees. Additionally, the ICCAC wanted the policy option to be clear in its goal of reducing GHG emissions and that this policy option (TLU-6) should not interfere with the adoption of alternative fuels that may get less MPG but which have the benefit of lower GHG emissions.

[5] http://www.epa.gov/oms/climate/420f05001.htm

TLU-7a. Fuel Efficient Operations for Light-Duty Vehicles: Fuel Efficient Replacement Tires Program

Policy Description

Improve the fuel economy of the light-duty vehicle (LDV) fleet by setting minimum energy efficiency standards for replacement tires and requiring that greater information about low-rolling resistance (LRR) replacement tires, including all season/all weather LRR tires, be made available to consumers at the point of sale. Snow and mud LRR tires are currently available and tire manufacturers such as Michelin are currently researching and developing fuel efficient all weather replacement tires.

Vehicle manufacturers currently use LRR tires on some new vehicles, but they are not easily available to consumers as replacement tires. When installing original equipment tires, carmakers sometimes use LRR tires to meet federal corporate automobile fuel economy standards (CAFE). When replacing the original equipment tires, consumers often purchase less fuel-efficient and potentially more costly tires (depending on annual vehicle miles traveled [VMT]). Currently, tire manufacturers and tire retailers are not required to provide information about the fuel efficiency of replacement tires.

An appropriate state agency would initiate a fuel efficient tire replacement program. The program would include consumer education, product labeling, and minimum standards elements.

These programs would be developed under a rule development process. All programs would incorporate the best scientific information, including the test results of tires conducted by the tire manufacturers, the Tire Industry Association, and the National Academy of Sciences and others.

Policy Design

This policy is designed to encourage consumer choice and to set an example by state government.

Goal Levels: Establish voluntary energy efficiency standards that achieve an average 4% gain in fuel economy.

Timing: By January 1, 2010 the state or appropriate agency would initiate a fuel efficient tire replacement program for the state fleet if all season/all weather tires are available and are incorporated into legislatively approved rental rates, establish voluntary energy efficiency standards for replacement tires, and develop a marketing program for fuel efficient replacement tires.

By January 1, 2012 the state or appropriate agency would ensure that a proportion of tires replaced on state-owned and -leased vehicles will be LRR tires (if they are available for the vehicle type and are rated for all season/all weather service) and would consider legislation or administrative regulation to set LRR standards for tires with mandatory manufacture labeling.

By January 1, 2015 the state or appropriate agency would ensure that 50% of all tires sold to consumers in the state of Iowa will be LRR tires. This percent of market penetration would increase to 100% of all tires sold to consumers in the state of Iowa will be LRR tires by 2020.

Parties Involved: Iowa Department of Transportation, Iowa Department of Natural Resources, Iowa Energy Center, LRR manufacturers, and tire distributors.

Implementation Mechanisms

The program would include consideration of the technical feasibility and cost of such a program, the relationship between tire fuel efficiency and tire safety, potential effects upon tire life, and impacts on the potential for tire recycling. In addition, the program may determine it necessary to exempt certain classes of tires that sell in low volumes, including specialty and high performance tires.

The minimum standard is likely to be less stringent than the energy efficiency of original equipment tires. Such a regulation would improve the fuel efficiency of the overall LDV fleet, but not necessarily the fuel efficiency of all tires since consumers would still make choices in the marketplace. While the replacement tires purchased in the future would be on average more fuel efficient than those historically purchased, they are not likely to be as fuel efficient as the tires included as original equipment by the automobile manufacturers. Still this would provide an increase in fuel economy over what have traditionally been purchased as replacement tires.

Information and Education: Provide information to the general public and commercial businesses (i.e., taxi and food delivery services) that use light-duty vehicles for daily business that the improved fuel efficiency is directly related to the decreased rolling resistance of a vehicle's tires. Information on the potential annual costs savings using LRR tires would also be provided. For example, a car averaging 15,000 miles per year would have annual fuel savings estimated to be $124. A chart of recommended tire models would be included with information on product labeling and minimum standards elements. Best scientific information including the results from tests of tires conducted by the tire manufacturers, the California Energy Commission, and the National Academy of Sciences would be reviewed and incorporated.

The manufacturers of the LRR tires would be contacted to encourage the promotion of their relevant products through regional newspaper and television advertising. The producers of LRRs may freely provide promotional materials.

Promotion and Marketing:

State Lead by Example: The state will lead by example by initiating a fuel efficient tire replacement program. This would include all weather fuel efficient tires and would require legislative approval for rental rates for vehicles, both owned and leased.

Over time, all state fleet tires in need of replacement will be changed to LRR tires, if available for the vehicle type and season.

Voluntary LRR Standards: Establish voluntary LRR standards that achieve an average 4.0% gain in fuel economy.

Encourage Procurement of LRR Tires:

Encourage local/county governments to act consistently with and support state procurement on their behalf.

Encourage federal agencies located within the state to act accordingly with and support state actions.

Encourage businesses that depend on vehicles to conduct daily business to act accordingly with and support state actions.

Marketing Program: Develop a marketing program with tire dealers and consumers to encourage the purchase of LRR tires. This effort might include a voluntary labeling program for tire fuel efficiency.

University Research: Encourage the Iowa university system to conduct research on alternative non-combustible applications for used tires.

Web Site: All state-supported programs would have dedicated detailed web sites. In addition to information and materials, program participation by the various governmental agencies and individual businesses (i.e., success stories) would also be documented and extolled.

Technical Assistance: Contact the LRR manufacturers and tire distributors to coordinate objectives and obtain technical support for outreach materials.

Funding Mechanisms and/or Incentives: Replacement of tires on state fleet vehicles is already budgeted through the Iowa DOT annual funding processes.

Voluntary and or Negotiated Agreements: Work with the manufactures and affected parties to achieve objectives with flexibility of the timelines.

Codes and Standards: The state of California and Germany have developed substantial information pertaining to LRR tires due to legislative actions that require tires to be replaced with more efficient ones. Associated documentation identifies testing methods and LRR standards. The appropriate state agency can review the information and establish suitable Iowa standards.

Pilots and Demonstrations: Coordinate with product developers to help them promote their technologies.

Reporting: The state will develop a system for tracking purposes so that the state can eventually determine the turnover to LRR tires and the benefits achieved from the conversion. A simple tracking system would be established relatively easily by contacting the primary tire distributors of the major Iowa cities on an annual basis and estimates can be gathered from their inventories.

Enforcement: No enforcement actions are necessary initially when the program is instituted as a voluntary program. After the mandatory labeling comes into effect, spot checks at the primary tire distributors in the main Iowa cities would be conducted annually by the county health departments and the state staffs.

Related Policies/Program in Place

In October of 2003, the state of California adopted the world's first fuel-efficient replacement tire law (AB 844). This law directed the California Energy Commission to develop a State Efficient Tire Program that includes the following issues: (1) develop a consumer education program, (2) require that retailers provide labeling information to consumers at the point of sale, and (3) promulgate through a rule development process a minimum standard for the fuel efficiency of replacement tires sold. The California rule development process began January 2007.

Although the climate in California is significantly more moderate than Iowa, "all-season/all-weather" LRR tires may be made available. Michelin tire manufacturers are currently researching and developing "all-weather LRR tires."

Estimated GHG Reductions and Net Costs or Cost Savings

Assuming 20% market penetration by 2012 to achieve the goal of 50% market penetration by 2015 with an increase to 100% at Year 2020, achieving an average 4% improvement in fuel economy:

Quantification Factors	2012	2020	Units
GHG emission savings	0.112	0.648	$MMtCO_2e$
Net present value (2008–2020)	–$15.3	–$306	$ Million
Cumulative reductions (2008–2020)	0.1712	3.407	$MMtCO_2e$
Cost-effectiveness	–$90	–$90	$/tCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Tires and Passenger Vehicle Fuel Economy, Transportation Research Board/National Research Council, 2006.
- California State Fuel-Efficient Tire Report, California Energy Commission, January 2003.

Quantification Methods:

CCS evaluated and compared a series of existing assessments as follows:

At the request of the United States Congress, the National Research Council (NRC) of the National Academy of Sciences (NAS) conducted a study of the feasibility of reducing rolling resistance in replacement tires. The 2006 NRC/NAS study made the following conclusions:

- "Reducing the average rolling resistance of replacement tires by a magnitude of 10% is technically and economically feasible.
- Tires and their rolling resistance characteristics can have a meaningful effect on vehicle fuel economy and consumption."

A 2003 study commissioned by the California Energy Commission found that about 300 million gallons of gasoline per year can be saved in that state with lower rolling resistance tires. A set of four low rolling resistance tires would cost consumers an estimated $5 to $12 more than conventional replacement tires. The fuel-efficient tires would reduce gasoline consumption by 1.5% to 4.5%, saving the typical driver up to $411 over the 50,000-mile life of the tires, assuming a 4.0% fuel efficiency increase associated with the LRR tires and $3.50 a gallon gasoline. Consumers in California would save more than $470 million annually at current retail prices or approximately $1.4 billion over the 3-year lifetime of a typical set of replacement tires.

Key Assumptions:

The estimate of costs associated with LRR replacement tires assume lower tread and thus faster tire wear and it includes production cost increases that are passed through to consumers. According to the NRC/NAS study, consumers would pay an additional $12.00 per year to replace tires (including installation), and they would pay an additional $1.00 per tire due to increased production costs.

Key Uncertainties

The low-rolling-resistance fuel efficient tires program is based upon existing off-the-shelf technologies and products that already exist in the consumer marketplace. These tires are already available in the marketplace, and are comparable with the tires included as original equipment on newly purchase light-duty vehicles.

Additional Benefits and Costs

None noted.

Feasibility Issues

None noted.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None noted.

TLU-7b. Fuel Efficient Operations for Light-Duty Vehicles: Consumer Information on Vehicle Miles Per Gallon (MPG)

Policy Description

Provide consumers with information about the fuel efficiency and cost in relation to the purchase, maintenance, and operation of their vehicles. Consumers would receive real-time information on MPG while their vehicles are in operation and alerts when their tire pressure is too low (i.e., devices such as Air Alert Valve Caps). Generally, a set of four light-emitting diode (LED) self-calibrating tire pressure valve caps such as Tire Alert cost about $22.00, and real time MPG monitoring systems such as ScanGauge are about $100.00. In addition, consumers would receive public education and information relating to the impact that vehicle maintenance practices have on the operation of their vehicles. Finally, consumers would be encouraged to consider a vehicle's MPG before and at the time of purchase.

Policy Design

This policy is designed to impact consumer choice and behavior.

Goals: Greatly increase the awareness and availability of consumer information on MPG to result in greater fuel efficiency across the state.

Timing: Program would begin in 2010, with program expansion as resources are made available.

Parties Involved: Iowa Department of Transportation, product manufacturers, product distributors, Iowa Automobile Dealers Association, Iowa Independent Automobile Dealers Association, independent repair shops, Iowa Energy Center.

Implementation Mechanisms

The program would include consideration of the feasibility and cost of such a program.

Information and Education: Provide information and education to the general public and commercial businesses on the relationship of efficient operation and proper maintenance of their vehicles to the fuel efficiency of their vehicle. This information will be developed and made available by the "parties involved" identified above.

Promotion and Marketing:

State Lead by Example: The state will lead by example by initiating an efficient vehicle operation and maintenance program.

Encourage:

Local/county governments, businesses that depend upon vehicles to conduct daily business, and federal agencies located within the state will all be encouraged to implement efficient operation and maintenance programs.

Marketing Program: A marketing program will be developed by the state to encourage the efficient operation and proper maintenance of vehicles.

Website: All state-supported programs would have dedicated detailed websites. In addition to information and materials, program participation by the various governmental agencies and individual businesses (i.e., success stories) would also be documented and extolled.

Funding Mechanisms and/or Incentives: This program would be promoted and incorporated into the TLU-7a policy option for the replacement of tires on state fleet vehicles that is already budgeted through the Iowa DOT annual funding processes. Additional funding mechanisms should also be examined.

Enforcement: No enforcement actions are necessary as the program will be instituted as a voluntary program.

Related Policies/Program in Place

None noted.

Estimated GHG Reductions and Net Costs or Cost Savings

The provision of consumer information on its own is not expected to produce measurable reductions in GHG emissions. However, the provision of consumer information has the potential to increase the effectiveness of other related programs. As a result, the GHG emissions reductions that may be associated with these programs is incorporated into the estimates for other TLU policies.

Key Uncertainties

None noted.

Additional Benefits and Costs

None noted.

Feasibility Issues

None noted.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None noted.

TLU-8. New Vehicle Standards for Increased Fuel Economy and Reduced Greenhouse Gas Emissions

Policy Description

Iowa can reduce its greenhouse gas emissions by improving the fuel economy of the light duty vehicle (LDV) fleet. As also noted in TLU-6, a first step is to charge a state agency with tracking the fuel economy of Iowa's entire fleet. Once a baseline for Iowa's fuel economy is established, the state could then establish goals for improving the fuel economy of the entire fleet. For example, if the current fuel economy is 20 miles per gallon (mpg), goals of 21 mpg by 2012 and 25 mpg by 2020 could be adopted. All other things equal, increasing fuel economy from 20 mpg to 25 mpg would reduce fuel consumption and greenhouse gases by 20%. Further reductions beyond 2020 are also likely. Iowa could establish a goal of 40 to 200 mpg by 2050, reflecting the Iowa Climate Change Advisory Council's overall goals of reducing GHG emissions by 50 to 90% by 2050.

Iowa would adopt the State Clean Car Program in order to reduce GHG emissions from new light-duty vehicles, with an expectation that the most significant greenhouse gas emissions reductions beyond the new federal CAFÉ standards would come from the "Tier 2" state clean car standards expected to be proposed in the near future.

Under the current federal law, states have the option of choosing between the federal standard for air pollution emissions and the state standard. This policy assumed the standards, which must still be approved by USEPA, would take effect in Iowa beginning with Model Year 2012 (calendar year 2011). Other Clean Car Program elements can include standards requiring reductions in smog- and soot-forming pollutants, and promoting introduction of very low-emitting technologies into new vehicles.

New cars and light trucks in all states must comply with Federal emission standards, and, generally speaking, states have the choice of adopting a stronger set of standards applicable in California. In 2005, California finalized a set of GHG standards for new light duty vehicles, phased in from 2009 to 2016. More than a dozen states already have adopted or stated an intention to adopt the California Clean Car Program standards, including Arizona, Connecticut, Maine, Massachusetts, Montana, New Jersey, New Mexico, New York, Oregon, Pennsylvania, Rhode Island, Utah, Vermont and Washington.

In December 2006, Japan revised its fuel economy targets upwards to improve the fleet average fuel economy of new passenger vehicles from 13.6 km/L (33 mpg) to 16.8 km/L (40 mpg) in 2015, and increase of 24%. The International Council on Clean Transportation (ICCT) estimates that this standard is equivalent to an average of 125 g/km for CO_2 emissions. In a 2007 review, the European Union announced an EU objective of 120 g CO_2/km (200 g or .44 lbs / mile) by 2012 to be met through an integrated approach, and is estimated to result in fleet emissions of 130 g/km (217 g or .48 lbs / mile) in 2012. China's standards took effect as Phase I in July 2005, increasing fuel efficiency from 26 mpg in 2002 to 28.4 mpg in 2006. Phase II is due to take effect in January 2008 and January 2009. Starting in 2006, the South Korean standards for mandatory fuel economy are 34.4 mpg for vehicles with engine displacements under 1,500 cubic centimeters and 26.6 mpg for vehicles with over 1,500 cubic centimeter engines.

Policy Design

Goals: Improve fuel economy by 20% by 2012, 100% by 2020, and 250% or more by 2050. Implementation to start in model year 2012 (calendar year 2011), with an 8 year phase in period. Go beyond the current federal emissions standards for cars and light trucks within the parameters of the next tier of the federal and state standards that can be considered within the planning horizon Under the federal Clean Air Act, states can choose between the federal standard or go with the more stringent state standards, provided that the necessary waiver has been granted by the USEPA. For further consideration of state standards, the state of Iowa would undertake a public involvement and consideration process before or during legislative or regulatory process for transparency, and for consideration of the range of potential impacts.

Timing: To meet federal compliance, a rule writing process would take place by the appropriate agencies so that Iowa can implement the California standards. Regulatory program could begin with calendar year 2011, vehicle model year 2012 for new cars and light trucks.

Parties Involved: The law would directly affect automobile manufacturers, car dealers, and consumers as well as the Iowa Department of Transportation, Iowa Department of Revenue, County Treasurers, Iowa Automobile Dealers Association, and Iowa Independent Automobile Dealers Association.

Other: The state clean car standards currently are being litigated. The timing may be affected by the date of enactment of legislation, likely litigation, and the regulatory process.

Implementation Mechanisms

The first step is to charge a state agency with tracking the fuel economy of Iowa's entire fleet. Once a baseline for Iowa's fuel economy is established, the state could then establish goals for improving the fuel economy of the entire fleet. The State of Florida has recently begun using a Florida-specific spreadsheet tool to assess future potential scenarios for improvements in vehicle fleet fuel efficiency. The Florida VEGA (Vehicle Energy and Greenhouse Gas Assessment) Tool is described at the following Web site: http://www.flclimatechange.us/ewebeditpro/items/O12F18689.pdf. It is recommended that the state of Iowa conduct further analyses of scenarios for increasing the fuel efficiency of its motor vehicle fleet to the goal levels described.

The second step would be to initiate a state rule-making process beginning with vehicle model year 2012. As an alternative to a state rulemaking process, the state would support raising the federal CAFE standards to provide for the equivalent level of GHG reductions.

Related Policies/Program in Place

None noted.

Estimated GHG Reductions and Net Costs or Cost Savings

Quantification Factors	2016	2020	Units
GHG emission savings	0.3	0.8	$MMtCO_2e$
Net present value (2008–2020)	N/A	–$246	$ Million
Cumulative reductions (2008–2020)	N/A	4.1	$MMtCO_2e$
Cost-effectiveness	–$60	–$60	$/tCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; N/A = not applicable; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent. Negative numbers indicate a cost savings.

Data Sources:

- Center for Climate Strategies, "Iowa Greenhouse Gas Inventory and Reference Case Projections," November 2008.
- Diane Brown and Elizabeth Ridlington, "Cars and Global Warming: Policy Options to Reduce Arizona's Global Warming Pollution from Cars and Light Trucks," AZ PIRG Education Fund: February 2006, http://www.arizonapirg.org/AZ.asp?id2=22371.
- Elizabeth Ridlington, Tony Dutzik, and Christopher Phelps, "Cars and Global Warming: Policy Recommendations to Reduce Connecticut's Global Warming Pollution from Cars and Light Trucks," Spring 2005.
- Feng An, Deborah Gordon, Hui He, Drew Kodjack, and Daniel Rutherford, The International Council on Clean Transportation, "Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update," July 2007

Quantification Methods:

The California Air Resources Board (CARB), the Public Interest Research Groups (PIRGs), and a coalition of New England States have all calculated the impact of the first tier of the state clean car standards on GHG emissions. The Center for Climate Strategies (CCS) reviewed and compared results of these analyses of clean car programs, and found all three modeling efforts to be reasonable and valid. The PIRG model has been applied in Connecticut, Arizona, and New Mexico. The model estimated a 13.7% reduction in GHG emissions from passenger vehicles by 2020 in Arizona and a 12% reduction in Connecticut. Both CARB and the New England states estimated higher reductions, in the range of 18-19%. The primary sources of variation in these modeling efforts are: (1) the mileage accumulation rates of VMT by passenger vehicle type, and (2) the fleet turnover rate.

The analysis for estimation of GHG emissions reductions from vehicle standards assumes that the effects of the Clean Car Program in Iowa will mainly be determined by the level of the "Tier 2" of the state clean car standards or the level of the next increase in the federal CAFE standards.

CARB has conducted analysis which estimates that the equivalent new light duty vehicle fuel economy for the state's clean car standards would be: 35.7 mpg in the year 2016 and 42.5 mpg in the year 2020. In addition, CARB's analysis estimates that the effect of the state clean car standard being adopted in Iowa would be a potential reduction of 1.3 $MMtCO_2e$ in the year 2016 and a potential reduction of 2.9 $MMtCO_2e$ in the year 2020. The cumulative estimated GHG reduction for the period 2009 through 2020 from adoption of the state clean car standards is 14.4 $MMtCO_2e$ for the State of Iowa. (Sources: http://www.arb.ca.gov/cc/ccms/reports/pavleycafe_reportfeb25_08.pdf and http://www.arb.ca.gov/cc/ccms/reports/final_pavley addendum.pdf)

In order to estimate the effect of state clean car standards independent of the federal CAFÉ standard, the potential federal CAFE-35 standards GHG reductions are subtracted from the state "Clean Car 1 & 2" standards GHG reductions. For the year 2016, CARB estimates this value to be 0.3 $MMtCO_2e$ and for the year 2020, CARB estimates this difference to be 0.8 $MMtCO_2e$. On a cumulative basis, the difference in the estimated values for the 2009-2020 time period is 4.1 $MMtCO_2e$. (Sources: Ibid above)

CCS conducted a review of the CARB analysis, and found it to be the only publicly available published analysis that has been peer reviewed. In addition, CCS has conducted an additional analysis as part of the Inventory and Reference Case Projections analysis, which estimates the federal CAFE 35 standard would result in 0.72 $MMtCO_2e$ GHG reductions in the year 2015, and 1.93 $MMtCO_2e$ reductions in the year 2020. Since the CARB analysis gives the federal standard "more credit' than the independently conducted CCS analysis, we use the CARB analysis in order to provide the greater potential benefit from the federal program.

For cost-effectiveness, two independent analyses conducted by CARB and the Northeast States for Coordinated Air Use Management (NESCAUM) estimated that the potential benefit from state standards are on the order of –$90/ ton and –$110/ton. CCS generally uses –$100 / ton as a central estimate of cost effectiveness. In order to take into account the benefit from the federal CAFE 35 standard, CCS assumes that the "low-hanging fruit" of the most cost-effective technologies would be adopted by automakers first. As a result, the GHG reductions estimated to result from CAFE 35 are expected to be in this –$90/ton to –$11/ton range. The further GHG reductions associated with the balance of the state Clean Car standards (both 1 & 2) are estimated to be in the range of –$50/ton to –$70/ton. In other words, they are still net beneficial, but not as cost beneficial as the car improvements resulting from the CAFÉ 35 standard. We apply the central estimate of –$60/ton to the balance of the GHG reductions resulting from the state standard.

There is a third tier of car improvements and potential GHG emissions reductions resulting from additional state policies beyond the state "Clean Car 1 & 2" standards. However, since there has not been a thorough analysis of the effect of these policies to date, the analysis shown here does not include the potential GHG emissions reductions, nor does it incorporate any cost savings associated with this "third tier" of vehicle improvements. It is recommended that an analysis be conducted for the midwestern states as a whole, in order to examine in greater detail the potential GHG reduction effect and cost-effectiveness resulting from this third tier of vehicle improvements. The Midwestern Governors Association (MGA) is conducting some work related to the combined effects of state policies among midwestern states. As a result, the MGA would be a potential organization to sponsor this analysis.

Key Assumptions:

The prior modeling efforts have established a valid and reasonable method of projecting GHG emissions reductions from state clean car policies. The CCS comparison of the three modeling methods provides some independent professional validation of the models and their results. The key assumption of the emissions reduction projected by CCS is that the most likely scenario for emissions reductions is one that would fall between the more conservative scenario projected by the PIRG model and the more optimistic scenario projected by the California and the New England models.

In addition, some recent analysis by the California Air Resources Board shows that while the Tier 1 level of state clean car standards and the recently enacted new CAFÉ standards (from the federal Energy Act of 2007) both result in new car standards at an estimated 35 MPG, the state clean car standards are expected to reach that goal sooner in time, which would result in greater GHG emissions reductions during the period of analysis. In addition, the CARB analysis shows that a significant level of additional GHG emissions reductions is possible, through the Tier 2 iteration of the state Clean Car Standards planned for the near future.

Key Uncertainties

A key policy option to achieve improved fuel economy would be adopting California's car standards. This option is problematic because, at present, the U.S. Environmental Protection Agency (US EPA) has not approved the waiver required for the adoption of California's car standards.

The net emissions impact of this policy depends on fleet turnover rates for light duty vehicles and future patterns of consumer purchase choices between passenger cars and light duty trucks. The timing of these policies also depends upon the decisions within the analysis period of both the federal courts and the United States Congress.

Additional analysis of scenarios may be helpful in for the future. The current estimates do not fully capture the full effect of the scenario described.

An Iowa Clean Car program in which the fuel economy of Iowa's entire fleet is tracked would likely rely on a greenhouse gas life cycle assessment (LCA) of the fuel choice as well as the emission standards for cars and light trucks. California has embarked on such an assessment in their Clean Car program, and the U.S. Environmental Protection Agency is also charged with doing an LCA for transportation fuels under the 2007 Energy Independence and Security Act (EISA). It is possible that ethanol, the current biofuel of choice, would fare poorly in terms of such an overall assessment. This is because greenhouse gases are emitted while growing corn (e.g., nitrous oxide emissions from the denitrification of nitrogen-fertilizers) and from converting land for additional corn supply. This could present a huge challenge to agriculture in Iowa and the ethanol industry depending upon exactly how the life cycle assessment of the fuel is performed. There are scientific uncertainties surrounding the standards that are being promulgated by the California Air Resources Board (CARB) under the California Low Emission Vehicle standards, and these standards could serve to limit the flex fuel market.

Additional Benefits and Costs

GHG emissions reductions from new vehicle standards are also expected to reduce the level of demand for imported oil and oil products, including refined gasoline.

Feasibility Issues

The off-the-shelf technologies for increased fuel economy are currently being offered in the marketplace by some manufacturers. Further advances in LDV fuel economy are expected to become commercially available in the time period analyzed.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

Concern was expressed that a policy limited to new vehicles would not affect the fuel economy of existing vehicles, potentially leading to a “jalopy effect” whereby owners retain their existing and less efficient vehicles for longer periods of time. In addition, state-level adoption of car standards that differ from those in other states in our region would create an uneven vehicle market and would likely create barriers to dealer trades within the multi-state region.

TLU-9. Freight Strategies (Truck and Rail)

Policy Description

The movement of freight on Iowa's transportation system plays a critical role in our economy. Iowa also serves as a crossroad for the movement of freight across the country. In fact, it is estimated that 43% of all freight movement in Iowa is just passing through the state. There has been tremendous growth in freight traffic with truck traffic having grown more than 50% in the last 15 years and expected to grow another 50% by 2020. National freight forecasts estimate an 89% increase in tons of freight by 2035.[6] To meet this increased demand while minimizing greenhouse gas emissions (GHG) will require many actions. This policy option focuses on infrastructure activities to support a greater increase in freight hauled on rail while considering federal EPA emissions reduction changes that are currently being implemented with over-the-road diesel truck engines.

The use of rail to haul freight is more efficient from an energy consumption and GHG emission perspective. According to EPA data, freight railroads account for just under 2% of U.S. GHG emissions from transportation sources. The American Association of Railroads (AAR) estimates that for every ton-mile of freight moved by rail instead of truck, two-thirds less GHG emissions are emitted. AAR also estimates that if 10% of long-haul freight now moving by truck moved by rail instead, annual GHG emissions would fall by more than 12 million tons.

The Iowa Department of Transportation (DOT) and all other involved parties will assure the most efficient movement of freight while reducing GHG emissions. This also has the effect of delaying large investment needs to add capacity to the state highway system. With such large growth in freight forecast it is unlikely that freight movements by truck could ever be reduced but shifting more of the growth to rail would minimize the growth of GHG emissions. This effort will require activities within Iowa, within the Midwest and nationally.

Policy Design

Goals: Reduce overall greenhouse gas emissions generated by freight movement through a combination of the following actions:

Timing:
By 2010, the Iowa Department of Transportation and other interested parties, will:

- Through regional, statewide and national planning activities, seek to remove bottlenecks (both physical and operational) for the efficient movement of freight by all modes of transportation.

[6] American Association of State Highway Transportation Officials, "Transportation Invest in our Future, America's Freight Challenge," May 2007.

- Establish a Statewide Freight Advisory Committee of public and private parties to identify actions to support the efficient movement of freight and opportunities for intermodal freight movement.
- Support initiatives to encourage railroad capital investment to increase capacity (e.g. tax credits).
- Assist the identification of opportunities for increased intermodal freight movements (e.g. the development of the ethanol terminal in Manly, IA where ethanol is brought in by truck from multiple plants and shipped by rail).
- Seek continued and increased legislative appropriations for the Rail Revolving Loan and Grant Program. This funding supports rail improvements including the construction of rail spurs to industry to encourage use of rail.
- Continue to utilize federal Congestion Mitigation and Air Quality (CMAQ) funding to support rail freight improvements.
- Seek opportunities to support truck stop electrification including use of federal Congestion Mitigation and Air Quality (CMAQ) funding. This could also include incentives (e.g. tax credits) to encourage installation of equipment.
- Provide incentives to trucking firms and truck owners to equip their vehicle(s) with devices that eliminate the need to idle including battery-electric auxiliary power systems, vehicle battery systems, thermal energy storage systems, fueled auxiliary power systems, etc.
- Provide incentives to trucking firms and truck owners including local and state municipalities to invest in hybrid truck technology as it becomes available in class 7 and 8 trucks over the next three years and beyond.

Parties Involved: Iowa Department of Transportation, local governments, Iowa Legislature, regional/metropolitan planning organizations, Iowa Department of Economic Development, Iowa's Motor Truck Association, railroads, shippers, developers, U.S. Department of Transportation, and other state DOTs.

Implementation Mechanisms

None noted.

Related Policies/Programs in place

None noted.

Estimated GHG Reductions and Net Costs or Cost Savings

Quantification Factors	2012	2020	Units
GHG emission savings	0.39	0.63	$MMtCO_2e$
Net present value (2008–2050)		$30	$ Million
Cumulative reductions (2008–2050)		5.9	$MMtCO_2e$
Cost-effectiveness		$5	$/$tCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

- Federal Highway Statistics 2006
- Iowa DOT
- US EPA SmartWay Partnership
- American Association of Railroad (AAR), *National Rail Freight Infrastructure Capacity and Investment Study*
- American Association of State Highway Transportation Officials (AASHTO), "Freight Demand and Logistics Bottom Line Report"

Quantification Methods:

Estimate the reduction in CO2 emissions from reduced idling based on estimating the portion of emissions and fuel consumption in the Iowa inventory that is attributable to Class 8 diesel trucks traveling on long-haul trips, estimate the portion of the total fuel consumption that would be consumed during idling, and apply a targeted reduction of 80% to this amount starting in 2008 and a reduction of 90% starting in 2015.

Estimate the mode shift potential from long-haul trucking to intermodal rail by estimating the amount of heavy duty truck traffic on long-haul trips, the commodity mix share that is amenable to an intermodal shift, the investment costs necessary to upgrade intermodal terminals and rail bottlenecks, and the expected mode shift likely based on logistics cost cross-price elasticities.

Key Assumptions:

This analysis assumes idle reductions are achieved only by Class 8 diesel truck population; these trucks idle for an average of 6 hours per day; they consume 0.8 to 1.2 gallons of diesel per hour during idling; and that an 80% (by 2010) or 100% (by 2020) reduction of diesel idling from these Class 8 trucks will be achieved. The cost analysis assumes a 5-year lifetime for idling technology equipment, applied to 80% of Class 8 vehicles starting in 2008 and 90% of Class 8 vehicles starting in 2015, at a cost of $6,000 per vehicle and a $4.80 per gallon diesel cost. Program administration costs, enforcement costs, and fines have not been factored into the cost analysis. Reduced vehicle maintenance costs have not been factored into the analysis. Track improvements and intermodal terminal expansion will occur over 10 years beginning in 2009.

Key Uncertainties

The movement of goods related to the renewable fuels industry is a rapidly evolving area. The rapid growth in ethanol production in Iowa in the last few years has had a significant impact on Iowa's highway and rail system. Preliminary analysis has attempted to quantify this impact and further analysis is soon to be completed by Iowa State University (ISU). The analysis by ISU is based on a comprehensive survey of farmers, ethanol/biodiesel producers and grain handlers. Phase I of this analysis is expected to be complete very soon and will provide important information on changes to the transportation of grain in Iowa due to ethanol/biodiesel production.

Additional ethanol growth in Iowa will soon be based on production from cellulosic material (switch grass, corn stover, etc.). Cellulosic material is significantly less dense than corn and therefore will require greater volume of shipments of material. The impact of this increase in volume is unknown but the Iowa Highway Research Board has approved funding for ISU's Center for Transportation Research and Education (CTRE) to evaluate this impact. By January 2010, CTRE will complete the study which will have the following objectives: (1) develop traffic/fiscal assessment tools to understand the impact of biofuels on highways; (2) inventory types of vehicles likely to be used in cellulosic industries and develop turning movement templates and axle loading characteristics; (3) document the physical and fiscal impact on the system over the next 15 to 20 years; and (4) develop public policy recommendations to address impacts on the system. Of note is that this study will also evaluate impacts of larger vehicles required for the rapidly growing wind power manufacturing and development activities in Iowa.

Additional Benefits and Costs

None noted.

Feasibility Issues

As noted under key uncertainties section.

Status of Group Approval

Approved.

Level of Group Support

Supermajority (Vote: 19–1).

Barriers to Consensus

Concerns were raised that the voices of all parties had not been heard and that not all comments made had been addressed.

TLU-10. Fuel Strategies: Low-Carbon Fuel Standard (20% Reduction)

Policy Description

This option seeks to reduce GHG emissions by decreasing the carbon intensity of vehicle fuels sold in Iowa. The Low Carbon Fuel Standard (LCFS) would require all fuel providers in Iowa to ensure the mix of fuel they sell into the Iowa market meets, on average, a declining standard for GHG emissions measured in CO2 equivalent per unit of fuel energy. The State should regulate quality standards for low carbon fuels. Low carbon fuels include, but are not limited to, biodiesel, cellulosic ethanol, hydrogen, compressed natural gas, liquefied petroleum gas, electricity, and low carbon blends such as E10 or E85. The standard would be measured on a lifecycle basis in order to include all emissions from fuel production to consumption.

Fuel providers (defined as refiners, importers, and blenders of on-road vehicle fuels) will need to demonstrate on an annual basis that their fuel mixtures provided to the market met the low carbon standard. Options for compliance may include: blending or selling increasing amounts of lower carbon fuels, using previously banked credits, and purchasing credits from fuel providers who earned credits by exceeding the standard. Penalties for noncompliance will be determined during the implementation process.

Increased use of renewable fuels typically results in lower GHG emissions when compared to the petroleum-based alternatives. Iowa’s long standing 10% ethanol blended fuel has displaced billions of gallons of gasoline over the course of its use in Iowa. Iowa currently leads the nation in ethanol and biodiesel production and maintains incentives that support renewable fuels. Currently, over 70% of all gasoline sold in Iowa is a 10% ethanol blend.

In December 2007, President Bush signed the Energy Independence and Security Act of 2007 creating a Federal Renewable Fuel Standard (RFS). The Federal RFS mandates that by the year 2022, 36 billion gallons of renewable fuels will be used in the United States (current use is estimated at 7.5 billion gallons). The standard is laid out to not only increase the production and use of renewable fuels, but also to reduce GHG emissions. The standard specifies a 50% reduction in GHG emissions from biomass-based diesel and advanced biofuels; a 20% reduction in GHG emissions from renewable fuels; and a 60% reduction in GHG emissions from cellulosic biofuel as compared to the GHG emissions created by burning traditional fossil fuels. The recent implementation of the United States Environmental Protection Agency’s (USEPA’s) Renewable Fuel Standard will help create additional demand for Iowa’s renewable fuels across the country. State renewable fuel exports will continue to grow as other states begin formalizing their own state standards for renewable fuels and GHG controls. The state of Iowa has also implemented an incentive program that provides tax credits to retail dealers that increases with increasing volume of biofuels sold.

The Midwest Governor’s Association (MGA) Goals

The MGA has developed dual goals for biobased products and transportation within the Midwest region:

1. Reduce the region's dependence upon fossil fuel for transportation purposes, and
2. Increase utilization of regionally produced biofuels and other low-carbon advanced transportation fuels for all transportation energy consumed in the region. Iowa should support and exceed the progress made through the MGA.

Iowa Objectives

In addition to supporting implementation of the MGA platform for biofuels, Iowa should design and implement programs to increase demand for biofuels and the infrastructure to support the increased demand, and to foster development of biofuels with lower carbon footprints and greater sustainability.

Policy Design

Goals: Create a Low Carbon Fuel Standard for transportation fuels (gasoline and diesel) sold in Iowa that would reduce carbon intensity of Iowa's on-road vehicle fuels by at least 20% by 2020. In addition to the reduction standard and program timing, the following issues should be addressed in creating the program:

- Credit generation and trading
- Life cycle model and boundary conditions

Timing: Following a design period, the program would be implemented prior to 2020. Fuel providers would be required to meet the 20% reduction standard no later than 2020. If interim targets for reduction in carbon intensity are established, they will reflect the likely importance of cellulosic ethanol to meeting the standard and the likelihood that cellulosic ethanol will not be available in large commercial quantities until 2015 or later.

Parties Involved: Fuel providers, Iowa Department of Economic Development, Iowa Department of Environment and Natural Resources.

Compliance Pathways: The Low Carbon Fuel Standard does not specify any particular fuel or vehicle technology. Table H-2, below, shows three possible compliance scenarios that would meet the standard for gasoline in California. As envisioned in California, much of the reduction in passenger vehicle fuel carbon intensity would be met by increasing ethanol use.

Table H-2. Low-carbon fuel standard compliance scenarios for California

Scenario number	1	2	3
Total petroleum displaced by low-carbon fuels (B gal)	3	3.1	3.2
Low-carbon fuels			
Total ethanol demand (B gal)	2.7	3.8	4.7
Number of flex fuel vehicles (millions)	3	6	8.5
Number of plug-in hybrids (millions)	4.1	1.7	0
Number of hydrogen fuel cell vehicles (millions)	0.5	0.5	0.2

Source: Office of the Governor (State of California), "The Role of a Low-Carbon Fuel Standard in Reducing Greenhouse Gas Emissions and Protecting Our Economy." White Paper. January 8, 2007, available at: http://gov.ca.gov/index.php?/fact-sheet/5155/

Table H-3 shows life-cycle ("well-to-wheels") GHG impacts of various biofuels options.

Table H-3. Estimated biofuel impacts on GHG emissions

Fuel/Technology	Blend	Feedstock	Reduction (grams of GHGs/mile)*
Ethanol	E10	Corn	1.5%
Ethanol	E10	cellulosic	7.2%
Ethanol	E85	Corn	17.6%
Ethanol	E85	cellulosic	83.2%
Biodiesel	B20	Soy	9.9%
Biodiesel	B20	Canola	11.2%
Biodiesel	B20	Palm	12.0%
Biodiesel	B100	soy	53.9%

* Ethanol reductions estimated relative to gasoline; biodiesel reductions estimated relative to diesel fuel. Actual reductions depend on many factors in the production, distribution, and use of fuels.

Sources: GREET v1.7 outputs; (S&T)2 Consultants, *Sensitivity Analysis of GHG Emissions From Biofuels in Canada*, 2006.

Implementation Mechanisms

A Governor's Executive Order would initiate the process for development of the LCFS, followed by a detailed report and rule-making proceedings that would involve consultation before implementation. The appropriate state agencies will undertake a study to develop the framework for the LCFS. Once the study is completed, it would be introduced to the State's legislative proceedings, at which point the appropriate state agency will conduct public hearings on the proposal. Once adopted, an appropriate state agency will initiate a rule-making proceeding, establishing and implementing the LCFS.

The LCFS is market-based and performance-based, allowing averaging, banking and trading to achieve lowest cost and consumer-responsive solutions. A LCFS is also fuel neutral where fuel providers will choose which fuels to sell and in what volumes. This provides flexible options for compliance including: blending or selling increasing amounts of lower carbon fuels, using previously banked credits and purchasing credits from fuel providers who earned credits by exceeding the standard.

Fuel providers, defined as refiners, importers, and blenders of passenger vehicle fuels, would demonstrate on an annual basis that their fuel mixtures provided to the market met the target by using credits previously banked or purchased. Providers that exceed the performance target for the compliance period will be able to generate credits in proportion to the degree of over performance and quantity of fuel provided. These credits can be held for future use or sold to other regulated fuel providers. Penalties for noncompliance will be determined during the implementation process.

Related Policies/Program in Place

Renewable Fuels Standards (U.S. and Iowa)

Iowa's state renewable fuel standard is the most progressive standard in the country. The standard will be implemented beginning in the calendar year 2009 with incentives eligible in 2010. The Iowa standard, in cooperation with the Federal RFS, guides production and sets goals for renewable fuel use over a span of 14 years.

Goals:

- 25% biofuel sales in Iowa by 2019
- 36 billion gallons produced in the U.S. by 2022
- 50% reduction in GHG emissions from biomass-based diesel and advanced biofuels
- 20% reduction in GHG emissions from renewable fuels
- 60% reduction in GHG emissions from cellulosic biofuels
- Goals defined in Iowa RFS and the 2007 Energy Independence and Security Act

Timing: Achieve by 2022 under the Federal RFS and 2019 under Iowa RFS

Parties Involved: Federal Government, State Government, Producers, Marketers, Blenders, Consumers, and Refiners.

Infrastructure

For the past three years, Iowa has been building its renewable fuel infrastructure for retail sites as well as points of bulk distribution.

The Renewable Fuels Infrastructure Board (RFIB) oversees the funding of biodiesel bulk facilities to create an extensive distribution network for biodiesel. The RFIB also funds retail locations that require new equipment for E85 due to incompatibility issues with existing equipment (moving from a hydrocarbon-based fuel to an alcohol-based fuel). This program is administered by the Iowa Department of Economic Development.

Federal Renewable Fuels Standards, Iowa Biofuels Incentives, Iowa Power Fund, Renewable Fuels Infrastructure Board.

The following related policy priorities of the Midwestern Governors Association (MGA) can help Iowa meet the related biofuels objectives:

1. **Market Pull and Distribution Infrastructure**

- Promote Broad Renewable Fuels Standards
- Include specific carve-outs for lower-carbon advanced biofuels
- Create incentives to increase demand for fuel-efficient lower-carbon vehicles
- Expand state government's use of biofuels and advanced transportation fuels
- Develop regional quality standards for biodiesel and other fuels
- Adopt retail tax incentives to encourage retailers to sell biofuels, advanced transportation fuels and biobased products

2. **Advance Conversion Technology Commercialization**

- Mitigate risk in developing next-generation technologies

3. **Broaden Existing Bioenergy Incentives and Create New Incentives Promoting Biomass**

- Including different liquid fuels, natural gas, heat, and electricity

4. **Develop Next-Generation Regulation for New Technologies**

- Provide regulatory exemptions to allow experimentation

5. **Provide Technical Assistance to Advanced Technology Projects**

- Fund front-end engineering and design studies and other feasibility studies

6. **Increase Regional Research Collaboration**

- Coordinate state and private research to develop an information clearinghouse on advanced bioenergy research and demonstration projects
- Promote regional commercial-scale demonstrations of various biomass feedstocks

7. **Develop the Midwestern Infrastructure for the Manufacture of Biobased Products**

- Support research for determining how the biomaterials supply chain can mature and how new products can achieve economic viability

8. **Develop Midwestern Biobased Products**

- Adopt biobased product procurement rules at the state level
- Participate in regional biobased product procurement program
- Create a regional certification program

9. Overcome the Difficulty of Biomass Feedstock Logistics

- Employ technical assistance and incentives to projects that are seeking to develop a supply of cellulosic biomass for bioenergy projects

10. Create a Uniform, Regional Low-Carbon Fuels Policy

- Convene affected stakeholders to develop the common policy
- Implement at the state level as a standard
- Report annually on progress

11. Develop Incentives to Increase Fuel Efficiency and Reduce Greenhouse Gas Emissions

- Incent consumer purchase of efficient biofuels vehicles
- Incent biofuels producers to improve efficiency and reduce greenhouse gas emissions
- Seek development of co-located industries that share products and by-products to improve economic efficiency and lower GHG emissions

12. Create Local Wealth

- Ensure that the benefits of biofuels, advanced transportation fuels, and biobased product development accrue to public and private entities in the communities where they are produced
- Give bonding authority or access to bonding funds to co-ops, municipal utilities, and other local and community-owned entities to fund biomass projects
- Wherever possible, make the opportunity available for local ownership in projects receiving public investments

13. Promote a Perennial Biomass Supply

- Support the development of a perennial biomass supply
- Encourage landowners to grow perennial crops and supply products to a bioenergy plant in a way that targets improvements in soil/water quality, wildlife habitat, soil erosion, and carbon sequestration

14. Create Collaborative Workforce Development Programs

- Collaborate between industry, governments, and educational institutions to develop curriculum at all levels of the educational system on biofuels, advanced transportation fuels, and biobased products

Estimated GHG Reductions and Net Costs or Cost Savings

Quantification Factors	2012	2020	Units
GHG emission savings	0.60	5.11	$MMtCO_2e$
Net present value (2008–2050)		–$1,359	$ Million
Cumulative reductions (2008–2050)		22.03	$MMtCO_2e$
Cost-effectiveness		–62	$/$tCO_2e$

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

Life-cycle impacts of biofuels obtained from Argonne National Laboratory's GREET model (v1.7). Fuel consumption, fuel economy, and gasoline and ethanol prices obtained Energy Information Administration's Annual Energy Outlook, 2007 and 2008 releases. Price of biodiesel and conventional diesel obtained from U.S. Department of Energy Alternative Fuels Price Report, January 2008.

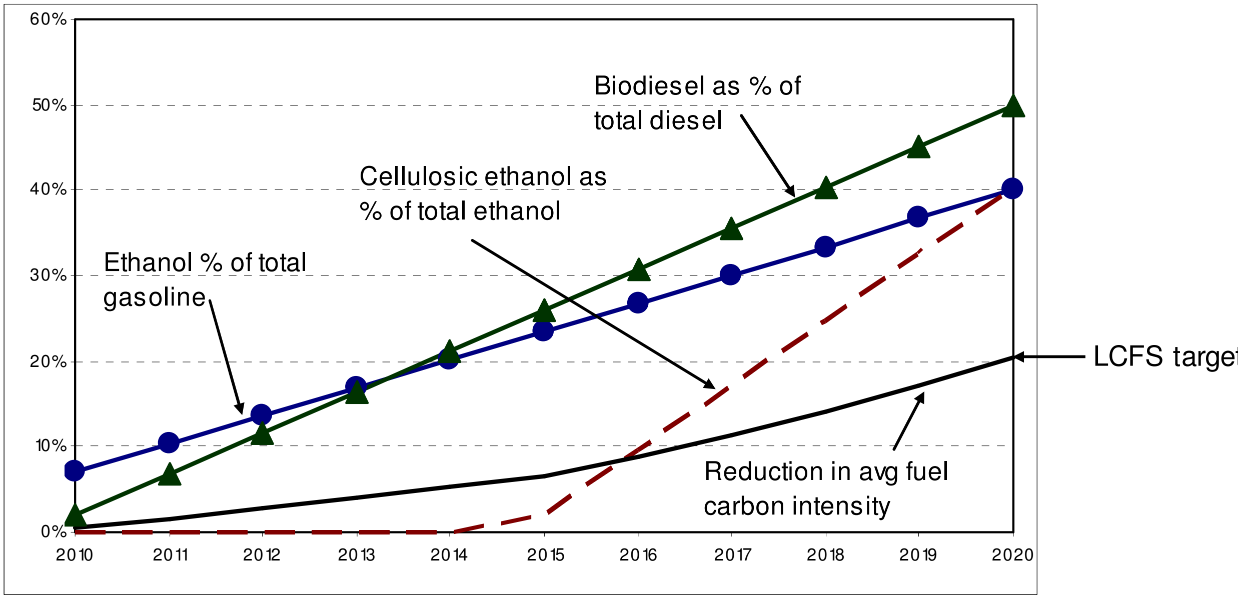
Quantification Methods:

The estimate of greenhouse gas emissions reductions from the low carbon fuel standard is based upon a 20% reduction in average carbon intensity of gasoline and diesel fuel sold in Iowa. A ramp-up period is estimated so that the 20% goal would be reached at the horizon year, 2020.

The GHG "credit" attributed to this mitigation option is the incremental reduction on top of any reduction due to current (baseline) use of biofuels. Ethanol currently makes up approximately 7% of Iowa gasoline sales (i.e., 70% of gasoline is an E10 blend); biodiesel sales are currently small and assumed to be zero.

In order to estimate the likely ramp up in biofuels usage needed to meet the LCFS, a scenario was developed, shown in Figure H-3, below. In this scenario, by 2020, ethanol in Iowa would represent 40% of gasoline sales, with 70% of the ethanol used in flex-fuel vehicles (E85) and the remainder used conventional vehicles operating on E10. All ethanol would come from corn feedstocks through 2014. Starting in 2015, the market share of cellulosic ethanol would ramp up so that by 2020, 40% of all ethanol would be from cellulosic feedstocks. Biodiesel (from soy) would make up 50% of total Iowa diesel sales by 2020. The cumulative impact of this increase in biofuels is a 20% reduction in average fuel carbon intensity in 2020.

Figure H-3. Projected ramp up of Iowa biofuels 2010–2020



Cost is calculated as the incremental cost of biofuels per gallon of gasoline equivalent (for ethanol) or diesel equivalent (for biodiesel) multiplied by total consumption of each fuel. Ethanol and gasoline prices in future years are drawn from the Energy Information Administration's Annual Energy Outlook, 2008. Based on information from the U.S. Department Energy's Alternative Fuels Price Report, January 2008, the difference in the average price of biodiesel compared with conventional diesel in the Midwest is approximately $0.17 per gallon. Note that the cost calculation does not include Federal subsidies in the form of tax credits for ethanol or biodiesel. In addition, costs related to any vehicle upgrades, (e.g., flex-fuel vehicles that can operate on ethanol blends up to E85) are not included

Key Assumptions:

- Program starts in 2010, first year of emission reduction.
- Program reaches 20% carbon intensity reduction goal by 2020.
- Program applies to all on-road vehicles, "replacing" current gasoline and diesel fuel.
- Baseline accounts for:
  - 7% ethanol existing market share, blended as E10 with ethanol feedstock for baseline usage assumed to be 100% corn.
  - 0% existing biodiesel market share.

Key Uncertainties

Transportation fuel providers would need to undertake changes in their production and distribution methods in order to achieve the goals. Because the policy does not prescribe particular technology pathways, there is uncertainty surrounding which fuels and technologies fuel providers will use to meet the standard. The program assumes that providers will use the most cost-effective options to meet the standard, but compliance costs are unknown at this time.

Additional Benefits and Costs

Use of biodiesel reduces diesel particulate matter emissions, which have adverse public health effects. Use of ethanol also reduces air pollution emissions.

A Low Carbon Fuel Standard for Iowa would likely rely on a greenhouse gas life-cycle assessment (LCA) of the fuel. In the case of ethanol, this may include the indirect emissions from growing corn as feedstock for the ethanol production industry and from conversion of land (emissions of carbon dioxide to the atmosphere from land disturbance). California has embarked on such an assessment for their Low Carbon Fuel Standards, and the U.S. Environmental Protection Agency is also charged with doing an LCA for transportation fuels under the 2007 Energy Independence and Security Act (EISA). It is possible that ethanol (E10 and E85) would fare poorly in terms of such an assessment (e.g., a 20% reduction in GHG emissions from renewable fuels, or EU's objective of 120 g CO_2e/km). This is because greenhouse gases are emitted while growing corn (e.g., nitrous oxide emissions from the denitrification of nitrogen-fertilizers) and from converting land to corn. This could present a huge challenge to agriculture in Iowa, producers, refiners, and blenders depending upon exactly how the life cycle assessment of the fuel is performed and if ethanol-from-corn fails to qualify as a low carbon fuel. It is likely that cellulosic ethanol, the next generation biofuel, will have a much better greenhouse gas performance assessment and will certainly be classified as a low carbon fuel.

Feasibility Issues

There are feasibility issues associated with transporting large volumes of biofuels to and within the state, as well as distributing biofuels to consumers. For example, ethanol cannot move in the pipeline network used for transport gasoline and diesel fuel. These issues would need to be resolved in order to achieve the LCFS.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None noted.

Appendix I
Agriculture, Forestry, and Waste Management Policy Options

Summary List of ICCAC Options

No.	Policy Option	GHG Reductions ($MMtCO_2e$) 2012	2020	Total 2009–2020	Net Present Value 2009–2020 (Million $)	Cost-Effective-ness ($/$tCO_2$e)	Level of Support
AFW-1	Nutrient Management						Majority (7 Objections)
	Increase Efficiency of Fertilizer	0.11	0.53	3.0	–$103	–$34	
	Seasonally Flooded Areas	0.002	0.009	0.05	$10	$194	
	Improved Nutrient Distribution	0.02	0.1	0.55	$373	$693	
AFW-2	Wetlands and Drainage	0.01	0.16	0.57	$120	$218	Super Majority (5 Objections)
AFW-3	Expanded Use of Agriculture and Forestry Biomass Feedstocks for Electricity, Heat, or Steam Production	4.4	20	113	$4,281	$38	Unanimous
AFW-4	Encourage Large-Scale Manure/Methane Management Capture Utilization						Unanimous
	Methane Management Capture Utilization	0.8	3	17	$63	$4	
	Manure Management	0.2	0.7	4.6	–$38	–$8	
AFW-5	Land Management to Promote Sequestration Benefits						Unanimous
	Conservation Tillage	2.9	9	56	–$6	–$0.1	
	Agriculture Land Conversion	0.1	0.4	2.6	$199	$76	
	Conservation Grazing	0.1	0.3	1.7	–$116	–$67	
	Afforestation	0.2	0.6	4.1	$216	$53	
	Unmanaged Grazed Forested Land	0.3	0.8	5.5	$93.7	$17	
	Urban Forestry	0.1	0.4	2.4	–$99	–$41	
AFW-6	Cellulosic Biofuel*	2.0	9.8	49	–$1,410	–$29	Unanimous
AFW-7	Improved On-Farm (or First Point of Purchase) Energy Use and Efficiency						Unanimous
	Renewable Energy	0.02	0.08	0.5	$23	$51	
	Energy Efficiency	0.2	0.9	5.9	–$610	–$104	
AFW-8	Waste Management Strategies	1.5	4.1	26.5	–$220	–$8	Unanimous
AFW-9	Landfill Methane Energy Programs	0.2	0.8	4.8	$4	$0.8	Unanimous
	Sector Total After Adjusting for Overlaps	**11**	**37**	**233**	**$2,139**	**$9**	
	Reductions From Recent Actions	**0.0**	**0.0**	**0.0**	**$0.0**	**$0.0**	
	Sector Total Plus Recent Actions	**11**	**37**	**233**	**$2,139**	**$9**	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

* Note that the costs/savings of this option include a $1.01/gallon federal subsidy for cellulosic ethanol.

Overlap Discussion

The amount of greenhouse gas (GHG) emissions reduced or sequestered and the costs of a policy option within the agriculture, forestry, and waste management (AFW) sectors overlap with some of the quantified benefits and costs of policy options within other sectors. Where this overlap has been determined to exist, the sector totals have been adjusted, and each instance is outlined below. Overlaps between options within AFW have been accounted for within the goal-setting process.

AFW-3 (Expanded Use of Agriculture and Forestry Biomass Feedstocks for Electricity, Heat, or Steam Production) outlines how biomass may be utilized for energy production. The Clean and Renewable Energy (CRE) Subcommittee also quantified the use of biomass for energy production (e.g., CRE-2[1] [Technology Initiatives, Including Renewables] and CRE-13 [Pricing Strategies To Promote Renewable Energy and/or CHP]). AFW demands a greater amount of biomass than does CRE. The biomass demand requirements for CRE (in million British thermal units [MMBtu]) and associated costs were removed from the AFW sector totals because these were considered to be accounted for under the CRE analyses.

AFW-5 (Urban Forestry) addresses planting trees in urban settings. The Energy Efficiency and Conservation (EEC) Subcommittee does not specifically include tree planting to reduce energy use in buildings as part of demand-side management and other energy efficiency programs. Thus, no adjustments were made to the sector total.

AFW-6 (Cellulosic Biofuel) focuses on biofuels. Similar to utilization of biomass for production of energy, utilization of biomass for production of cellulosic biofuels was greater under AFW than in the transportation and land use (TLU) sectors. To adjust for the overlap between these two Subcommittees, the AFW sector total emission reductions and costs were reduced by the proportion determined to be included under the TLU-10 (Fuel Strategies [20% Low Carbon Fuel Standard]) analysis.

AFW-7 (Energy Efficiency) addresses energy efficiency improvements through on-farm applications. The EEC Subcommittee is responsible for quantifying energy efficiency improvements across all sectors. It was assumed that the energy efficiency reductions in AFW-7 overlap with the reductions quantified by the EEC Subcommittee. Therefore, the energy efficiency GHG reductions and cost savings from energy efficiency (in AFW-7) have been removed from the sector total.

AFW-9 (Landfill Methane Energy Programs) focuses on landfill methane programs, which are also addressed by CRE-2 and CRE-13). The GHG reductions and cost savings from AFW-9 have been removed from the sector total.

[1] CRE-2 (Technology Initiatives, Including Renewables) incorporates or adjusts for biomass used by CRE-5 (Performance Standards (50% Reduction by 2050) and CRE-8 (Support for Grid-Based Renewable Energy & Development).

No reductions from recent actions have been made to the AFW sector totals.

Table I-1. Iowa Climate Change Advisory Council (ICCAC) policies: biomass supply and demand assessment

Biomass Resource	Annual Biomass Supply, 2012 (dry short tons)	Annual Biomass Supply, 2020 (dry short tons)	Notes
Forest residue*	396,000	396,000	2005 NREL report.† Estimated using USDA USFS Timber Product Output database for 2002, includes logging residues and other removals.
Primary mill residue (unused)	2,000	2,000	2005 NREL report. Derived from the USDA USFS Timber Product Output database for 2002, includes mill residues burned as waste or landfilled.
Secondary mill residue	32,000	32,000	2005 NREL report. Includes wood scraps and sawdust from woodworking shops—furniture factories, wood container and pallet mills, and wholesale lumberyards. Estimated using number of businesses from the U.S. Census Bureau, 2002 County Business Patterns and assumptions on the wood waste generated.
Urban wood waste	353,000	353,000	2005 NREL report. MSW wood—wood chips, pallets, and yard waste; utility tree trimming and private tree companies; and construction and demolition wood. Data on the collected urban wood waste are not available; thus, numerous assumptions were applied for estimation.
Agricultural residue	26,003,000	26,003,000	2005 NREL report. Estimated using 2002 total grain production, crop-to-residue ratio, moisture content, and taking into consideration the amount of residue left on the field for soil protection, grazing, and other agricultural activities. The NREL report assumes that about 30%–40% of the total residue could be collected as a biomass feedstock (note that this may be higher than the achievable amount in practice). The NREL report assumes that 30% residue cover is reasonable for soil protection, 20%–25% of the stover in grazing, and about 10%–15% of the crop residue is used for other purposes, e.g., bedding, silage.
Energy crop	5,000,000	5,000,000	Taken from the AFW-3 energy crop goal (Annually harvest at least 5 million dry tons of dedicated energy crop production materials by 2020). Note that the 2005 NREL report estimates a potential 9,413,000 tons of willow or hybrid poplar could be grown on CRP lands; 11,297,000 tons of switchgrass could be grown on CRP lands, but the lower estimate was used.
MSW fiber, including yard and landscape waste debris	369,465	157,706	From AFW-8.
Total annual biomass supply	29,669,465	29,457,796	

Biomass Resource	Annual Biomass Supply, 2012 (dry short tons)	Annual Biomass Supply, 2020 (dry short tons)	Notes
AFW-3	3,552,000	16,000,000	From goals: Annually harvest at least 5 million dry tons of dedicated energy crop production, 10 million tons of annual crop residue, and 1 million tons of forest products or wood residues.
AFW-6	2,190,000	10,000,000	From goals: Increase in-state cellulosic feedstock production by 10 million dry tons by 2020.
Total	**5,742,000**	**26,000,000**	

ICCAC = Iowa Climate Change Advisory Council; NREL = National Renewable Energy Laboratory; USDA = U.S. Department of Agriculture; USFS = U.S. Forest Service; MSW = municipal solid waste; CRP = Conservation Reserve Program; AFW = Agriculture, Forestry and Waste Management [Subcommittee].

* Forest residue data for the NREL report were derived from the USDA USFS Timber Product Output database for 2002. In this category, NREL included logging residues and other removals. NREL defined logging residues as “the unused portions of trees cut, or killed by logging, and left in the woods. Other removals are considered trees cut or otherwise killed by cultural operations (e.g., pre-commercial thinning, weeding) or land clearings and forest uses that are not directly associated with round wood product harvests.

† A. Milbrandt. 2005 (Dec.). *A Geographic Perspective on the Current Biomass Resource Availability in the United States*. Technical Report NREL/TP-560-39181 (prepared under Task No. HY55.2200).

AFW-1. Nutrient Management

Policy Description

Demonstrate and encourage the implementation of GHG-beneficial management practices, including nutrient and soil management techniques to lower nitrous oxide (N_2O) emissions and increase soil carbon (C) retention,[2] limit or restrict nitrogen (N) fertilizer application on field areas that are seasonally flooded, and increase the use of cover crops.[3]

Improve the efficiency of fertilizer use and other nitrogen-based soil amendment use through implementation of improved management practices; development and use of crops and crop hybrids and varieties capable of improved nutrient uptake efficiency; and full accounting of nutrient applications through manure and other organic-based nutrient sources.

Support research critical for identifying GHG emissions associated with different nutrient management practices, and research identifying those practices leading to reduced net GHG emissions.

Policy Design

Goals:

- *Efficiency*—Increase the efficiency of fertilizer use (in terms of nitrogen applied/crop yield) by 10% by 2020.
- *Seasonally flooded areas*—Reduce nitrogen application by 50% on 50% of seasonally flooded areas by 2020.
- *Improved nutrient distribution*—Provide more of the state's cropland nitrogen requirements through improved distribution of natural and organic nitrogen sources (manures). Replace 10% of manufactured nitrogen sources through better manure distribution by 2020.

Timing: Most of these goals are currently being considered and implemented for economic reasons, i.e., nutrient credit for manure. However, not all operators receive the economic benefit of this investment. Reducing application to seasonally flooded areas will require additional technology capable of site-specific applications based on land form in addition to that from soil test maps.

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[2] The dilemma relative to nutrient management, N in particular, involves balances. For example, the Subcommittee (SC) is confident that mandating N application reductions would reduce N_2O emissions and GHG emissions associated with N manufacture. However, reduced rates would most likely result in lower yields, lower plant biomass production, and net loss of soil organic matter and carbon dioxide (CO_2) emissions. The science to understand the direction of change exists, but not the scientific capability to quantify these input and output values on a highly variable landscape in a changeable climate, and thus determine if given options would consistently result in winners or losers.

[3] Cover crops have been studied for decades with marginal advances, and at this time seem somewhat risky as a required target mandate for this group. Research investment is needed to develop cropping systems in which cover crops are complimentary to, rather than competitive with, the primary crop.

Parties Involved: Industry, scientists, and producers.

Other: None identified.

Implementation Mechanisms

Possible methods of increasing the efficiency (yield/nitrogen input) include:

- Incentives to encourage rapid adoption of new seed technologies that result in higher nitrogen utilization,
- Incentives for more soil testing,
- Support for educational efforts on nitrogen utilization and fertilization practices, and
- Incentives for more precision placement of nitrogen fertilizers.

Potential practices for reducing GHG emissions associated with manure handling and storage include, but are not limited to, manure composting (to reduce methane emissions) and improved methods for application of effluent to fields (for reduced N_2O emissions). Application improvements include incorporation into soil instead of surface spray/spreading.

Related Policies/Programs in Place

None identified.

Type(s) of GHG Reductions

N_2O: Reduced on-field application of nitrogen will reduce formation of N_2O. Reductions may also occur when nitrogen runoff and leaching are reduced, which leads to the formation and emission of N_2O.

CO_2: Reductions occur as soil carbon levels in crop soils are increased above business as usual (BAU) levels. Increasing the levels of carbon in soils indirectly sequesters carbon from the atmosphere.

Estimated GHG Reductions and Net Costs or Cost Savings

GHG Reduction Potential in 2012, 2020 (MMtCO$_2$e [million metric tons of carbon dioxide equivalent]): 0.1 and 0.6, respectively.

Net Cost per tCO$_2$e: $75.

Data Sources:

Efficiency—Annual N_2O emissions from synthetic fertilizer and manure applications were taken from the Iowa Inventory & Forecast (I&F).[4] The average reduction in fertilizer usage resulting from implementation of nutrient management practices (15%) was taken from a guidance

[4] See Table H-5 in Appendix H of the Iowa Inventory & Forecast (I&F).

document from the U.S. Environmental Protection Agency (EPA).[5] Cost information for synthetic fertilizers was taken from the U.S. Department of Agriculture (USDA) Economic Research Service (ERS).[6] The average cost of synthetic nitrogen fertilizers in the United States in 2007 was $370/ton. Information on United States and Iowa corn crops was used to estimate corn yields for 2005–2020.[7]

Seasonally flooded areas—Iowa State University (ISU) figures were used to determine the amount of wetlands in the state of Iowa.[8] Conservation Reserve Program (CRP) data were used to determine the amount of wetlands currently under cultivation in the state.[9]

Quantification Methods:

Nitrogen Efficiency

The GHG benefits of this option are quantified by calculating the CO_2e emissions/kilogram of nitrogen (kgN) applied in Iowa. This uses a figure for the nitrogen emissions from fertilizer (4.76 $kgCO_2e$/kgN applied), calculated from the Iowa I&F, which is then combined with a figure for the life-cycle emissions of nitrogen fertilizer (West and Marland, 2002).[10] A BAU projection is created for fertilizer use (assumes no growth in fertilizer use between 2005 and 2020) and corn production (from the Food and Agricultural Policy Research Institute database) through the year 2020. In order to increase efficiency (corn production and fertilizer use) by 10% under the policy scenario, fertilizer use is reduced compared to the BAU estimate. Costs were calculated on the basis of an estimate of the staffing, laboratory, and travel costs of creating an information program that would encourage better nutrient management ($500,000/year + start-up costs) and soil testing costs ($4.25/20-acre field, tested annually).[11] There were also cost savings in terms of reduced costs of nitrogen fertilizer. The assumed costs of fertilizer are based on the fuel prices,

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[5] U.S. Environmental Protection Agency. “Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters.” Table 2-14. Available at: http://www.epa.gov/owow/nps/MMGI/Chapter2/ch2-2c.html#Practices,

[6] U.S. Department of Agriculture, Economic Research Service. National Agricultural Statistics Service Table 7. "Average U.S. Farm Prices of Selected Fertilizers." Available at: http://www.ers.usda.gov/Data/FertilizerUse/Tables/Table7.xls.

[7] Food and Agricultural Policy Research Institute. "FAPRI 2008 U.S. and World Agricultural Outlook Database." National Corn Production. Available at: http://www.fapri.iastate.edu/tools/outlook.aspx.

[8] Iowa State University. National Wetlands Inventory. Available at: http://www.ag.iastate.edu/centers/iawetlands/NWIhome.html.

[9] U.S. Department of Agriculture, Conservation Reserve Program. Monthly Summary—March 2008. Available at: http://www.fsa.usda.gov/Internet/FSA_File/mar2008.pdf

[10] West, T.O., and Marland, G. 2001. "A Synthesis of Carbon Sequestration, Carbon Emissions and Net Carbon Flux in Agriculture: Comparing Tillage Practices in the United States." *Agriculture, Ecosystems & Environment* September 2002:91(1-3):217-232. Available at: http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T3Y-46MBDPX-10&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=4bf71c930423acddffbcef6d46d763c3.

[11] Personal communication with Richard Cruz and Natalia Rogovska. 8/8/08. It was assumed there were no costs associated with the increased labor that may result from enhanced soil testing in this option. This could vary, depending on the value of a particular farmer’s time and the length of time it takes to conduct annual soil tests.

and are shown in Table I-1-1.[12] Other methods, such as the use of cover crops, might also reduce the need for nitrogen applications, but that was not quantified in this analysis.

Table I-1-1. Costs and GHG reductions from nutrient management

Year	Fertilizer Used With Policies (tN)	Target Fertilizer Reduction (tN)	Annual Cost of Fertilizer Programs ($MM)	Fertilizer Price ($/t)	Avoided Cost of Fertilizer ($MM)	Net Cost ($MM)	Discounted Cost ($MM)	$MMtCO_2e$ Emissions Reductions
2011	1,026,896	10,269	$2.20	$404	–$4.15	$2.38	$1.78	0.06
2012	1,016,828	20,337	$1.95	$409	–$8.32	–$2.04	–$1.45	0.11
2013	1,006,956	30,209	$1.95	$410	–$12.40	–$6.12	–$4.14	0.17
2014	997,274	39,891	$1.95	$417	–$16.65	–$10.36	–$6.68	0.22
2015	987,776	49,389	$1.95	$428	–$21.16	–$14.87	–$9.13	0.28
2016	978,458	58,707	$1.95	$446	–$26.17	–$19.89	–$11.6	0.33
2017	969,313	67,852	$1.95	$471	–$31.93	–$25.65	–$14.3	0.38
2018	960,338	76,827	$1.95	$497	–$38.17	–$31.89	–$16.9	0.43
2019	951,528	85,637	$1.95	$523	–$44.78	–$38.49	–$19.4	0.48
2020	942,877	94,288	$1.95	$530	–$50.00	–$43.72	–$21.0	0.53
Total							**–$103**	**2.99**

tN = metric tons of nitrogen; $MM = million dollars; $/t = dollars per metric ton; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Seasonally Flooded Areas

The amount of farmable wetlands in Iowa was estimated by dividing the acres of farmable wetlands covered by the CRP by the number of acres of total wetlands under the CRP.[13] This percentage (51%) was then multiplied by the total amount of wetlands in Iowa, as estimated by ISU. These farmable acres (218,821) were then assumed to have fertilizer use similar to that of the state as a whole. These acres were divided by the total acres under cultivation in Iowa to determine what percentage of Iowa farmland is located in wetlands (0.7%), and then multiplied by the BAU estimates of fertilizer use created from the nitrogen efficiency quantification to determine the BAU fertilizer used on wetlands. This fertilizer use is then projected to decrease by 50% on half of the land in the state, or a 25% reduction overall by 2020. The GHG benefits of this are estimated on the basis of the reduced nitrogen fertilizer use multiplied by the CO_2e emissions per kgN applied, as described in the *Nitrogen Efficiency* quantification above (AFW-1 Nitrogen Efficiency). The costs of this program were estimated to be $30–$50/acre, mostly in

[12] Fertilizer costs come from analysis of fertilizer costs based on fuel prices, provided by Dave Miller. August 13, 2008.

[13] U.S. Department of Agriculture, Conservation Reserve Program. Monthly Summary—March 2008. Available at: http://www.fsa.usda.gov/Internet/FSA_File/mar2008.pdf.

extra labor, fuel, and capital costs for machinery upgrades to do the differential applications.[14] There were also cost savings in terms of reduced costs of nitrogen fertilizer (Table I-1-2).

Table I-1-2. Costs and GHG reductions from seasonally flooded areas

Year	Reduction Pathway	Acres Under Policy	Cost	Nitrogen Avoided (t)	Cost Savings	Discounted Cost (2005$)	Emissions Reductions ($MMtCO_2e$)
2008	1.00	0	$0	0	$0	$0	0.000
2009	1.00	0	$0	0	$0	$0	0.000
2010	1.00	0	$0	0	$0	$0	0.000
2011	1.02	8,753	$350,114	164	$66,224	$211,843	0.001
2012	1.04	17,506	$700,228	322	$131,538	$404,157	0.002
2013	1.06	26,259	$1,050,341	473	$194,194	$579,475	0.003
2014	1.08	35,011	$1,400,455	619	$258,379	$736,193	0.003
2015	1.10	43,764	$1,750,569	760	$325,516	$874,859	0.004
2016	1.13	56,893	$2,275,740	962	$428,744	$1,079,900	0.005
2017	1.16	70,023	$2,800,910	1,153	$542,641	$1,257,489	0.006
2018	1.19	83,152	$3,326,081	1,335	$663,182	$1,412,193	0.007
2019	1.22	96,281	$3,851,252	1,507	$788,159	$1,547,070	0.008
2020	1.25	109,411	$4,376,423	1,672	$886,560	$1,678,684	0.009
Total						**$9,781,863**	**0.048**

t = metric tons; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Improved Nutrient Distribution

Since this item involves reducing the amount of nitrogen fertilizers applied while keeping actual nitrogen application constant by using local manure applications, the GHG benefits take into account only the life cycle costs of nitrogen fertilizer. The GHG emissions from the application of nitrogen are assumed to remain constant under this policy. A BAU estimate of fertilizer use is created for the state, as described in the *Nutrient Efficiency* quantification (see AFW-1 Nitrogen Efficiency). BAU fertilizer use is then reduced by 10% by 2020. The amount of fertilizer saved is then multiplied by the life-cycle emissions of nitrogen fertilizer to determine the GHG benefits of this item. There are two types of manure costs factored into this analysis: (1) the physical cost of the manure, estimated at $0.30/pound (lb) of nitrogen;[15] and (2) transportation, which is estimated at $0.001/gallon/mile (gal/mi).[16] It is assumed that manure will be traveling an average of 15 miles to be distributed.[17] The manure in Iowa is assumed to be pig manure, since most of

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[14] Based on personal communication with Dave Miller, May 27, 2008.

[15] Agriculture Marketing Resource Center. "Valuing Manure Nutrients." http://www.agmrc.org/agmrc/business/operatingbusiness/valuingmanurenutrients.htm.

[16] Leibold, K., and T. Olsen. "Value of Manure Nutrients." *Odor and Nutrient Management*. Winter 2007. Iowa State Extension Service. Available at: http://www.extension.iastate.edu/pages/communications/epc/Winter06/valuemanurenutrients.html.

[17] Based on Personal Communication with Dave Miller, May 27, 2008.

the manure in the state is from pigs.[18] Pig manure has 38 lbs of N per 1,000 gal of manure,[19] so more than 58,000 gal are required to provide one metric ton of nitrogen (tN). These transportation and physical costs are added together to determine the gross cost of the nutrient distribution program, and the avoided fertilizer costs are subtracted from this to determine the net costs (Table I-1-3).

Table I-1-3. Nutrient distribution costs and GHG benefits

Year	Baseline Fertilizer Use (t)	Nitrogen Fertilizer Reduction (t)	$MMtCO_2e$ Saved	Purchase Cost of Manure	Transportation Cost of Manure	Fertilizer Costs Avoided	Total Cost of Program	Discounted Cost of Program
2010	1,037,165	0	0	$0	$0	$0	$0	$0
2011	1,037,165	11,148	0.01	$7,372,964	$9,701,269	$4,504,145	$12,570,088	$9,379,994
2012	1,037,165	22,381	0.02	$14,802,580	$19,477,079	$9,156,804	$25,122,856	$17,854,345
2013	1,037,165	33,704	0.03	$22,291,317	$29,330,680	$13,832,700	$37,789,298	$25,577,284
2014	1,037,165	45,120	0.04	$29,841,624	$39,265,294	$18,827,581	$50,279,338	$32,410,509
2015	1,037,165	56,633	0.05	$37,455,932	$49,284,121	$24,258,687	$62,481,366	$38,358,138
2016	1,037,165	68,246	0.06	$45,136,656	$59,390,337	$30,425,962	$74,101,031	$43,325,338
2017	1,037,165	79,963	0.07	$52,886,199	$69,587,104	$37,633,533	$84,839,771	$47,241,959
2018	1,037,165	91,788	0.08	$60,706,952	$79,877,568	$45,608,513	$94,976,006	$50,367,804
2019	1,037,165	103,724	0.09	$68,601,293	$90,264,860	$54,233,191	$104,632,963	$52,846,756
2020	1,037,165	115,775	0.10	$76,571,597	$100,752,102	$61,394,223	$115,929,476	$55,764,060
Total			**0.55**					**$373,126,188**

t = metric ton; MMtCO2e = million metric tons of carbon dioxide equivalent.

Key Assumptions:

Nitrogen Efficiency—It is assumed that it is possible to reduce fertilizer application without having a negative impact on crop yield. In order to do this, improved timing and efficiency of application are required.

It is assumed that no costs are associated with the increased labor that may result from enhanced soil testing in this option. This could vary, depending on the value of a particular farmer's time and the length of time it takes to conduct annual soil tests.

Key Uncertainties

Nutrient Distribution—The costs of nutrient distribution may change, depending on the distance the manure needs to be transported. If this program is successful in encouraging localized nutrient distribution, then costs will likely be lower.

[18] Iowa Inventory and Forecast Report.

[19] Lory, J.A., and R. Massey. "Using Manure as a Fertilizer For Crop Production." Available at: http://www.epa.gov/msbasin/taskforce/2006symposia/8ManureLory.pdf.

Changes in acreage and nutrients for the use of biomass or biofuels will most likely affect the level of nutrient application required. For example, if corn stover is removed for cellulosic ethanol (as is planned in AFW-6), then that plant material will not be providing nutrients when it decomposes back into the soil. This in turn may require increased fertilizer application to maintain the productivity of the soil.

In AFW-2, drainage of seasonally flooded areas is a goal. If this develops, reduced nitrogen application on 50% of seasonally flooded soils may not be necessary because these areas will more likely be productive a greater portion of the time. Thus, fully implementing this option in AFW-1 might be appropriate early in the program, but as the drainage option is implemented for AFW-2, it may be beneficial to scale back the nutrient reduction recommendations for seasonally flooded areas.

The fertilizer costs are based on an analysis provided by AFW Subcommittee member Dave Miller that predicts fertilizer prices by using natural gas prices, which come from the *Annual Energy Outlook 2008* (AEO 2008) (Early Release).[20] Fuel prices are difficult to predict, and if the prices used in AEO 2008 are not correct, then the estimates for fertilizer costs are also likely to be inaccurate.

Additional Benefits and Costs

Seasonally Flooded Areas—This serves to reduce the amount of nitrogen being applied to wetlands in the state. These areas may be of particular importance to biodiversity and environmental quality, but these benefits will be very difficult to measure.

Feasibility Issues

There may be barriers to start-up for a market for local manure products. Improved nutrient distribution will rely upon such a market to ensure that farmers will be able to sell their manure.

Status of Group Approval

Approved.

Level of Group Support

Majority (7 objections).

Barriers to Consensus

There were some concerns about the amount of GHG benefits and the cost per ton of GHGs reduced.

[20] Fuel cost (in dollars per million British thermal units [$/MMBtu]) come from Figure 1. Energy Prices 2006 $/MMBtu. See U.S. Department of Energy, Energy Information Administration. *Annual Energy Outlook 2008: With Projections to 2030.* DOE/EIA-0383(2008). Washington, DC, June 2008. Available at: http://www.eia.doe.gov/oiaf/aeo/prices.html.

AFW-2. Wetlands and Drainage

Policy Description

Over the next 50 years, the drainage infrastructure of 6 million acres within the Des Moines Lobe[21] of Iowa will undergo redesign and replacement because the existing common outlet drains are approaching the end of their life. These drainage systems can be redesigned with or without GHG considerations and water quality benefits. Designing to reduce nitrogen transport to water resources also reduces N_2O emissions in Iowa and downstream, with significant global GHG benefits over the longer term. This is due to the function of strategically targeted and designed denitrification wetland systems and the long life of both the wetlands and the drainage systems (≈125 years).

This policy option will implement the Iowa Integrated Drainage and Wetland Landscape Systems initiative for reducing N_2O emissions and nutrient transport to water resources from cropland subsurface drainage, to (1) protect in-state emissions and (2) reduce nutrients—nitrogen and phosphorus—transported to water resources.

Strategically located and designed denitrification wetlands reduce N_2O emissions by providing more complete denitrification to elemental nitrogen than if the nitrate were transported to downstream surface and groundwater systems where denitrification would at least partly occur. The denitrification wetlands provide the co-benefits of reducing nitrogen delivery to receiving water resources by 40%–90% from large contributing watersheds (500–4,000 acres) by denitrifying incoming nitrate (NO_3^-).

Redesign and replacement to increase the flow capacity of common outlet subsurface tile drains reduce N_2O emissions by reducing denitrification and N_2O emissions from wet and seasonally flooded croplands. Increased capacity drains provide the co-benefits of reducing phosphorus delivery to water resources by decreasing surface runoff and quick flow to streams. This reduces erosion, sediment transport, and phosphorus transport to streams.

Research: Additional research is needed to further quantify the GHG implications from N_2O, CO_2, and methane (CH_4) of:

- Subsurface drainage in agricultural croplands,
- Strategically located and designed nitrogen removal wetlands, and
- Denitrification in receiving streams and rivers.

Policy Design

Goals:

- During 2009–2012, implement approximately 5 pilot demonstration sites per year, for a total of 25 initial pilot demonstrations. Each pilot demonstration will be implemented in an Iowa drainage district having an average watershed drainage area of 2,400 acres.

[21] A watershed located in north-central Iowa drained mostly by the Des Moines, Raccoon, Iowa, and Skunk Rivers.

- During 2012–2020, following confirmation of benefits from monitoring and assessments of the initial 25 pilot demonstrations, complete 200 additional pilot demonstrations implemented in Iowa drainage districts.
- By 2050, achieve full implementation of the Iowa Integrated Drainage and Wetland Landscape Systems initiative across the 6 million acres of Iowa's 3,000 drainage districts.

Timing: Initial pilot demonstrations (up to 225 individual sites and drainage districts) will be deployed through 2020. Following confirmation of suitable benefits, full implementation is targeted across 3,000 drainage districts and 6 million acres of cropland during the 2020–2050 period. This policy option will achieve limited N_2O reductions 2009–2020, because activities conducted during that period will primarily be pilot demonstrations and assessments of pilot sites to confirm GHG, water quality, wildlife habitat, and other benefits. Adoption across the 6 million acres of land within Iowa's 3,000 existing drainage districts will occur during the 2020–2050 period, with significant N_2O reductions occurring during that period as well as during the remainder of the estimated 125-year life of the replacement systems. Widespread deployment of these integrated landscape systems by 2050 through voluntary initiatives is relatively ensured if this initiative goes forward, because the existing common outlet drains are nearing the end of design life and are subject to structural failure, necessitating replacement to avoid the economic loss of taking high-value land out of row-crop production.

Parties Involved: Public conservation agencies, research institutions, existing Iowa drainage districts, and private landowners.

Other: Combining nitrate-removal wetlands with drainage improvements through this voluntary Iowa initiative will reduce GHG emissions and reduce nitrate and phosphorus transport to water resources, thus protecting local drinking water supplies and reducing hypoxia in the Gulf of Mexico.

Implementation Mechanisms

Existing authorities of Iowa Drainage Districts codified in Iowa statutes. Existing USDA authorities and authorities of the Iowa Department of Agriculture and Land Stewardship (IDALS) to conduct the Iowa Conservation Reserve Enhancement Program (CREP), which will be the public funding partner to assist with implementation.

Existing federal laws and regulations are problematic for implementing integrated drainage and wetland landscape systems, because they have not encouraged the optimization of landscape function but are instead maintaining historically farmed wetlands, which are continuously cropped and highly degraded. While the environmental benefits and market economics are strong to optimize landscape function through redesign and replacement of the common outlet drains, implementation of this initiative is not ensured under current federal wetland regulations. Future federal wetland regulatory policy needs to focus on landscape optimization to improve wetland function and water quality, reduce GHG emissions, and enhance crop production.

The initiative capitalizes on the aging infrastructure of Iowa's drainage districts, now 80–90 years old, and the need to replace the drains. Environmental stewardship may help encourage the replacement of drains to reduce nitrogen and phosphorus in water resources, thus facilitating associated N_2O GHG reductions. The initiative also capitalizes on the enhanced economic returns of grain production to provide the private market-sector driver to implementation, largely the result of biofuels consumption of feed grains.

Following successful pilot demonstrations, the initiative will be implemented primarily through private (landowner) funds. Some public funding will be required for the initiative, for incentives for the initial pilot demonstrations, and for necessary assessments of the pilot sites.

Related Policies/Programs in Place

None identified.

Type(s) of GHG Reductions

N_2O: Reduced N_2O emissions through reduced denitrification in strategically located and designed denitrification wetlands and through improved subsurface drainage to reduce N_2O emissions in seasonally wet and flooded croplands.

CO_2: Conservation of wetlands helps maintain the ability of the land to sequester carbon in soil and biomass.

CH_4: Improved drainage reduces anaerobic decomposition, thereby preventing methane (CH_4) creation.

Estimated GHG Reductions and Net Costs or Cost Savings

GHG Reduction Potential in 2012, 2020 ($MMtCO_2e$): 0.007 and 0.16, respectively. Note that GHG reductions from full implementation across 6 million acres by 2050 are estimated at 1.8 $MMtCO_2e$/year and will continue over the estimated 125-year design life of the wetland and drainage systems.

Net Cost per tCO_2e: $218.

Preliminary quantification indicates approximately 31 $MMtCO_2e$ and –$2.4 billion costs (i.e., net cost benefit) over the 2009–2050 period. This results in a cost-effectiveness over the 2009–2050 period of approximately –$78/$tCO_2e$ (i.e., net cost savings).

Data Sources:

The quantification method was developed by a combination of the AFW Subcommittee members and external experts. The group responsible for the development of the analysis includes:

- Rick Cruse, Ph.D. Agronomy, ISU
- James Baker, Ph.D., Emeritus, Agricultural & Biosystems Engineering, ISU
- Bill Crumpton, Ph.D., Ecology & Evolutionary Biology, ISU
- Matt Helmers, Ph.D., Agriculture and Biosystems Engineering, ISU
- Dan Jaynes, Ph.D., Agricultural Research Service, National Soil Tilth Lab, ISU
- Dean Lemke, P.E., Chair, IDALS

Quantification Methods:

The quantification methods described below indicate modest benefits in the short term. The nature of this policy results in the delivery of significant benefits (e.g., GHG, water quality, and crop production) in the longer term (i.e., post-2050). Quantification estimates indicate that this option could result in 1.8 $MMtCO_2e$ GHG reductions by 2050. Additionally, the implementation of this policy has the potential to improve agricultural net income revenues by 7%–20% through improved drainage. The long payback period is due to the long life of the wetland and drainage systems (≈125 years).

Strategically Located and Designed Denitrification Wetlands

N_2O emission rates reported for wetlands receiving agricultural NO_3^- loads are approximately equivalent to rates reported for cultivated crops. This means that restoring wetlands on formerly cultivated cropland would have no significant net effect on N_2O emissions from the area restored to wetland.[22, 23] This also means that N_2O emissions from restored wetlands can be disregarded in calculating the net change in N_2O emissions for wetlands restored on former cropland.

From Mosier et al. (1998),[24] N_2O emissions from waters receiving nitrogen in agricultural leaching/runoff can be estimated as:

N_2O emissions = (kgN in leaching and runoff) × emission factor (EF)

Where EF = (0.025 kgN_2O-N)/(kgN in leaching and runoff)

and N_2O-N = the nitrogen component of N_2O

In a parallel fashion, the net downstream reduction in N_2O emissions due to nitrate removal in wetlands can be calculated as:

Reduction in N_2O emissions = (kgN removed in wetland) × EF

This product could be expected from the total mass of nitrate-nitrogen removed by the wetland and the emission factor (EF) for N_2O emission if the nitrate were removed by the wetland instead of being transported to surface water and groundwater systems downstream.

Table I-2-1 shows the mass reduction in N_2O emissions that could be expected for nitrate removal wetlands intercepting agricultural leaching/runoff from source areas of 6 million acres (with wetlands occupying 0.5%, 1.0%, and 2.0% of the total area; the size of the wetland is

[22] Upper Mississippi River Sub-basin Hypoxia Nutrient Committee. *Final Report: Gulf Hypoxia and Local Water Quality Concerns Workshop*, September 26-28, 2005. Available at: http://www.umrshnc.org/.

[23] EPA Science Advisory Board. 2007 *Hypoxia in the Northern Gulf of Mexico: An Update by the EPA Science Advisory Board*. EPA-SAB-08-004. Washington D.C.: U.S. Environmental Protection Agency, December 2007. Available at: http://www.epa.gov/msbasin/pdf/sab_report_2007.pdf.

[24] Mosier, A.R., C. Kroeze, C. Nevison, O. Oenema, S. Seitzinger, and O. Van Cleemput. "Closing the Global N_2O Budget: Nitrous Oxide Emissions Through the Agricultural Nitrogen Cycle." *Nutrient Cycling in Agroecosystems* 1998;52 (2-3):225-248. Available at: http://library.wur.nl/WebQuery/wurpubs/lang/336355.

dependent upon topography, because the systems are designed for gravity flow). Table I-2-1 includes:

- The estimated annual agricultural nitrate loading to receiving waters from 1.5 million to 6 million acres;
- The resulting N_2O emissions from receiving waters;
- The estimated nitrate reduction in wetlands intercepting agricultural loading from 1.5 million to 6 million acres with wetland areas of 0.5%, 1.0%, and 2.0% or the source area; and
- The reduction in N_2O emissions that could be expected for wetlands intercepting agricultural loading of 6 million acres with wetland areas of 0.5%, 1.0%, and 2.0% or the source area.

Table I-2-1. Nitrogen loading and reduction for 6-million-acre source area

Wetland/Watershed Ratio (%)	NO_3^--N Load From Catchment (t/year)	N_2O-N Emissions Based on Load From Catchment (t/year)	NO_3^--N Mass Removal in Wetlands (t/year)	Reduction in N_2O-N Emissions Due to NO_3^--N Removal in Wetlands (t/year)
0.5	90,069	2,252	28,918	722
1.0	90,069	2,252	45,107	1,128
2.0	90,069	2,252	70,360	1,759

NO_3^--N = nitrate-nitrogen; t/year = metric tons per year; N_2O-N = nitrous oxide-nitrogen.

Wetlands occupying 0.5%–2% of the 1.5–6-million-acre source areas could be expected to reduce N_2O emissions from waters receiving nitrogen in agricultural leaching/runoff from those source areas by approximately 32%–78% compared to emissions if the wetlands did not exist.

Increased Capacity of Common Outlet Subsurface Drainage

Hofstra and Bouwman (2005)[25] estimated N_2O emissions from agricultural soils and the impacts of drainage. They reviewed 336 experiments from around the world that measured N_2O emissions from various combinations of soils, crops, and fertilizers. They developed a meta-model from those results that can be used to predict annual N_2O emissions based on four factors—drainage, nitrogen fertility rate, crop type, and method of measurement.

Based on soil survey information, it was estimated that about 68% of the soils in the Des Moines Lobe are somewhat poorly drained or wetter soils that need tile drainage. The remaining 32% were estimated to be soils that do not need tile drainage. For the integrated drainage wetland systems, it was estimated that the poorly drained and wetter soils would be artificially drained, such that they would have emissions rates similar to the soils that are assumed to not need tile drainage. The open-chamber method[26] with upland soils and a nitrogen application rate of 150–

[25] Hofstra, N., and A.F. Bouwman. "Denitrification in Agricultural Soils: Summarizing Published Data and Estimating Global Annual Rates." *Nutrient Cycling in Agroecosystems* July 2005;72(3):267-278. Available at: http://www.springerlink.com/content/l1122nh244525022/.

[26] An open dynamic chamber is a widely used method for soil CO_2 efflux measurements.

225 lb/acre was used to estimate denitrification or N_2O emissions (Hofstra and Bouwman, 2005). The overall N_2O emissions, with 68% of the soils considered to have poor drainage and 32% of the soils considered to have good drainage, were compared to a condition where 100% of the soils was considered to have good drainage. The N_2O emissions were estimated to be 3.86 kg/hectare (ha)/year from the soils with good drainage and 6.22 kg/ha/year for the soils with poor drainage.

The combined effect of wetland denitrification and increased capacity for subsurface drainage is about 0.16 $MMtCO_2e$ in 2020. The GHG benefits greatly improve after the demonstration phase, and are projected to increase to approximately 1.79 $MMtCO_2e$ annually beginning in 2050.

On the cost side, there are two main cost components:

1. Implementation costs associated with the additional cost required for land acquisition, engineering, construction, seeding, and engineering for and construction of new drains; and
2. Cost savings gained through increased income from improved crop production resulting from the enhanced drainage.

The implementation costs are broken down in Table I-2-2.

Table I-2-2. Additional wetland improvement implementation costs under policy

Implementation Cost Components	Cost ($/watershed acre)
Denitrification wetland	$440
Construction of new drains	$120
Engineering for new drains[27]	$0
Total	**$560**

As a result of improving the wetlands within Iowa, there is the potential to increase crop yield by 7%–20% watershed-wide, which in turn provides potential cost savings for the implementation of this option. This analysis assumes an average crop yield improvement of 10% (compared to BAU) on 77% of the watershed (i.e., 7.7% total improvement). The analysis further assumes that 55% of watershed acres are in corn production, while 45% are in soybean production. It is assumed that current crop production is approximately 190 bushels/acre for corn (current price is approximately $5.00/bushel) and 55 bushels/acre for soybeans (current price is approximately $10.00/bushel). While commodity prices are uncertain and volatile, they are used to provide estimates of the potential benefits that result from improved drainage. These assumptions indicate an average income increase of $59.29/watershed acre/year over the 125-year design life of wetlands and drains.

The results shown in Table I-2-3 indicate the net costs over the period 2009–2020. However, significant benefits (both GHG and cost) are realized post-2020. Preliminary quantification

[27] It is assumed that drain engineering costs would not result in additional costs for this policy, as much of the these costs would be incurred through business as usual drainage management.

indicates approximately 31 $MMtCO_2e$ and –\$2.4 billion costs (i.e., net cost benefit) over the 2009–2050 period. This results in a cost-effectiveness of approximately –\$78/tCO_2e (i.e., net cost savings) over the 2009–2050 period.

Table I-2-3. Approximate implementation costs of AFW-2

Year	Approximate Cumulative Acres From Goal	Income (Cost Benefits) From Improved Drainage Management	Implementation Cost	Total Net Costs
2009	—	$0	$0	$0
2010	20,000	–$1,024,339	$9,674,981	$8,650,642
2011	40,000	–$2,048,677	$9,674,981	$7,626,304
2012	60,000	–$3,073,016	$9,674,981	$6,601,965
2013	120,000	–$6,146,032	$29,024,943	$22,878,912
2014	180,000	–$9,219,048	$29,024,943	$19,805,896
2015	240,000	–$12,292,063	$29,024,943	$16,732,880
2016	300,000	–$15,365,079	$29,024,943	$13,659,864
2017	360,000	–$18,438,095	$29,024,943	$10,586,848
2018	420,000	–$21,511,111	$29,024,943	$7,513,832
2019	480,000	–$24,584,127	$29,024,943	$4,440,816
2020	540,000	–$27,657,143	$29,024,943	$1,367,800
Total		**–$141,358,730**	**$261,224,490**	**$119,865,760**

Key Assumptions:

This analysis assumes (1) a crop yield improvement of 7.7%, and (2) 55% of the watershed produces corn, while 45% produces soybeans.

Key Uncertainties

The impacts on carbon formation (CO_2 and CH_4) were considered in the analysis, but not in sufficient detail to be certain of the overall impacts. However, it was determined that the changes in CO_2 and CH_4 emissions are likely to be less than the changes seen in N_2O. Given that the global warming potential (as a CO_2 equivalent) for N_2O is more than 10 times that of CH_4 and more than 300 times that of CO_2, the emission changes from these gases are not likely to be significant. Formation of CH_4 occurs at greater rates in warmer areas, whereas colder weather is more conducive to the formation of N_2O in wetlands.

Research is necessary to reduce the uncertainties in carbon and methane fluxes in wetlands and to provide better information on appropriate management techniques and the potential for GHG emissions savings through effective management, restoration, and conservation of wetlands.

Additional Benefits and Costs

In addition to the public-sector costs to help with implementation, enhanced crop yields are expected to increase net income to landowners as a secondary result of improving capacity of subsurface drainage to reduce surface runoff, quick flow, and sediment-borne phosphorus to water resources. Crop yield improvements have been predicted by previous studies to be between

7% and 20% annually, estimated at 8% for this analysis. Minor public-sector funding will be needed to help with implementation, and public funding will be needed especially to seed the initial pilot demonstrations. However, upon full implementation, the total net returns beyond expenditures are expected to be positive.

Improved wetland function and value will likely have additional benefits from improved ecosystem services. Ecosystem services, such as carbon sequestration, air purification, water filtration and cooling, nutrient storage and cycling, storm and flood damage protection, and hydrologic regime maintenance are all provided in high-value wetlands and other natural lands.[28] They also serve as vital habitat for wild species, maintain a vast genetic library, provide scenery, and contribute in many ways to human health and quality of life.

Quantification estimates indicate that this option could deliver 1.8 $MMtCO_2e$ in GHG reductions by 2050.

Feasibility Issues

None identified.

Status of Group Approval

Approved.

Level of Group Support

Super Majority (5 objections).

Barriers to Consensus

There were some concerns over the short-term GHG benefits and the cost per ton of GHGs reduced.

[28] Costanza, R., et al. "The Value of the World's Ecosystem Services and Natural Capital." *Nature* May 15, 1997;387:253-260. Available at: http://www.nature.com/nature/journal/v387/n6630/abs/387253a0.html.

AFW-3. Expanded Use of Agriculture and Forestry Biomass Feedstocks for Electricity, Heat, or Steam Production

Policy Description

Increase the amount of biomass (including biomass from forest sources) available for co-generation of electricity or for use in combined heat and power (CHP) applications to displace the use of fossil energy sources, recognizing that local electricity or heat production yields the greatest net energy and carbon displacement payoff. Increase the acreage and the yield of energy crop production and utilization through the planting of energy-purpose crops.

Note that this option is focused on the supply-side aspects of promoting biomass fuel, with an emphasis on the development of feedstocks, collection, processing, and transport technologies. The demand-side aspects of renewable fuels (including biomass use) are being addressed through the CRE options (CRE-13: Pricing Strategies To Promote Renewable Energy, and CRE-2: Technology Initiatives).

Policy Design

Goals:

- *Energy crop*—Annually harvest at least 5 million dry tons of dedicated materials for energy crop production by 2020, which includes establishing 1 million acres of identified energy crop production by 2020, transitioning 50% of expiring CRP contracts to energy crop production.
- *Agriculture crop residue*—Annually harvest at least 10 million tons of crop residue biomass for energy production by 2020.
- *Forest biomass*—Annually harvest at least 75% of available forest products or wood residues for biomass energy production by 2020.
- *Biomass energy plant*—Have at least one major industrial operation contracting with producers to use biomass as the primary energy source for plant operations by 2015 [unquantified].
- *Biofuels energy plant*—Have at least one biofuels production plant contracting with producers to use biomass as the primary energy source by 2015 [unquantified].

Timing: As stated above.

Parties Involved: Farmers, landowners, and energy producers.

Other: None identified.

Implementation Mechanisms

Incentive Programs

- Section 476C tax incentives.

- State and federal cost-share programs for energy crop establishment.
- USDA value-added agriculture development grants.
- Federal Renewable Fuel Standard.
- Cellulosic fuel requirement standards and incentives.
- Research funding.
- State fuel standards and incentives.

Incentives and/or mechanisms are required to promote the collection and distribution of biomass feedstocks and to encourage the location of energy facilities close to the source of the biomass feedstock.

Biomass Delivery Supply Chain

There is a need to streamline the biomass delivery supply chain from biomass producer through to energy facility. Iowa currently does not have a well-established delivery supply chain for forest biomass as an energy feedstock. A study needs to be undertaken to analyze how to selectively harvest and deliver biomass products in a manner that is beneficial to local ecosystems, is economically feasible, and reflects responsible land use. That study needs to involve a wide range of stakeholders, including foresters, conservationists, environmental organizations, industry, and local governments. A system for evaluating and determining where and how to begin harvesting forest biomass as an energy feedstock also needs be developed and implemented.

Related Policies/Programs in Place

Section 476C of the Iowa Code provides for a renewable energy tax credit for biomass and other qualifying renewable energy sources used to generate electricity or heat for a commercial purpose.

A producer or purchaser of renewable energy may receive renewable energy tax credits under Section 476C in an amount equal to $0.015 per kilowatt-hour (kWh) of electricity, or $4.50/MMBtu of heat for commercial purposes, or $4.50/MMBtu of methane gas or other biogas used to generate electricity, or $1.44/1,000 cubic feet of hydrogen fuel generated by and purchased from an eligible renewable energy facility.

Alternative Energy Law (Iowa's Renewable Portfolio Standard): Iowa requires its two investor-owned utilities—MidAmerican Energy and Alliant Energy Interstate Power and Light (IP&L)—to contract for a combined total of 105 megawatts (MW) of their generation from renewable energy resources.

Fuel Mix Disclosure: Iowa's rate-regulated electric utilities must report annually to customers the percentage mix of fuel and energy used to produce electricity. The percentages for renewables must be further broken down into percentages of electricity generated by wind, solar, hydropower, biomass, and other resources. Each utility's annual report must also include an estimate of sulfur dioxide (SO_2), nitrogen oxides (NO_x), and CO_2 emissions for each fuel and resource.

Energy Research Grants: The Iowa Energy Center (IEC) provides grants for energy research on topics that have strong relevance to Iowa.

Type(s) of GHG Reductions

CO_2, N_2O, CH_4: Displaces emissions from fossil fuel combustion.

Estimated GHG Reductions and Net Costs or Cost Savings

GHG Reduction Potential in 2012, 2020 ($MMtCO_2e$): 4 and 20, respectively.

Net Cost per tCO_2e: $38.

Data Sources:

- Milbrandt, A. December 2005. *A Geographic Perspective on the Current Biomass Resource Availability in the United States*, Technical Report NREL/TP-560-39181, prepared under Task No. HY55.2200.
- Princeton Energy Resources International, LLC, and Exeter Associates, Inc. *The Potential for Biomass Cofiring in Maryland.* DNR 12-2242006-107; PPES-06-02. Annapolis, MD: Maryland Department of Natural Resources, Maryland Power Plant Research Program, March 2006. Available at: http://esm.versar.com/PPRP/bibliography/PPES_06_02/PPES_06_02.pdf.
- U.S. Department of Energy, Energy Information Administration. "Average Heat Content of Selected Biomass Fuels." Table 10 Annual Electric Generator. April 2008. Available at: http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/table10.html.
- Oak Ridge National Laboratory. Table A2: "Approximate Heat Content of Selected Fuels for Electric Power Generation." Available at: http://cta.ornl.gov/bedb/appendix_a/Approximate_Heat_Content_of_Selected_Fuels_for_Electric_Power_Generation.xls.

Quantification Methods:

GHG Benefit

This analysis focuses on the incremental GHG benefits associated with the utilization of additional biomass to offset the consumption of fossil fuels. The analysis assumes that biomass will be used to replace coal in the RCI sectors and the electricity sector (where coal represents about 82% of electricity generated in Iowa).[29]

The GHG benefits were calculated by the difference in emissions associated with each of the input fuels (0.0959 tCO_2e/MMBtu for sub-bituminous coal, 0.0539 tCO_2e/MMBtu for natural gas, and 0.0019 tCO_2e/MMBtu for biomass, including non-methane and non-N_2O emissions).[30]

[29] Based on eGRID data: coal 82%, nuclear 11%, oil 0.3%, natural gas 2%, wind 2%, biomass 0.3%.

[30] Emission factors obtained from CCS energy fuel emission factors.

The amount of biomass utilized by each of the three components (agriculture, forest, and energy crops) is illustrated in Tables I-3-1, I-3-2, and I-3-3. These tables also show the corresponding GHG benefits for each of the components.

Table I-3-1. GHG benefits from agriculture crop residue

Year	Percent of Utilization	Agriculture Crop Residue Feedstock (dry tons)	Agriculture Crop Residue Feedstock (MMBtu)*	Avoided Emissions Agriculture Residue ($MMtCO_2e$)
2009	7%	714,286	9,214,286	0.866
2010	14%	1,428,571	18,428,571	1.73
2011	21%	2,142,857	27,642,857	2.60
2012	29%	2,857,143	36,857,143	3.47
2013	36%	3,571,429	46,071,429	4.33
2014	43%	4,285,714	55,285,714	5.20
2015	50%	5,000,000	64,500,000	6.06
2016	60%	6,000,000	77,400,000	7.28
2017	70%	7,000,000	90,300,000	8.49
2018	80%	8,000,000	103,200,000	9.70
2019	90%	9,000,000	116,100,000	10.9
2020	100%	10,000,000	129,000,000	12.1
Cumulative				**72.8**

MMBtu = million British thermal units; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

* Agriculture residue heat content is assumed to be 12.9 MMBtu/ton (low end of range = 6,450–7,300 Btu/lb); from Scurlock J., "Bioenergy Feedstock Characteristics," Oak Ridge National Laboratory (ORNL); available at: http://bioenergy.ornl.gov/papers/misc/biochar_factsheet.html.

Table I-3-2. GHG benefits from forestry biomass

Year	Percent of Utilization	Forest Biomass Feedstock (dry tons)	Forest Biomass Feedstock (MMBtu)*	Avoided Emissions From Forest Biomass Feedstocks ($MMtCO_2e$)
2009	6%	48,938	685,125	0.064
2010	13%	97,875	1,370,250	0.129
2011	19%	146,813	2,055,375	0.193
2012	25%	195,750	2,740,500	0.258
2013	31%	244,688	3,425,625	0.322
2014	38%	293,625	4,110,750	0.386
2015	44%	342,563	4,795,875	0.451
2016	50%	391,500	5,481,000	0.515
2017	56%	440,438	6,166,125	0.579
2018	63%	489,375	6,851,250	0.644
2019	69%	538,313	7,536,375	0.708
2020	75%	587,250	8,221,500	0.773
Cumulative				**5.02**

MMBtu = million British thermal units; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

* Forest biomass heat content is assumed to be 14 MMBtu/ton, which is the midpoint (7,000 Btu/lb) of the range of 6,000–8,000 Btu/lb for solid wood products; from "Heat Content of Selected Fuels," Oak Ridge National Laboratory (ORNL); available at: http://cta.ornl.gov/bedb/appendix_a/Approximate_Heat_Content_of_Selected_Fuels_for_Electric_Power_Generation.xls

Table I-3-3. GHG benefits from dedicated energy crops

Year	Percentage of Utilization	Total Dedicated Energy Crop Available (dry tons)	Total Dedicated Energy Crop Available (MMBtu)*	Avoided Emissions, Energy Crops ($MMtCO_2e$)
2009	4%	200,000	2,936,400	0.276
2010	6%	300,000	4,404,600	0.414
2011	8%	400,000	5,872,800	0.552
2012	10%	500,000	7,341,000	0.690
2013	21%	1,062,500	15,599,625	1.47
2014	33%	1,625,000	23,858,250	2.24
2015	44%	2,187,500	32,116,875	3.02
2016	55%	2,750,000	40,375,500	3.79
2017	66%	3,312,500	48,634,125	4.57
2018	78%	3,875,000	56,892,750	5.35
2019	89%	4,437,500	65,151,375	6.12
2020	100%	5,000,000	73,410,000	6.90
Cumulative				**35.4**

MMBtu = million British thermal units; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

* Energy heat content is assumed to be 14.7 MMBtu/ton (7,341 Btu/lb for switchgrass); from "Heat Content of Selected Fuels," Oak Ridge National Laboratory (ORNL), available at: http://cta.ornl.gov/bedb/appendix_a/Approximate_Heat_Content_of_Selected_Fuels_for_Electric_Power_Generation.xls

Costs

The two main components to the cost calculation are fuel and capital. The fuel component is based on the difference in costs between supply of biomass fuel and the assumed fossil fuel that it is replacing (i.e., coal). The assumed costs of biomass are identified in Table F-3-4. Delivered coal fuel cost ($/MMBtu) were taken from AEO 2008 (http://www.eia.doe.gov/oiaf/aeo/prices.html).

The cost of implementing this policy option is estimated by assuming the replacement of coal with biomass. The difference in cost of feedstock supply between biomass and coal is calculated using the costs outlined in Table I-3-4. The difference in costs (dollars per million British thermal units [$/MMBtu]) is multiplied by the amount of coal energy (MMBtu) being replaced by biomass. The assumed incremental capital costs are based on the capital costs associated with establishing a biomass plant compared with establishing a coal plant. Capital, operational, and maintenance costs were taken from Table 38 of AEO 2007. While use of biomass may be pursued through other technology types (e.g., gasification) or end uses (e.g., heat or steam), this methodology was used to provide an estimate of possible capital costs required to enable the utilization of biomass. (Table I-3-5)

Table I-3-4. Assumed costs of feedstocks

Fuel Type	Cost $/Ton Delivered	Heat Content (MMBtu/ton)	Cost $/MMBtu Delivered
Agricultural by-products*	$74	12.9	$5.76
Energy crop (switchgrass)†	$136	14.7	$9.29
Forest residue‡	$70	14.0	$4.98

MMBtu = million British thermal units.

* Price of agriculture residue from ISU Extension publication "Estimating a Value for Corn Stover," Ag Decision maker File A1-70, December 2007. Additional transportation costs of $14.75 were assumed; low end of range = 6,450–7,300 Btu/lb.; Duffy, Mike. "Estimated Costs for Production, Storage and Transportation of Switchgrass," Ag Decision Maker File A1-22. Iowa State University Extension. February 2008. Available at: http://www.extension.iastate.edu/agdm/crops/html/a1-22.html. Heat content from Scurlock J. "Bioenergy Feedstock Characteristics." Oak Ridge National Laboratory (ORNL): http://bioenergy.ornl.gov/papers/misc/biochar_factsheet.html.

† Cost of energy crop from Duffy 2008, cited above. Heat Content of Selected Fuels, ORNL (7,341 Btu/lb), http://cta.ornl.gov/bedb/appendix_a/Approximate_Heat_Content_of_Selected_Fuels_for_Electric_Power_Generation.xls. A profit margin of 20% was added to the $114/ton to estimate the price paid by the end-user and includes transportation costs of $14.75 per ton.

‡ Forest Residue costs come from personal communications with Bill Johnson (Alliant Energy) on August 7 2008. Forest residue prices range between $40 and $70 per dry ton, excluding transportation. The average of $55/ton was assumed with an additional transportation cost of $14.75, taken from Duffy 2008, cited above. Assumed heat content was taken from ORNL, Heat Content of Selected Fuels (6,000–8,000 Btu/lb for solid wood products), http://cta.ornl.gov/bedb/appendix_a/Approximate_Heat_Content_of_Selected_Fuels_for_Electric_Power_Generation.xls.

Table I-3-5. Summary of costs

Year	Total Biomass Utilization* (MMBtu)	Approximate Cumulative Capacity (MW)	Annualized Capital Costs† (2005$)	Estimated Additional Variable Operational and Maintenance Costs‡ (2005$)	Estimated Additional Fixed Operational and Maintenance Costs§ (2005$)	Fuel Costs* (2005$)	Discounted Costs (2005 $MM)
2009	12,835,811	193	$6,392,849	–$1,930,197	$4,689,283	$55,459,894	$64.6
2010	24,203,421	365	$12,054,463	–$3,639,612	$4,152,908	$95,573,110	$108
2011	35,571,032	536	$17,716,078	–$5,349,027	$4,152,908	$132,123,392	$149
2012	46,938,643	707	$23,377,693	–$7,058,443	$4,152,908	$165,309,560	$186
2013	65,096,679	981	$32,421,264	–$9,788,974	$6,633,642	$232,278,175	$262
2014	83,254,714	1,255	$41,464,836	–$12,519,506	$6,633,642	$291,654,738	$327
2015	101,412,750	1,528	$50,508,408	–$15,250,038	$6,633,642	$345,871,906	$388
2016	123,256,500	1,858	$61,387,642	–$18,534,812	$7,980,137	$404,272,568	$455
2017	145,100,250	2,187	$72,266,876	–$21,819,586	$7,980,137	$454,954,296	$513
2018	166,944,000	2,516	$83,146,110	–$25,104,361	$7,980,137	$497,890,112	$564
2019	188,787,750	2,845	$94,025,344	–$28,389,135	$7,980,137	$537,903,724	$612
2020	210,631,500	3,174	$104,904,578	–$31,673,910	$7,980,137	$571,964,340	$653
Cumulative							**$4,281**

MMBtu = million British thermal units; MW = megawatt; $MM = million dollars.

* Agriculture residue, forest feedstocks, and energy crops.

† Capital costs were taken from Table 39 of AEO 2007, available at: http://www.eia.doe.gov/oiaf/aeo/assumption/pdf/electricity.pdf

‡ Variable operational and maintenance costs were taken from Table 38 of AEO 2007, available at: http://www.eia.doe.gov/oiaf/aeo/assumption/pdf/electricity.pdf

§ Fixed operational and maintenance costs were taken from Table 38 of AEO 2007, available at: http://www.eia.doe.gov/oiaf/aeo/assumption/pdf/electricity.pdf

Key Assumptions:

The capital infrastructure life span is assumed to be 30 years, and the interest rate is assumed to be 5%, giving a capital recovery factor of 0.065 (i.e., a $1 million plant is assumed to cost approximately $65,000 per year over the life of the project).

The fuel mix being replaced by biomass is assumed to be 100% coal. Biomass is assumed to have a reduction of 0.0940 tCO_2e/MMBtu when replacing coal combustion.

While energy production from biomass may be pursued through a range of technology types (e.g., co-firing, gasification, or direct firing) or end uses (e.g., electricity, heat, or steam), the capital costs from AEO 2008 were used to provide an estimate of possible capital costs required to enable the utilization of biomass. The capital costs associated with using biomass as an alternative to fossil-based generation are dependent on many factors, including the end use (i.e., electricity, heat, or steam), the design and size of the systems, the technology employed, and the configuration specifications of the system. Each system implemented under this policy would require a detailed analysis (incorporating specific engineering design and cost aspects) to provide a more accurate cost estimate for the system.

Revenue from the production tax credit[31] was not included in this analysis. While this tax credit may be available to systems put into place prior to January 1, 2012, it is not included in this analysis to reflect the true cost of implementation.

Key Uncertainties

Availability, collection, and distribution will be key issues that will affect the implementation of this option, particularly on the cost side. Collection and distribution are particularly important for the utilization of agriculture and forest residues.

Additional Benefits and Costs

Biochar—Biochar is a by-product of certain thermochemical energy production processes. The application of biochar to crop fields is believed increase both soil productivity and soil carbon levels. The land application of biochar should be conducted, even though the level of GHG benefits is not fully understood and additional research is required.

Any biomass produced, sold, and used under this option allows for funds to remain within Iowa, unlike other energy feedstocks (e.g., coal and natural gas), which require that payments be made to the state from which that feedstock is sourced.

If implemented correctly, the production of energy crops can provide watershed benefits.

[31] Section 476C of the Iowa code provides for a renewable energy tax credit, which includes biomass. The production tax credit is equal to $4.50/MMBtu of methane gas. This tax credit is available to biogas recovery facilities (anaerobic digester systems), that were placed into service on or after July 1, 2005, and before January 1, 2012.

Feasibility Issues

The sustainability of utilizing forest residue from harvesting operations could reduce the feasibility of this option. The forest residue data for the National Renewable Energy Laboratory (NREL) report were derived from the USDA Forest Service's (USFS's) Timber Product Output database for 2002. Under forest residue, NREL included logging residues and other removals, defined as "the unused portions of trees cut, or killed by logging, and left in the woods." Other removals would be trees cut or otherwise killed by cultural operations (e.g., pre-commercial thinning, weeding) or land clearings and forest uses that are not directly associated with high-quality wood product harvests. It is likely that 75% utilization is achievable from a sustainability perspective, but may be less feasible from an economic perspective.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

AFW-4. Encourage Large-Scale Manure/Methane Management Capture Utilization

Policy Description

This policy option reduces methane emissions from livestock manure by installing (1) large-scale anaerobic digester systems at locations that can service multiple concentrated animal feeding operations (CAFOs) and (2) anaerobic digester systems at larger individual CAFOs.

Methane captured from the digesters is used to create heat or power, which offsets fossil fuel-based energy production and the associated GHG emissions. This option is focused on implementing these projects on a large scale (e.g., community-based systems or large CAFOs).

Policy Design

Goals:

- *Utilization*—By 2020, utilize 50% of available methane from livestock manure (primarily dairy, swine, and poultry) for renewable electricity, heat, and steam generation or incorporation into natural gas distribution systems.
- *Management*—By 2020, apply improved manure handling and storage practices on 50% of manure generated.

Timing: As stated above.

Parties Involved: Landowners, farmers, energy producers, and energy users.

Other: None identified.

Implementation Mechanisms

Reduce GHG emissions associated with manure handling and storage. Potential practices include manure composting (to reduce methane emissions) and improved methods for application of effluent to fields (for reduced N_2O emissions). Application improvements include incorporation into soil instead of surface spray/spreading.

Other implementation mechanisms include tax incentives, grants, and loan guarantees.

Related Policies/Programs in Place

Section 476C of the Iowa Code provides for a renewable energy tax credit for biomass and other qualifying renewable energy sources used to generate electricity or heat for commercial purposes.

A producer or purchaser of renewable energy may receive renewable energy tax credits under Section 476C in an amount equal to $0.015/kWh of electricity, or $4.50/MMBtu of heat for commercial purposes, or $4.50/MMBtu of methane gas or other biogas used to generate electricity, or $1.44/1,000 cubic feet of hydrogen fuel generated by and purchased from an eligible renewable energy facility.

Alternate Energy Revolving Loan Program: The IEC provides zero-percent interest loans for up to half the project cost, or a maximum of $250,000 (http://www.energy.iastate.edu/AERLP/index.htm).

Energy Research Grants: The IEC provides grants for energy research on topics that have strong relevance to Iowa (http://www.energy.iastate.edu/Funding/gp-research.htm).

Alternative Fuel Production Loans: The Value-Added Agricultural Products and Processes Financial Assistance Program offers a combination of forgivable and traditional low-interest loans for business projects involving the production of biomass or alternative fuels (http://www.iowalifechanging.com/business/vaapfap.html)

IA DNR Anaerobic Digestion Outreach Program: Recognizing the enormous opportunity for the wide-scale implementation of farm-scale and community-based anaerobic digester systems in Iowa, the IA DNR Energy and Waste Management Bureau set about promoting the digester concept to Iowa communities having substantial concentrations of livestock production, considerable volumes of organic wastes, and numerous energy users.

Type(s) of GHG Reductions

- **CO_2, N_2O, CH_4:** Displaces emissions from fossil fuel combustion.
- **CH_4:** Capture and utilization of or preventing the creation of methane.
- **N_2O:** Reductions occur when nitrogen runoff and leaching are reduced, which leads to the formation and emission of N_2O.

Estimated GHG Reductions and Net Costs or Cost Savings

Table I-4-1. GHG reduction potential in 2012, 2020 ($MMtCO_2e$) and net cost per tCO_2e

Quantification Factors	2012	2020	Net Cost Per tCO_2e
Methane management capture utilization	0.8	2.6	$4
Manure management	0.2	0.7	–$8

tCO_2e = metric tons of carbon dioxide equivalent.

Data Sources: As indicated in the methodology below.

Quantification Methods:

Utilization GHG Benefits

Methane emissions (in $MMtCO_2e$) data from the I&F were used as the starting point to estimate the GHG benefits of utilizing the volumes of methane targeted by the policy and to add in the additional benefit of electricity generation using this captured methane (through offsetting fossil-based generation). The first portion of GHG benefit is obtained from reduced methane emissions by capturing emissions from manure and poultry litter.[32] An assumed collection efficiency of 75%[33] is applied to methane emissions from manure and poultry litter, which is then multiplied by the assumed policy target ramping up to achieve 50% utilization by 2020.

The second portion of the GHG benefit is from offsetting fossil fuels—either natural gas displacement or the displacement of fossil-based electricity generation. It was assumed that 50% of the methane available would be utilized to offset natural gas, and 50% would offset electricity. To estimate the electricity produced, the methane captured in each year was converted to its heat content (Btu) and then multiplied by a natural gas heat rate of 11,664 Btu/kWh.[34] The CO_2e associated with this amount of electricity in each year is estimated by converting the kWh to megawatt-hours (MWh) and then multiplying this value by the electricity emission factor taken from the EEC Subcommittee (Table I-4-2).

Table I-4-2. GHG emission factor for electricity displacement

Year	Electricity Displacement Emission Factor
2008	0.490
2009	0.471
2010	0.467
2011	0.466
2012	0.464
2013	0.717
2014	0.713
2015	0.705
2016	0.704
2017	0.703
2018	0.694
2019	0.694
2020	0.692

The total GHG benefit is estimated as the sum of both portions of the benefit described above and is summarized in Table I-4-3.

[32] While this analysis assumes that methane is captured and utilized from poultry litter, it is probably more likely that energy is obtained through the direct firing of poultry litter (rather than through methane collection).

[33] The collection efficiency is an assumed value based on engineering judgment. No applicable studies were identified that provided information on methane collection efficiencies achieved using manure digesters (as it relates to collection of entire farm-level emissions).

[34] U.S. Department of Energy, Energy Information Administration. Table A.6: Average heat rates by prime mover and energy source. Available at: http://www.eia.doe.gov/cneaf/electricity/epa/epata6.html.

Table I-4-3. GHG reductions from methane utilization

Year	Methane Emissions From Dairy, Swine, and Poultry ($MMtCO_2e$)	Policy Utilization Objective	Methane Captured and Utilized Under Policy ($MMtCO_2e$)	$MMtCH_4$	$MMBtuCH_4$	CO_2e Offset as Electricity ($MMtCO_2e$)	CO_2e Offset as Natural Gas Displacement ($MMtCO_2e$)	Total Emission Reductions ($MMtCO_2e$)
2009	5.74	4%	0.179	0.009	450,056	0.009	0.012	0.201
2010	5.74	8%	0.359	0.017	900,023	0.018	0.024	0.401
2011	5.78	13%	0.542	0.026	1,358,844	0.027	0.037	0.605
2012	5.82	17%	0.727	0.035	1,823,637	0.036	0.049	0.812
2013	5.85	21%	0.915	0.044	2,294,480	0.071	0.062	1.05
2014	5.89	25%	1.10	0.053	2,771,448	0.085	0.075	1.26
2015	5.93	29%	1.30	0.062	3,254,619	0.098	0.088	1.48
2016	5.97	33%	1.49	0.071	3,743,861	0.113	0.101	1.71
2017	6.01	38%	1.69	0.080	4,239,428	0.128	0.114	1.93
2018	6.05	42%	1.89	0.090	4,741,409	0.141	0.128	2.16
2019	6.09	46%	2.09	0.100	5,249,891	0.156	0.141	2.39
2020	6.13	50%	2.30	0.109	5,764,962	0.171	0.155	2.62
Total Cumulative								**16.2**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $MMtCH_4$ = million metric tons of methane; $MMBtuCH_4$ = million British thermal units of methane.

Utilization Costs

The costs for the dairy and swine components are estimated using a USDA Natural Resources Conservation Service (NRCS) analysis.[35] The production costs are assumed to be $0.11/kWh and $3.17/MMBtu for swine anaerobic digesters and $0.05/kWh and $4.00/MMBtu for dairy anaerobic digesters.[36] These costs were converted to 2005 dollars (from 2006 dollars) and assume a 30% thermal efficiency. They include annualized capital costs for the digester, generator, and operation and maintenance (O&M) costs.[37] A study in South Carolina by Flora. and Riahi-Nezhad provided the assumed costs for the poultry component ($0.103/kWh in 2005 dollars using anaerobic digestion).[38] The value of electricity produced is taken from the projected

[35] Beddoes, J.C., K.S. Bracmort, R.T. Burns, and W.F. Lazarus. *An Analysis of Energy Production Costs From Anaerobic Digestion Systems on U.S. Livestock Production Facilities*. Technical Note No. 1. Washington, DC: U.S. Department of Agriculture, Natural Resources Conservation Service, October 2007. Available at: policy.nrcs.usda.gov/TN_BIME_1_a.pdf.

[36] It is assumed that the technology employed for swine and dairy anaerobic digesters is covered anaerobic lagoon. Costs were obtained from Table 1 of Beddoes et al., cited above.

[37] The economic analysis conducted by Beddoes et al. does not include feedstock and digester effluent transportation costs. The technical note does not address the economics of centralized digesters, where biomass is collected from several farms and then processed in a single unit.

[38] Flora, J.R.V., and C. Riahi-Nezhad. *Availability of Poultry Manure as a Potential Bio-Fuel Feedstock for Energy Production: Final Report*. Columbia, SC: University of South Carolina, Department of Civil and Environmental Engineering, August 31, 2006. Available at: http://www.scbiomass.org/Publications/Poultry Litter Final Report.pdf.

all-sector average electricity price for the Mid-Continent Area Power Pool prices.[39] This price represents the value to the farmer for the electricity produced (to offset on-farm use) and is netted out from the production costs to estimate net costs. The costs are summarized in Table I-4-4.

Table I-4-4. Costs of methane utilization

Year	Total Net Costs* of Deploying Methane Capture and Utilization Technology			
	Dairy	Swine	Poultry	Including Dairy, Swine, and Poultry
2009	–$34,975	–$31,831	–$691	$781,431
2010	–$64,172	$57,195	–$315	$1,483,626
2011	–$89,139	$251,425	$1,024	$2,217,577
2012	–$110,379	$536,305	$3,157	$2,994,964
2013	–$125,389	$987,339	$6,747	$3,799,316
2014	–$137,771	$1,510,458	$10,932	$4,688,510
2015	–$147,419	$2,112,610	$15,764	$5,683,750
2016	–$162,876	$2,543,702	$19,453	$6,604,378
2017	–$185,425	$2,756,012	$21,263	$7,459,372
2018	–$213,259	$2,793,174	$21,503	$8,164,873
2019	–$233,982	$3,033,820	$23,681	$9,063,501
2020	–$236,690	$3,836,563	$31,369	$9,965,820
Total				**$62,907,119**

* Net cost includes the cost of implementing methane capture and utilization technology (either natural gas or electricity displacement) less savings received through implementation (e.g., natural gas price and electricity purchase).

Management GHG Benefits

The GHG benefits of this policy were estimated for Iowa pig farms, which yield approximately 84% of total manure management emissions. The emissions from pig farms were taken from the Iowa I&F. According to a recent waste management study, improved aerobic waste treatment systems in swine farms previously using anaerobic lagoons for manure management were able to reduce GHG emissions by 97%.[40] Treatment methods included specialized flocculation (clumping) and aeration with nitrifying bacteria pellets to convert the volatile solids into stable carbon compounds. Waste management systems in Iowa are assumed to be 25% anaerobic

[39] U.S. Department of Energy, Energy Information Administration. *Annual Energy Outlook*. Accessed May 12, 2008, at: http://www.eia.doe.gov/oiaf/aeo/supplement/index.html.

[40] Vanotti, M.B., A.A. Szogi, and C.A. Vives. "Greenhouse Gas Emission Reduction and Environmental Quality Improvement From Implementation of Aerobic Waste Treatment Systems in Swine Farms." *Waste Management* 2008;28(4):759-766. Available at: http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VFR-4R8KT18-3&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=db75fa272fe41653220c60dc09cb4733.

lagoons, and the rest are deep-pit storage. While it is likely that the advanced methods described in the Vanotti et al. study could be applied to other manure management systems, such as deep-pit systems, they were not considered in the analysis. It was assumed that the costs and GHG benefits of installing these new aerobic manure management techniques to systems other than anaerobic lagoon facilities (under Iowa-specific conditions) would be different from those cited in Vanotti's studies. Thus, the analysis done for AFW-4 is likely a conservative estimate of the emission reductions possible through manure management, because the policy considers only the potential GHG reductions from improved management of anaerobic lagoons. Table I-4-5 shows the implementation path used for this policy and the GHG benefits expected.

Table I-4-5. GHG emissions reductions from improved manure management

Year	Farms Using Improved Manure Management	BAU Manure Management Emissions From Swine ($MMtCO_2e$)	Emissions Reduction From Policy ($MMtCO_2e$)
2008	0%	5.60	0.00
2009	4%	5.60	0.06
2010	8%	5.60	0.11
2011	13%	5.64	0.17
2012	17%	5.68	0.23
2013	21%	5.72	0.29
2014	25%	5.76	0.35
2015	29%	5.81	0.41
2016	33%	5.85	0.47
2017	38%	5.89	0.53
2018	42%	5.93	0.60
2019	46%	5.97	0.66
2020	50%	6.01	0.73
Total			**4.61**

BAU = business as usual; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Management Costs

The costs of this policy were estimated based on a study by Vanotti and Szogi,[41] which found that these new methods of manure management resulted in a net savings of $0.75/head. Costs are negative because of the improved health (and therefore sale price) of pigs as a result of this cleaner manure management system. This cost figure assumes the sale of carbon credits for an additional revenue stream. It was discounted back to 2005 dollars and applied to pig farms under the policy in Iowa. The estimated pig populations come from the Iowa I&F, and the cost estimates come from multiplying the pig population under the improved manure management

[41] Vanotti, M.B., and A.A. Szogi. "Water Quality Improvements of Wastewater From Confined Animal Feeding Operations After Advanced Treatment." *Journal of Environmental Quality* 37:S-86-S-96, September/October 2008. Available at: http://jeq.scijournals.org/cgi/content/abstract/37/5_Supplement/S-86.

program by the estimated cost/head figure. Table I-4-6 presents more information on the costs of the program.

Table I-4-6. Costs of improved manure management

Year	Swine in Iowa (thousand head)	Swine Considered in Policy (thousand head)	Net Costs (Million $)
2008	16,088	0	$0.0
2009	16,208	675	–$0.5
2010	16,328	1,361	–$0.9
2011	16,447	2,056	–$1.4
2012	16,567	2,761	–$1.9
2013	16,687	3,476	–$2.4
2014	16,806	4,202	–$2.9
2015	16,926	4,937	–$3.4
2016	17,046	5,682	–$3.9
2017	17,166	6,437	–$4.4
2018	17,285	7,202	–$4.9
2019	17,405	7,977	–$5.4
2020	17,525	8,762	–$6.0
Total			–$38

Key Assumptions:

The manure management costs assume that carbon credits can be aggregated and sold.

Revenue from the production tax credit[42] was not included in this analysis. While this tax credit may be available to systems put into place prior to January 1, 2012, it is not included in this analysis to reflect the true cost of implementation.

Key Uncertainties

Some swine farms in Iowa may already have digesters in place, which were taken into account in the BAU estimate. Because no information was available on the level of manure management currently in place in Iowa, it was assumed that installation of additional digesters is practical in all locations.

The Vanotti et al. studies[43],[44] assume that the improved manure handling and storage practices occur on large facilities (>6,000 head per facility). The availability of facilities this large in Iowa

[42] Section 476C of the Iowa code provides for a renewable energy tax credit, which includes biomass. The production tax credit is equal to $4.50/MMBtu of methane gas was available to biogas recovery facilities (anaerobic digester systems) which were placed into service on or after July 1, 2005, and before January 1, 2012.

[43] Vanotti, M.B., and A.A. Szogi. "Water Quality Improvements of Wastewater From Confined Animal Feeding Operations After Advanced Treatment." *Journal of Environmental Quality* 37:S-86-S-96, September/October 2008. Available at: http://jeq.scijournals.org/cgi/content/abstract/37/5_Supplement/S-86.

may be somewhat limited, and some of the economies of scale used in the study may not be available in practice.

Additional Benefits and Costs

Improved manure management often has additional benefits in terms of avoided odors and local air pollutants.

Methane production from manure may reduce the nutrient level of manure and reduce its potential to replace inorganic commercial fertilizer.

Feasibility Issues

The feasibility of utilizing methane and displacing natural gas or electricity may be limited by on-farm or community energy requirements and/or the location of industries that could use that energy.

This analysis suggests that there are economic benefits to implementing methane utilization at dairy farms, which suggests that there are non-economic barriers to implementation, including lack of economies of scale (i.e., size of dairy farms), seasonal variability (i.e., reduced winter methane production), and limited demand by nearby industries.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

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[44] Vanotti, M.B., A.A. Szogi, and C.A. Vives. "Greenhouse Gas Emission Reduction and Environmental Quality Improvement From Implementation of Aerobic Waste Treatment Systems in Swine Farms." *Waste Management* 2008;28(4):759-766. Available at: http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VFR-4R8KT18-3&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=db75fa272fe41653220c60dc09cb4733.

AFW-5. Land Management to Promote Sequestration Benefits

Policy Description

On cultivated lands, the amount of carbon stored in the soil can be increased by the adoption of practices, such as continuous conservation and no-till cultivation. By minimizing mechanical soil disturbance, these practices reduce the oxidation of soil carbon compounds and allow more stable aggregates to form. Other benefits include reduced wind and water erosion, reduced fuel consumption, and improved wildlife habitat.

This policy option would convert marginal agricultural land used for annual crops to permanent cover, such as grassland/rangeland, orchard, or forest, where the soil carbon or carbon in biomass is higher under the new land use. It would also adopt mechanisms to discourage theses acres from returning to either conventionally tilled production or suburban/urban development.

Heavy grazing can cause significant soil disturbance and result in carbon losses from soils. Rotational grazing, where animals are regularly moved from field to field, can reduce soil disturbance, improve plant vigor, and enhance soil carbon levels.

This policy option would also establish forests on land that has not historically been forested (e.g., afforestation of agricultural land) and promote forest cover and associated carbon stocks by regenerating or establishing forests in areas with little or no present forest cover (reforestation), and would maintain and improve the health and longevity of trees in urban and residential areas to protect and enhance the carbon stored in tree biomass. Indirect emissions reductions may also occur by reducing heating and cooling needs as a result of planting shade trees.

Policy Design

Goals:

- *Conservation tillage*—By 2020, manage 75% of annual cropland with continuous no-till or low-till production practices.
- *Agricultural land conversion*—By 2020, convert 333,000 acres of marginal agricultural land to higher-sequestration permanent cover (including grassland, rangeland, or orchard).
- *Conservation grazing*—By 2020, apply conservation grazing practices, including rotational grazing, to 50% of Iowa grazing lands.
- *Forestation*—By 2020, establish 250,000 acres of new forestlands, and improve management practices on 500,000 acres of unmanaged grazed forested land.
- *Urban forestry*—By 2020, increase the canopy cover of urban forest in Iowa communities by 25%.

Timing: As stated above.

Parties Involved: Landowners and forest managers.

Other: None identified.

Implementation Mechanisms

Encouraging landowner participation in the Iowa Forest Reserve Law program would enhance afforestation and forest retention efforts.

Related Policies/Programs in Place

Iowa Forest Reserve Law:

> "Forests and woodlands provide many benefits to Iowans and their visitors. Iowans earn millions of dollars each year from the harvest of timber and the manufacturing of wood and wood fiber products. On steep slopes and ridgetops, forests prevent erosion of soils and subsequent pollution of lakes and streams. In addition, forests provide habitat for a wide variety of game and non-game wildlife; they provide a pleasant environment for many recreation activities such as hiking, camping, picnicking, and hunting; and they add a great deal of beauty and diversity to the Iowa landscape. To encourage proper stewardship of these woodlands, the Iowa Forest Reserve Law provides that forest land that meets certain criteria may be exempt from property taxes."[45]

The forestland must meet certain size and tree species criteria, and livestock are not permitted.

Type(s) of GHG Reductions

CO_2: Increases the sequestration of carbon and prevent the carbon currently stored in Iowa's forests and farmland from being released. Reductions also occur, because soil carbon levels in crop soils are increased above BAU levels. Increasing the levels of carbon in soils indirectly sequesters carbon from the atmosphere.

Estimated GHG Reductions and Net Costs or Cost Savings

Table I-5-1. GHG reduction potential in 2012 and 2020 ($MMtCO_2e$) and net cost per tCO_2e

Policy Options	2012	2020	Cost-Effectiveness ($/tCO_2e$)
Conservation tillage	2.9	8.6	–$0.1
Agricultural land conversion	0.1	0.4	$76
Conservation grazing	0.09	0.3	–$67
Afforestation	0.2	0.6	$53
Unmanaged grazed forestland	0.3	0.8	$17
Urban forestry	0.1	0.4	–$41

$/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

Reforestation and Afforestation

Smith, J.E., L.S. Heath, K.E. Skog, and R.A. Birdsey. *Methods for Calculating Forest Ecosystem and Harvested Carbon With Standards Estimates for Forest Types of the United States*. General

[45] Iowa State University Extension. "Iowa's Forest Reserve Laws." March 2006. Available at: http://www.extension.iastate.edu/Publications/PM605.pdf.

Technical Report NE-343, Tables B47, B49, and B51. U.S. Department of Agriculture, Forest Service, Northern Research Station, December 21, 2005. Available at: http://www.treesearch.fs.fed.us/pubs/22954.

U.S. Department of Agriculture, Forest Service. Forest Inventory Mapmaker version 3.0. Available at: http://www.ncrs2.fs.fed.us/4801/fiadb/fim30/wcfim30.asp.

Walker, S., S. Grimland, J. Winsten, and S. Brown. "Opportunities for Improving Carbon Storage Through Afforestation of Agricultural Lands." Part 3A in *Terrestrial Carbon Sequestration in the Northeast: Quantities and Costs*. The Nature Conservancy, Winrock International, and The Sampson Group. October 2007. Available at: http://www.sampsongroup.com/Papers/carbon.htm.

Urban Forestry

Nowak, D.J., et al. "Effects of Urban Forests and Their Management on Human Health and Environmental Quality. State Urban Forest Data: Iowa." U.S. Department of Agriculture, U.S. Forest Service, Northern Research Station. Available at: http://www.fs.fed.us/ne/syracuse/Data/State/data_IA.htm.

McPherson, Gregory. "Urban Forestry in North America" Renewable Resources Journal. Autumn 2006. http://www.fs.fed.us/ecosystemservices/pdf/urban-forestry-2006.pdf

McPherson, E.G., and J.R. Simpson. *Carbon Dioxide Reduction Through Urban Forestry: Guidelines for Professional and Volunteer Tree Planters*. Gen. Tech. Rep. PSW-GTR-171. Washington, DC: U.S. Department of Agriculture, U.S. Forest Service, 1999. Available at: http://www.treesearch.fs.fed.us/pubs/6779.

Quantification Methods:

Conservation Tillage GHG Benefits

Total cropland in Iowa was estimated at about 23 million acres[46] in 1998. For the purposes of this analysis, conservation tillage is defined as any system that leaves 50% or more of the soil covered with residue.[47]

Based on the policy design parameters, the schedule for acres to be put into conservation tillage/no-till cultivation is displayed in Table I-5-2. This table represents the percentage of cropland required by this policy option, less the area currently implementing conservation tillage.

[46] 1998 Iowa total cropland from the Conservation Technology Information Center (CTIC) Iowa Crop Residue Management Survey (see http://www.conservationinformation.org/index.asp?site=1&action=crm_results).

[47] The definitions of *tillage practices* from the Conservation Technology Information Center (CTIC) are used under this policy. However, only no-till/strip-till and ridge-till are considered "conservation tillage" practices. No-till means leaving the residue from last year's crop undisturbed until planting. Strip-till means no more than a third of the row width is disturbed with a coulter, residue manager, or specialized shank that creates a strip. If shanks are used, nutrients may be injected at the same time. Ridge-till means that 4–6-inch-high ridges are formed at cultivation. Planters using specialized attachments scrape off the top 2 inches of the ridge before placing the seed in the ground.

In 1998, according to the Conservation Technology Information Center (CTIC),[48] almost 4 million acres were using conservation tillage practices in Iowa. This represents approximately 17% of total cropland in Iowa.

Table I-5-2. GHG reductions from conservation tillage practices

Year	Percentage of Total Cropland in Program	Acres in Program ("New" Acres)	$MMtCO_2e$ Sequestered	Diesel Saved (1,000 gallons)	$MMtCO_2e$ From Diesel Avoided	Total $MMtCO_2e$ Saved Per Year
2009	22%	1,114,784	0.669	3,902	0.048	0.717
2010	27%	2,229,569	1.34	7,803	0.096	1.43
2011	31%	3,344,353	2.01	11,705	0.144	2.15
2012	36%	4,459,138	2.68	15,607	0.192	2.87
2013	41%	5,573,922	3.34	19,509	0.240	3.58
2014	46%	6,688,707	4.01	23,410	0.288	4.30
2015	51%	7,803,491	4.68	27,312	0.336	5.02
2016	56%	8,918,276	5.35	31,214	0.384	5.74
2017	60%	10,033,060	6.02	35,116	0.432	6.45
2018	65%	11,147,844	6.69	39,017	0.480	7.17
2019	70%	12,262,629	7.36	42,919	0.528	7.89
2020	75%	13,377,413	8.03	46,821	0.576	8.60
Cumulative Benefit						**55.9**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

For the policy period, it is assumed that the sequestration rate provided by the Chicago Climate Exchange (CCX) for the carbon credit program (0.6 tCO_2/acre/year because Iowa is considered to be in CCX Zone A) is indicative of the sequestration that would occur as a result of improved tillage practices.[49] Thus, 0.6 tCO_2/acre/year was used to estimate the amount of carbon to be sequestered per acre. The issuance rates are viewed as a discounted average that could be expected to occur for the entire pool of enrolled acreage over the 5-year contract period.[50] It was assumed that carbon accumulation occurred for 20 years, which extends beyond the policy period. To estimate carbon stored each year, the annual accumulation rate was multiplied by the number of acres still accumulating carbon each year. The CCX program currently runs until 2010, and while it is likely that the program will be extended, at this stage, it is not known whether that will be the case.

Additional GHG savings from reduced fossil fuel consumption are estimated by multiplying the fossil diesel emission factor and diesel fuel reduction per acre estimate. The reduction in fossil

[48] From 1998 Conservation Technology Information Center data:http://www.conservationinformation.org.

[49] Chicago Climate Exchange. "Agricultural Soil Carbon Offsets." Available at: http://www.chicagoclimatex.com/content.jsf?id=781.

[50] Chicago Climate Exchange. "Offsets for Carbon Capture and Storage in Agricultural Soils FAQs." Available at: http://www.chicagoclimateexchange.com/docs/offsets/Soil_Carbon_Offsets_faq.pdf.

diesel fuel use from the adoption of conservation tillage methods is 3.5 gal/acre.[51] The life-cycle fossil diesel GHG emission factor of 12.31 tCO_2e/1,000 gal was used.[52] Results are shown in Table F-5-3, along with a total estimated benefit from carbon sequestration and fossil fuel reductions.

Conservation Tillage Costs

The costs of adopting soil management practices (e.g., conservation tillage/no-till practices) presented in Table I-5-3 are based on the financial incentives provided through the Minnesota Agriculture Best Management Practices (Ag BMP) program.[53] This program provides low-interest loans to farmers as an incentive to initiate or improve their current tillage practices. The equipment funded is generally specialized tillage or planting implements that leave crop residues covering at least 15%–30% of the ground after planting. The average total cost for this equipment is $23,000, though the average loan for tillage equipment is $16,000. The average size of a farm that uses an Ag BMP loan to purchase conservation tillage equipment is 984 acres. Based on the average loan size ($16,000) and the average size of the farm utilizing the loan (984 acres), it is assumed that a once-off loan of $16.26/acre is required to incentivize the adoption of conservation tillage practices. This per-acre loan payment is applied to each new acre entering the program to determine the approximate cost of encouraging the use of soil management practices. Note that while initial up-front incentives may be required to encourage the use of soil management practices, there may also be savings associated with reduced costs of fuel, labor, chemicals, and equipment.[54] The reduction in fossil diesel fuel use from the adoption of conservation tillage methods is 3.5 gal/acre.[55] The GHG emission factor for life-cycle fossil diesel is assumed to be 12.31 tCO_2e/1,000 gal.[56]

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[51] Reduction associated with conservation tillage compared with conventional tillage. Accessed August 2006 at: http://www.ctic.purdue.edu/Core4/CT/CRM/Benefits.html.

[52] Life-cycle emissions factor for fossil diesel from J. Hill et al., "Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels," *Proceedings of the National Academy of Sciences*, 103(30):11206–11210. From the assessment used to evaluate U.S. soybean-based biodiesel life-cycle impacts. See: http://www.pnas.org/cgi/content/full/103/30/11099.

[53] Minnesota Department of Agriculture. *Agricultural Best Management Practices Loan Program: State Revolving Fund Status Report*. Minn. Publication 06-0636. February 28, 2006. Available at: http://www.mda.state.mn.us/grants/loans/agbmploan.htm.

[54] As an example, estimated cost savings related to the adoption of no-till farming have been estimated to be as high as $14/acre. Sourced from the high end of the range provided by: Walton, S., and G. Bullen. "Economic Comparison of Three Cotton Tillage Systems in Three NC Regions." North Carolina Cooperative Extension. Accessed January 2008 at: www.ces.ncsu.edu/depts/agecon/Cotton_Econ/production/Economic_Comparison.ppt.

[55] Reduction associated with less intensive land use (e.g., fewer passes). The estimate is based on conservation tillage compared with conventional tillage. See: Purdue University, Conservation Technology Information Center. "What's Conservation Tillage?" Accessed May 2008 at: http://www.conservationinformation.org/Core4Brochures/CTBrochure.pdf.

[56] Life-cycle emissions factor for fossil diesel from J. Hill et al., "Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels," *Proceedings of the National Academy of Sciences* 103(30):11206–11210. From the assessment used to evaluate U.S. soybean-based biodiesel life-cycle impacts. See: http://www.pnas.org/cgi/content/full/103/30/11099.

It was assumed that income from adopting no-till practices could be obtained through a carbon credit program (for example, the CCX). The price of carbon was assumed to be $4/tCO_2e$.[57]

Table I-5-3. GHG reductions from conservation tillage practices

Year	Total $MMtCO_2e$ Saved per Year	Annual Cost of Funding Conservation Tillage Equipment	Costs Benefits From No-Till	Net Costs
2009	0.717	$18,126,576	–$2,867,605	$15,258,972
2010	1.43	$18,126,576	–$5,735,209	$12,391,367
2011	2.15	$18,126,576	–$8,602,814	$9,523,762
2012	2.87	$18,126,576	–$11,470,418	$6,656,158
2013	3.58	$18,126,576	–$14,338,023	$3,788,553
2014	4.30	$18,126,576	–$17,205,628	$920,949
2015	5.02	$18,126,576	–$20,073,232	–$1,946,656
2016	5.74	$18,126,576	–$22,940,837	–$4,814,261
2017	6.45	$18,126,576	–$25,808,441	–$7,681,865
2018	7.17	$18,126,576	–$28,676,046	–$10,549,470
2019	7.89	$18,126,576	–$31,543,651	–$13,417,074
2020	8.60	$18,126,576	–$34,411,255	–$16,284,679
Total	**55.9**		**–$223,673,159**	**–$6,154,244**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Agricultural Land Conversion GHG Benefits

The GHG sequestration benefits of converting marginal agricultural land to higher sequestration permanent cover were quantified by assuming a constant rate of carbon accumulation of 1 tCO_2e/acre/year.[58] The sequestration rate was applied to acres in the program as indicated in Table 5-3. The benefits from reduced use of diesel fuel and reduced use of fertilizer were calculated using a method similar to that used for AFW-1. It was assumed that nitrogen was not applied under the policy scenario but was applied in the reference case at a rate of 84 lb/acre,[59] and the average CO_2 emissions factor was 5.02×10^{-6} $MMtCO_2e$/tN applied based on historical data and the life cycle emissions factor for nitrogen production (i.e., emissions associated with the production, transport, and energy consumption during application).[60] Additional GHG

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[57] Price based on realistic CCX price (http://www.chicagoclimateexchange.com).

[58] Taken from CCX agricultural grass soil carbon sequestration offset project guidelines. Iowa is in zone A. See: http://www.chicagoclimatex.com/docs/offsets/Grassland_Conversion_Protocol.pdf.

[59] Based on average fertilizer use (lb/acre) in Iowa in 2005 (nitrogen applied in Iowa in 2005 was 1,037,165 tN, and total cropland is 27.15 million acres).

[60] The avoided life-cycle GHG emissions (i.e., emissions associated with the production, transport, and energy consumption during application) were taken from Sam Wood and Annette Cowie. *A Review of Greenhouse Gas Emission Factors for Fertiliser Production.* Research and Development Division, State Forests of New South Wales, Cooperative Research Centre for Greenhouse Accounting. June 2004. Available at: http://www.ieabioenergy-task38.org/publications/GHG_Emission_Fertilizer%20Production_July2004.pdf.

savings (Table I-5-4) from reductions in fossil fuel consumption were estimated by multiplying the fossil diesel emission factor (12.31 tCO_2e/1,000 gal)[61] by the diesel fuel reduction per acre (3.5 gal/acre).[62]

Table I-5-4. GHG benefits of agricultural land conversion

Year	Acres in Program	$MMtCO_2e$ Sequestered	Diesel Fuel Saved (1,000 gallons)	$MMtCO_2e$ From Diesel Avoided	Amount of Nitrogen Avoided (short tons)	GHG Emissions Saved ($MMtCO_2e$)
2009	27,750	0.028	97	0.001	1,169	0.035
2010	55,500	0.056	194	0.002	2,337	0.070
2011	83,250	0.083	291	0.004	3,506	0.105
2012	111,000	0.111	389	0.005	4,674	0.140
2013	138,750	0.139	486	0.006	5,843	0.174
2014	166,500	0.167	583	0.007	7,011	0.209
2015	194,250	0.194	680	0.008	8,180	0.244
2016	222,000	0.222	777	0.010	9,348	0.279
2017	249,750	0.250	874	0.011	10,517	0.314
2018	277,500	0.278	971	0.012	11,685	0.349
2019	305,250	0.305	1,068	0.013	12,854	0.384
2020	333,000	0.333	1,166	0.014	14,022	0.419
Cumulative						**2.62**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Agricultural Land Conversion Costs

The cost of the program was assumed to be constant over the period at $146/acre/year in 2008 dollars.[63] The establishment costs were assumed to be $86/acre. The one-time establishment fee is based on the average establishment costs provided by the ISU study.[64] It is further assumed that the federal government (through USDA) will pay up to 50% of these establishment costs

The estimate provided for the U.S. (taken from West and Marland, 2002) was 857.5 grams (g) CO_2e/kgN, or 0.778 tCO_2e/tN.

[61] J. Hill et al., "Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels," *Proceedings of the National Academy of Sciences* 103(30):11206–11210. From the assessment used to evaluate U.S. soybean-based biodiesel life-cycle impacts. See http://www.pnas.org/cgi/content/short/103/30/11206.

[62] Reduction associated with less intensive land use (e.g., fewer passes). The estimate is based on conservation tillage compared to conventional tillage. See: Purdue University, Conservation Technology Information Center. *What's Conservation Tillage?* Accessed May 2008.at: http://www.conservationinformation.org/Core4Brochures/CTBrochure.pdf.

[63] Total continuous CRP land annual payments for Iowa were $146.11/acre as of March 2008. Payment include annual incentive and maintenance allowance payments, but not one-time signing and practice incentive payments or payment reductions, such as for lands enrolled less than a full year and lands hayed or grazed. Available at: http://www.fsa.usda.gov/Internet/FSA_File/mar2008.pdf.

[64] Iowa State University Extension. "Estimated Costs of Pasture and Hay Production." November 2000. Available at: http://www.econ.iastate.edu/faculty/duffy/Pages/pastureandhay.pdf

(e.g., cover crop or tree establishment costs). This results in a net establishment cost of $43/acre. It was assumed that carbon credits ($4/$tCO_2$) would be generated through the CCX or a similar future program.[65] Cost savings were also assumed to occur through reduced nutrient application and fuel consumption, using a method similar to that applied above.[66] These costs are discounted to 2005 dollars and are assumed to be constant in real terms across the policy period. Costs for each year are indicated in Table I-5-5.

Table I-5-5. Costs of agricultural land conversion

Year	Avoided Cost of Fertilizer	Avoided Cost of Diesel	Total Costs*	Savings (Revenue Generated Through Carbon Credits)	Net Cost (2005$)
2009	–$480,438	–$455,711	$3,601,775	–$111,000	$3,490,775
2010	–$942,419	–$911,421	$6,186,559	–$222,000	$5,964,559
2011	–$1,416,392	–$1,367,132	$8,759,350	–$333,000	$8,426,350
2012	–$1,912,310	–$1,822,842	$11,310,196	–$444,000	$10,866,196
2013	–$2,397,911	–$2,278,553	$13,871,359	–$555,000	$13,316,359
2014	–$2,925,602	–$2,734,263	$16,390,433	–$666,000	$15,724,433
2015	–$3,503,778	–$3,189,974	$18,859,021	–$777,000	$18,082,021
2016	–$4,167,703	–$3,645,684	$21,241,861	–$888,000	$20,353,861
2017	–$4,949,565	–$4,101,395	$23,506,763	–$999,000	$22,507,763
2018	–$5,806,299	–$4,557,105	$25,696,794	–$1,110,000	$24,586,794
2019	–$6,720,745	–$5,012,816	$27,829,112	–$1,221,000	$26,608,112
2020	–$7,435,889	–$5,468,526	$30,160,732	–$1,332,000	$28,828,732
Cumulative					**$198,755,957**

* Total costs include conservation costs, establishment costs, and savings from avoided use of fertilizer.

Conservation Grazing GHG Benefits

The GHG benefits of rotational grazing were estimated using the low end of the range provided by the CCX offset protocol for rangeland soil carbon management.[67] Offsets are issued at standard rates, depending on project type and location. Iowa has not been placed in a zone, and rates vary from 0.12 to 0.52 tCO_2e/acre/year. As a conservative estimate, the midpoint of this range was assumed (0.32 tCO_2e/acre/year). The sequestration rate depends on the determination of whether the range is in a non-degraded or degraded condition. It was assumed that this rate of

[65] Assumes that carbon credits can be obtained through future programs. Price based on realistic CCX price (http://www.chicagoclimateexchange.com).

[66] Assuming an application rate of 84 lb/acre, and multiplying the total fertilizer reduction in each year by the average cost of fertilizer provided by David Miller (Director, Research & Commodity Services, Iowa Farm Bureau Federation), See AFW-1 for further detail. For diesel, the assumed price is $4.69/gal, taken from the national average from the EIA gasoline and diesel update (http://tonto.eia.doe.gov/oog/info/gdu/gasdiesel.asp), accessed on June 20, 2008.

[67] See Chicago Climate Exchange. "Rangeland Soil Carbon Management Offsets." Available at: http://www.chicagoclimateexchange.com/docs/offsets/CCX_Rangeland_Soil_Carbon.pdf.

accumulation occurred for the duration of the policy period. The results are summarized in Table I-5-6.

Table I-5-6. GHG benefits and costs of conservation grazing

Year	Achieve Percentage of Goal	Acres In Program	Total Carbon Sequestered ($MMtCO_2e$)	Costs*	Savings†	Net Cost (2005$)
2009	8%	72,500	0.023	$14,500,000	$3,717,800	$10,782,200
2010	17%	145,000	0.046	$14,500,000	$7,435,600	$7,064,400
2011	25%	217,500	0.070	$14,500,000	$11,153,400	$3,346,600
2012	33%	290,000	0.093	$14,500,000	$14,871,200	–$371,200
2013	42%	362,500	0.116	$14,500,000	$18,589,000	–$4,089,000
2014	50%	435,000	0.139	$14,500,000	$22,306,800	–$7,806,800
2015	58%	507,500	0.162	$14,500,000	$26,024,600	–$11,524,600
2016	67%	580,000	0.186	$14,500,000	$29,742,400	–$15,242,400
2017	75%	652,500	0.209	$14,500,000	$33,460,200	–$18,960,200
2018	83%	725,000	0.232	$14,500,000	$37,178,000	–$22,678,000
2019	92%	797,500	0.255	$14,500,000	$40,895,800	–$26,395,800
2020	100%	870,000	0.278	$14,500,000	$44,613,600	–$30,113,600
Cumulative			**1.74**			**–$115,988,400**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

* Costs include additional up-front establishment costs.

† Savings includes revenue generated through carbon credits and net income from adopting rotational grazing.

Conservation Grazing Costs

Unlike with land conversion programs, there is only a change of management practices, and thus there are no land conversion costs. It was assumed that carbon credits ($4/tCO_2$) would be generated through the CCX or a similar future program.[68]

In addition, there is likely to be annual income from the adoption of rotational grazing. The net annual income is assumed to be $50/acre/year. This is based on assumed additional income of $100/acre/year and assumed additional labor costs of adopting rotation grazing of $50/acre/year. To achieve this additional income, there are other up-front capital costs for fencing and watering systems (assumed to be $200/acre).[69] These costs are assumed to be in 2005 dollars and to be constant in real terms across the policy period. Costs for each year are indicated in Table I-5-6.

Afforestation GHG Benefits

Forests grown or planted on land not currently in forest cover will most likely accumulate carbon at a rate consistent with the accumulation rates of average forests in the region. Therefore,

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[68] Assumes that carbon credits can be obtained through future programs. Price based on realistic CCX price (http://www.chicagoclimateexchange.com).

[69] Personal communications David Miller, Director, Research & Commodity Services, Iowa Farm Bureau Federation, via email dated 05/27/2008.

carbon sequestered by afforestation can be assumed to occur at the same rate as carbon sequestration in average Iowa forests. For this analysis, it was assumed that afforested land would have otherwise been used for annual crop production.

Average carbon storage was found using methods described in USFS GTR-NE-343, assuming that afforestation activity would create forests consistent with the existing forest type distribution in Iowa. This distribution was based on USDA USFS Forest Inventory and Analysis data. Afforestation statewide was assumed to occur on 50% oak/hickory, 25% elm/ash/cottonwood, and 25% maple/beech/birch forests.

For afforestation calculations, annual carbon sequestration rates in each forest type group were calculated by subtracting carbon stocks in new stands (0 years old) from carbon stocks in 35-year-old stands and dividing by 35 years. A weighted statewide average carbon sequestration rate for afforestation activity was calculated, taking into account the variation in carbon sequestration across forest types (Table I-5-7). The 35-year period was chosen to reflect the average length of an afforestation project period. In this afforestation calculation, soil carbon was taken into account. Soil carbon was assumed to accumulate at a rate consistent with soil carbon accumulation in afforested stands in GTR-NE-343.

Since afforested land would otherwise have been used for agricultural production, an additional GHG benefit of afforestation is the reduction of emissions from diesel fuel used to power farm equipment. This GHG benefit was considered to be parallel to expected reductions resulting from a switch to conservation tillage, as described above. GHG emission reductions associated with reduced management intensity were thus estimated by multiplying the fossil diesel emission factor (12.31 tCO_2e/1,000 gal)[70] by the diesel fuel reduction per acre (3.5 gal/acre).[71]

Table I-5-7. Forest carbon sequestration rates for afforestation activity

Afforestation	tCO_2e/Acre (0 years)	tCO_2e/Acre (35 years)	tCO_2e/Acre/Year (Average)
Oak-hickory afforestation (Table B15, NR-GTR-343)	53.9	136.0	2.3
Elm-ash-cottonwood afforestation (Table B13, NR-GTR-343)	97.2	187.4	2.6
Maple-beech-birch afforestation (Table B14, NR-GTR-343)	75.5	164.3	2.5
Average carbon accumulation rate for afforestation			2.5

tCO_2e/acre = metric tons of carbon dioxide equivalent per acre.

Source: Smith et al. 2006, NE-GTR-343.

[70] J. Hill et al., "Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels," *Proceedings of the National Academy of Sciences* 103(30):11206–11210. From the assessment used to evaluate U.S. soybean-based bio-diesel life cycle impacts. See: http://www.pnas.org/cgi/content/short/103/30/11206.

[71] Reduction associated with less intensive land use (e.g., fewer passes). The estimate is based on conservation tillage compared to conventional tillage. See Purdue University, Conservation Technology Information Center. *What's Conservation Tillage?* Available at http://www.conservationinformation.org/Core4Brochures/CTBrochure.pdf, accessed May 2008.

To achieve the goal of afforesting 250,000 acres by 2020, it was assumed that 20,833 acres would be planted each year from 2009 to 2020. Forests planted in one year continue to sequester carbon in subsequent years. Thus carbon storage in a given year was calculated as the sum of annual carbon sequestration on cumulative planted acreage. To determine the total amount of carbon sequestered from 2009 to 2020, the number of acres planted in that year and all prior years was multiplied by the average annual carbon sequestration rate for each land-use type (Table I-5-8).

Table I-5-8. Calculation of GHG benefits due to afforestation from 2009 to 2020

Year	Acres Planted This Year (acre/year)	Acres Planted in Prior Years	Carbon Sequestered in Cumulative Planted Acreage ($MMtCO_2e$/year)	Diesel Saved (1,000 gallons)	$MMtCO_2e$ From Diesel Avoided	Total $MMtCO_2e$ Saved Per Year
2009	20,833	0	0.051	73	0.001	0.052
2010	20,833	20,833	0.102	146	0.002	0.104
2011	20,833	41,666	0.153	219	0.003	0.156
2012	20,833	62,499	0.204	292	0.004	0.208
2013	20,833	83,332	0.255	365	0.004	0.260
2014	20,833	104,165	0.306	437	0.005	0.312
2015	20,833	124,998	0.357	510	0.006	0.364
2016	20,833	145,831	0.409	583	0.007	0.416
2017	20,833	166,664	0.460	656	0.008	0.468
2018	20,833	187,497	0.511	729	0.009	0.520
2019	20,833	208,330	0.562	802	0.010	0.572
2020	20,837	229,163	0.613	875	0.011	0.624
Total	**250,000**		**3.984**	**5,687**	**0.070**	**4.054**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Afforestation Costs and Benefits

Cost analyses of vegetation planting typically use four categories: (1) opportunity cost (of planting forest rather than another, potentially more lucrative land use); (2) conversion cost; (3) maintenance cost; and (4) measuring/monitoring costs (Walker et al. 2007).

The opportunity cost for afforestation activity was assumed to be $106.15/acre/year, which was the annual average rental payment to farmers in Iowa with land enrolled in the CRP as of 2007.[72] One-time costs of vegetation establishment include site preparation and vegetation planting. For afforestation activity in Iowa, the Forest Land Enhancement Program indicates the willingness to cost-share 75% of the total project cost, to a maximum of $600/acre.[73] The full cost of

[72] USDA CRP: Summary and Enrollment Statistics, FY2007. Available at: http://www.fsa.usda.gov/Internet/FSA_File/annual_consv_2007.pdf.

[73] Iowa State Department of Natural Resources, Bureau of Forestry. "Forest Land Enhancement Program Components and Practices in Iowa." Available at: http://www.iowadnr.gov/forestry/pdf/FLEP%20Rates.pdf.

afforestation activity, including site preparation and planting, was thus estimated at 100% of a typical project cost, or $800/acre. Maintenance and monitoring costs on afforested land were assumed to be negligible between 2009 and 2020. It was further assumed that carbon credits due to afforestation activity would be available at a rate of $4/tCO_2e$ for the carbon sequestration portion of the GHG benefit.[74] Revenue from harvested wood was not included, because timber harvest is not likely to occur over the policy implementation period from 2009 to 2020. To calculate the economic benefit of selling carbon credits, the carbon stored in cumulative planted acreage was discounted by 30%, and this carbon sequestration estimate was multiplied by the price per credit ($4.00/tCO_2e$).

Discounted costs to 2020 were calculated using a 5% discount rate. Results, including annual costs, are summarized in Table I-5-9. The cost of implementing this option, expressed in 2005 dollars, was calculated to be $54.62/tCO_2$ stored or avoided.

Table I-5-9. Net economic costs and benefits of afforestation activity in Iowa

Year	Acres Planted This Year (acre/year)	Acres Planted in Prior Years	Opportunity Cost	Establishment Cost	Economic Benefit (Trading Carbon Credits)	Net Economic Cost	Discounted Cost (5%, 2005$)
2009	20,833	0	$2,211,423	$16,666,400	$142,998	$18,734,825	$15,413,187
2010	20,833	20,833	$4,422,846	$16,666,400	$285,995	$20,803,250	$16,299,891
2011	20,833	41,666	$6,634,269	$16,666,400	$428,993	$22,871,676	$17,067,197
2012	20,833	62,499	$8,845,692	$16,666,400	$571,991	$24,940,101	$17,724,464
2013	20,833	83,332	$11,057,115	$16,666,400	$714,989	$27,008,526	$18,280,434
2014	20,833	104,165	$13,268,538	$16,666,400	$857,986	$29,076,951	$18,743,262
2015	20,833	124,998	$15,479,961	$16,666,400	$1,000,984	$31,145,377	$19,120,560
2016	20,833	145,831	$17,691,384	$16,666,400	$1,143,982	$33,213,802	$19,419,422
2017	20,833	166,664	$19,902,807	$16,666,400	$1,286,979	$35,282,227	$19,646,464
2018	20,833	187,497	$22,114,230	$16,666,400	$1,429,977	$37,350,652	$19,807,848
2019	20,833	208,330	$24,325,652	$16,666,400	$1,572,975	$39,419,078	$19,909,313
2020	20,837	229,163	$26,537,500	$16,669,600	$1,716,000	$41,491,100	$19,957,929
Total	**250,000**						**$221,389,970**

GHG Benefit of Improved Management Practices on Unmanaged Grazed Forested Land

Enhanced carbon sequestration can occur on land that is currently grazed if livestock are excluded and trees are allowed to grow. This option quantifies the impact of livestock exclusion on 500,000 acres of currently unmanaged grazed forestland. The land treated under this policy option is currently used for livestock grazing, and it is not part of the forested land base in Iowa as defined by the USDA USFS. After this policy option is implemented, the land would most likely be classified as forest in future inventories.

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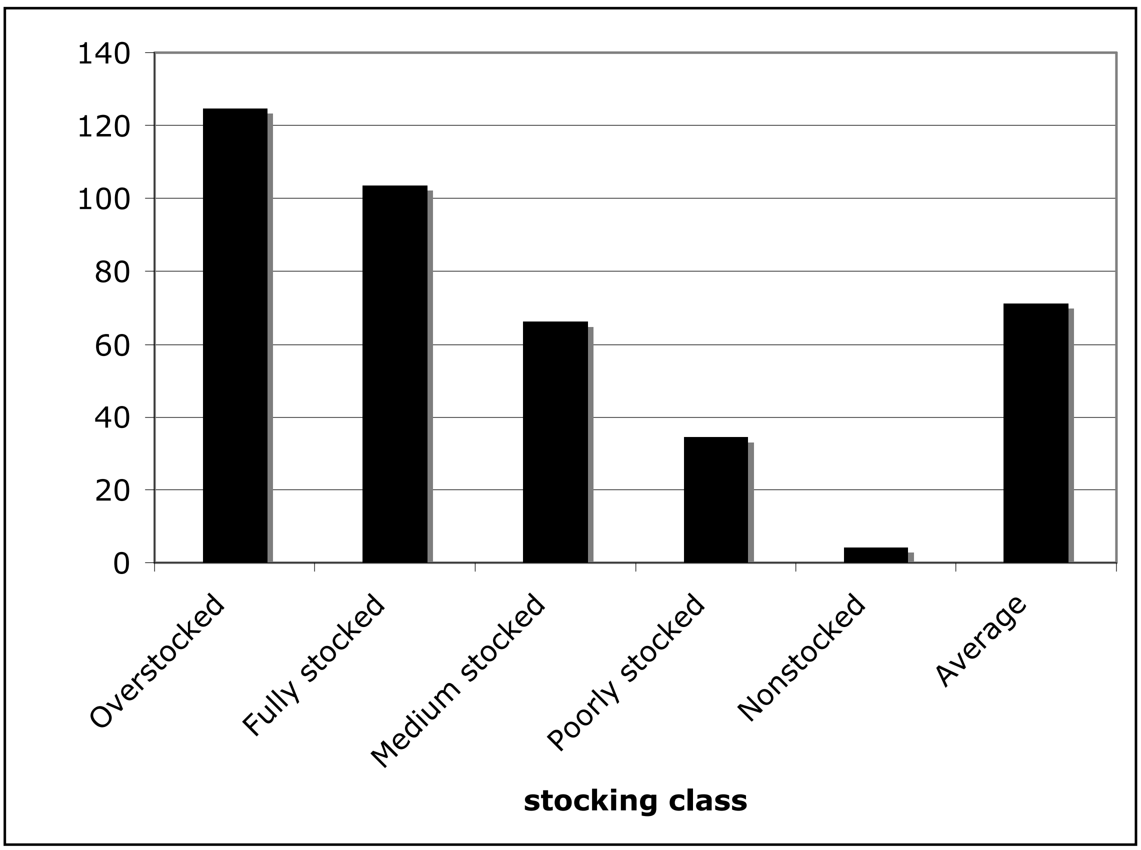
[74] Assume projects will be eligible for CCX enrollment. Price based on realistic market value. See: http://www.chicagoclimateexchange.com/.

A relationship between forest stocking and existing carbon stocks in Iowa forests was created, using current data on forest area and carbon stocks by stocking class[75] (Figure I-5-1). It was assumed that full policy implementation would result in a shift from a lower stocking class into the next highest stocking class over a 20-year period. Specifically, nonstocked forests would become poorly stocked as a result of livestock exclusion, poorly stocked forests would move into the medium stocked category, and forests in a medium stocking class would move into the fully stocked category. Of the 500,000 acres, it was assumed that 20% (100,000 acres) would originally be in the nonstocked category, 200,000 acres (40%) would originally be in the poorly stocked category, and the remaining 200,000 acres (40%) would originally be in the medium stocked category (Table I-5-10).

Figure I-5-1. Total carbon stocks in Iowa forests by stocking class (units tCO_2e/acre)



To calculate the incremental carbon storage resulting from transition from a less-stocked to a more-stocked forest condition, the difference in biomass carbon stocks between the current stocking and the next-highest stocking class was calculated for nonstocked, poorly stocked, and medium stocked classes, and was then divided by 20 to estimate the annual incremental carbon storage due to increased stocking (Table I-5-10). A weighted average of 1.69 tCO_2e/acre/year was calculated to represent the average carbon storage resulting from implementation of this

[75] USDA Forest Service. Forest Inventory Mapmaker version 3.0. Available at: http://www.ncrs2.fs.fed.us/4801/fiadb/fim30/wcfim30.asp.

policy option, assuming proportional representation of nonstocked, poorly stocked, and medium stocked forest in each year.

Table F-5-10. Incremental carbon storage (per acre) resulting from enhanced stocking of unmanaged grazed forested land in Iowa

Number of Acres to Transition Stocking Classes	Original Stocking Class	tCO_2e/ Acre	Incremental Carbon Storage (tCO_2e/acre) Realized by Transition to the Next-Highest Class	Incremental Annual Carbon Storage (tCO_2e/acre/year) (20-year period)
100,000	Nonstocked	4.10	30.31	1.52
200,000	Poorly stocked	34.41	31.70	1.59
200,000	Medium stocked	18.03	37.41	1.87
	Fully stocked	103.52		
	Overstocked	124.78		
Weighted average (tCO_2e/acre/year) for fully stocking 500,000 acres				**1.69**

tCO_2e = metric tons of carbon dioxide equivalent.

To reach the goal of 500,000 acres by 2020, a linear ramp-up to the goal level was assumed such that 41,667 acres were added to the program each year. These acres were assumed to be proportionally representative, such that one-twelfth of the acres in the nonstocked, poorly stocked, and medium stocked categories would be added in each of the 12 years between 2009 and 2020. The cumulative impact of the policy option (2009–2020) is 5.48 $MMtCO_2e$ (Table I-5-11).

Table I-5-11. Cumulative impact of enhanced carbon sequestration on 500,000 acres of unmanaged grazed forestland in Iowa

Year	Acres Added This Year (acre/year)	Acres Added in Prior Years	Carbon Sequestered in Cumulative Acreage ($MMtCO_2e$/year)
2009	41,667	0	0.070
2010	41,667	41,667	0.140
2011	41,667	83,333	0.211
2012	41,667	125,000	0.281
2013	41,667	166,667	0.351
2014	41,667	208,333	0.421
2015	41,667	250,000	0.492
2016	41,667	291,667	0.562
2017	41,667	333,333	0.632
2018	41,667	375,000	0.702
2019	41,667	416,667	0.772
2020	41,667	458,333	0.843
Total	**500,000**		**5.477**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Improved Management Practices on Unmanaged Grazed Forested Land: Economic Costs

The cost of implementing this option is essentially the cost of livestock exclusion, since the land is currently growing trees and is not used for agriculture. No planting is necessary, and maintenance is minimal. It was assumed that fencing would be used to exclude livestock from forested acreage, that the average fenced parcel would be 40 acres in size, and that fencing would be installed on half of the perimeter of the parcel. The fencing cost was assumed to be $1.76/foot; this is a one-time cost associated with policy implementation.[76] In addition, an annual cost of $30/acre was assumed; this is an ongoing payment to landowners to encourage livestock exclusion from forested parcels.[77] The net present value (NPV) of this option, expressed in 2005 dollars, is $93.7 million (Table I-5-12). The cost-effectiveness of this option is $17.11/t$CO_2$e.

Table I-5-12. Economic costs of implementing management on unmanaged grazed forestland in Iowa

Year	Acres Added	Net Economic Cost	Discounted Cost
2009	41,667	$6,090,000	$5,010,258
2010	41,667	$7,340,000	$5,751,082
2011	41,667	$8,590,000	$6,409,990
2012	41,667	$9,840,000	$6,993,104
2013	41,667	$11,090,000	$7,506,149
2014	41,667	$12,340,000	$7,954,474
2015	41,667	$13,590,000	$8,343,081
2016	41,667	$14,840,000	$8,676,641
2017	41,667	$16,090,000	$8,959,514
2018	41,667	$17,340,000	$9,195,772
2019	41,667	$18,590,000	$9,389,213
2020	41,667	$19,840,000	$9,543,379
Total	**500,000**		**$93,732,658**

Urban Forestry GHG Benefit

Carbon Sequestration in Urban Trees

The average annual per-tree gross carbon sequestration value for urban trees was determined by dividing the total estimated annual carbon sequestration in Iowa urban trees (313,000 tCO_2/year, equating to 1.15 million tCO_2e/year) by the total number of urban trees. Annual gross carbon sequestration per urban tree was thus calculated as 0.006 tCO_2/tree/year (0.022 tCO_2e/tree/year). Gross sequestration as calculated above does not account for the emissions resulting from tree mortality, disposal, and decomposition. To account for these emissions, the estimated gross carbon sequestration per tree was multiplied by 0.72, which is the ratio of gross to net

[76] Iowa DNR reimburses landowners at a rate of $0.88/foot to install standard barbed-wire fencing for livestock exclusion, which is 50% of the total fencing cost. Personal communication, Larry Beeler (NRCS Assistant State Conservationist) with J. Jenkins, Center for Climate Strategies (CCS), August 20, 2008.

[77] The NRCS Environmental Quality Incentives Program reimburses Iowa landowners at this rate for livestock exclusion (personal communication, Larry Beeler with J. Jenkins, CCS, August 20, 2008).

sequestration for urban trees reported by Nowak and Crane (2002)[78] and used in EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks*.[79] Annual net carbon sequestration per urban tree in Iowa is 0.004 tCO_2/tree/year (0.015 tCO_2e/tree/year).

Since trees planted in one year continue to accumulate carbon in subsequent years, annual carbon sequestration in any given year was calculated as the sum of carbon stored in trees planted in that year plus sequestration by trees that were planted in prior years. It was assumed that new trees planted in urban areas in Iowa would sequester carbon at a rate consistent with sequestration by the average urban trees statewide.

Avoided Fossil Fuel Emissions

GHG reductions from avoided fossil fuel use for heating and cooling can occur as a result of planting trees that provide additional shade and wind protection to buildings, though these benefits are not likely to be achieved the first year after planting. Normally, trees are quite small when they are planted, so some time is required before the full effect of the avoided emissions can be realized. To account for this, a sliding scale was used, such that trees planted in 2009 would achieve the full avoided GHG emissions benefit 20 years after planting (in 2029), and a linear phase-in of avoided GHG benefits would occur each year. Avoided GHG benefits for trees planted in each year from 2009 to 2020 were thus calculated proportionally to their expected size in 2029, as shown in Table I-5-13. Using this approach, it was assumed that the trees planted in 2009 would achieve their full shade and wind protection potential (shown in Table I-5-14) in 2029, well after the conclusion of the 2009–2020 policy implementation period.

The total avoided GHG benefits are a function of three different types of impacts: reduced cooling demand, reduced demand for heating due to wind reduction, and increased demand for heating due to wintertime shading. An average potential GHG reduction factor of 0.054 tCO_2e/tree/year for trees in the North Central region was calculated from data in McPherson and Simpson in GTR-PSW-171.[80] The estimate assumed that the trees planted are split among residential settings with pre-1950, 1950–1980, and post-1980 homes using the default distribution for the North Central region provided by McPherson and Simpson of 42%, 48%, and 10%, respectively. This estimate further assumes a default distribution of trees planted around buildings, based on measured data from existing urban canopy in the region.

[78] D.J. Nowak and D.E. Crane. "Carbon Storage and Sequestration by Urban Trees in the USA." *Environmental Pollution* March 2002;116(3):381-389. Available at: http://www.treesearch.fs.fed.us/pubs/15521.

[79] U.S. Environmental Protection Agency. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006*. USEPA #430-R-08-005. April 2008. Available at: http://www.epa.gov/climatechange/emissions/usinventoryreport.html.

[80] E.G. McPherson and J.R. Simpson. *Carbon Dioxide Reduction Through Urban Forestry*: *Guidelines for Professional and Volunteer Tree Planters*. Appendix A, Table V.5. Gen. Tech. Rep. PSW-GTR-171. Washington, DC: USDA USFS, 1999. Available at: http://www.treesearch.fs.fed.us/pubs/6779.

Table I-5-13. Sliding scale applied to calculate the avoided GHG emissions resulting from urban tree planting

Year	Proportion of Maximum Benefit Achieved By Trees Planted This Year											
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
2009	0.05											
2010	0.10	0.05										
2011	0.15	0.10	0.05									
2012	0.20	0.15	0.10	0.05								
2013	0.25	0.20	0.15	0.10	0.05							
2014	0.30	0.25	0.20	0.15	0.10	0.05						
2015	0.35	0.30	0.25	0.20	0.15	0.10	0.05					
2016	0.40	0.35	0.30	0.25	0.20	0.15	0.10	0.05				
2017	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.10	0.05			
2018	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.10	0.05		
2019	0.55	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.10	0.05	
2020	0.60	0.55	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.10	0.05

To calculate potential avoided GHG emissions due to increased shading, it was assumed that all of the new trees are planted where they have a shading effect. Because these data were used as potential maxima, large trees planted (half evergreen, half deciduous) and the average tree distribution around buildings were also assumed. Note that these fossil fuel reduction factors are average for existing buildings and do not necessarily assume that trees are optimally placed around buildings to maximize energy efficiency. These factors are also dependent on the electricity fuel mix (e.g., coal, hydroelectric, nuclear) in the regions of interest and may thus change if the mix changes. The average urban tree planted in Iowa was assumed to result in avoided emissions of 0.055 tCO_2e/year (Tables I-5-14 and I-5-15).

Table I-5-14. Net GHG emission reductions from evergreen shade trees planted in the North Central climate region

Housing Age	Proportion of Urban Trees in This Housing Age Category	Cooling (tCO_2 saved per tree)	Heating (tCO_2 emitted per tree)	Wind (tCO_2 saved per tree)	Net Effect (tCO_2e/tree)
Pre-1950	0.42	0.0246	–0.0394	0.1436	0.1288
1950–1980	0.48	0.0178	–0.0353	0.1306	0.1131
Post-1980	0.1	0.0266	–0.0417	0.1425	0.1274
Weighted average (tCO_2e/tree/year)					**0.1211**

tCO_2 = metric tons of carbon; tCO_2e = metric tons of carbon dioxide equivalent.

Source: McPherson and Simpson, PSW-GTR-171, Appendix A, Table V.3.

Table I-5-15. Net GHG emission reductions from deciduous shade trees planted in the North Central climate region

Housing Age	Proportion of Urban Trees in This Housing Age Category	Cooling (tCO_2 saved per tree)	Heating (tCO_2 emitted per tree)	Wind (tCO_2 saved per tree)	Net Effect (tCO_2e per tree)
Pre-1950	0.42	0.0487	–0.0574	0.0000	–0.0087
1950–1980	0.48	0.0190	–0.0316	0.0000	–0.0126
Post-1980	0.1	0.0527	–0.0607	0.0000	–0.0080
Weighted average (tCO_2e/tree/year)					**–0.01050**

tCO_2 = metric tons carbon dioxide; tCO_2e = metric tons of carbon dioxide equivalent.

Source: McPherson and Simpson, PSW-GTR-171, Appendix A, Table V.3.

The annual avoided GHG benefit of trees in each year of the policy implementation period was calculated proportionally to the expected size of the trees in each age cohort in each year (Table I-5-16). For each year between 2009 and 2020, this was calculated by multiplying the number of trees planted in each preceding year by the maximum potential avoided GHG effect. This was then multiplied by the scaling factor (Table I-5-13) that represents the proportion of the maximum benefit achieved in a given year by trees planted in a prior year. For each year of policy implementation, the shade- and wind-protection effects of trees planted in that year and each prior year were summed to find the total avoided GHG impact of urban tree planting in that year (Table I-5-16).

Table I-5-16. Avoided GHG emissions from urban tree planting over the policy implementation period

Year	Cumulative GHG Savings From Shading Effects From Trees Planted in This Year												Total GHG Savings in This Year (tCO_2e)
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
2009	0.003												0.003
2010	0.006	0.003											0.009
2011	0.009	0.006	0.003										0.018
2012	0.012	0.009	0.006	0.003									0.030
2013	0.015	0.012	0.009	0.006	0.003								0.045
2014	0.018	0.015	0.012	0.009	0.006	0.003							0.063
2015	0.021	0.018	0.015	0.012	0.009	0.006	0.003						0.085
2016	0.024	0.021	0.018	0.015	0.012	0.009	0.006	0.003					0.109
2017	0.027	0.024	0.021	0.018	0.015	0.012	0.009	0.006	0.003				0.136
2018	0.030	0.027	0.024	0.021	0.018	0.015	0.012	0.009	0.006	0.003			0.166
2019	0.033	0.030	0.027	0.024	0.021	0.018	0.015	0.012	0.009	0.006	0.003		0.200
2020	0.036	0.033	0.030	0.027	0.024	0.021	0.018	0.015	0.012	0.009	0.006	0.003	0.236

GHG = greenhouse gas; tCO_2e = metric tons of carbon dioxide equivalent.

The total GHG benefit was calculated as the sum of direct carbon sequestration plus fossil fuel offset from reduced cooling demand and wind reduction. The avoided emissions and carbon sequestration benefits are summed in Table I-5-17 to show the total net benefits of urban tree planting over the policy implementation period.

Table I-5-17. Summary of GHG benefits from urban tree planting

Year	Number of Trees Planted This Year	Number of Trees Planted in Prior Years	Carbon Sequestered in Cumulative Trees Planted (tC/year)	Carbon Sequestered ($MMtCO_2e$/year)	Carbon Savings From Shading Effects ($MMtCO_2e$/year)	Total Carbon Savings ($MMtCO_2e$/year)
2009	1,093,208	0	4,695	0.017	0.003	0.020
2010	1,093,208	1,093,208	9,390	0.034	0.009	0.043
2011	1,093,208	2,186,417	14,085	0.052	0.018	0.070
2012	1,093,208	3,279,625	18,780	0.069	0.030	0.099
2013	1,093,208	4,372,833	23,475	0.086	0.045	0.131
2014	1,093,208	5,466,042	28,170	0.103	0.063	0.167
2015	1,093,208	6,559,250	32,865	0.121	0.085	0.205
2016	1,093,208	7,652,458	37,560	0.138	0.109	0.247
2017	1,093,208	8,745,667	42,255	0.155	0.136	0.291
2018	1,093,208	9,838,875	46,950	0.172	0.166	0.338
2019	1,093,208	10,932,083	51,645	0.189	0.200	0.389
2020	1,093,208	12,025,292	56,340	0.207	0.236	0.442
Total	**13,118,500**			**1.343**	**1.100**	**2.443**

tC = metric tons of carbon; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Since the full benefit of urban tree planting is not likely to be realized during the 11-year policy implementation period between 2009 and 2020, a separate analysis was also conducted to quantify the GHG benefit over the 40 years following the 11-year implementation period. This analysis assumed that the full GHG fossil fuel offset benefit of urban tree planting would be realized 20 years after tree planting, such that trees planted at the end of the policy implementation period (in 2020) would reach their full shading potential in 2039. The effects of trees planted between 2009 and 2020 were considered, but their benefits were calculated over the 40-year period to 2048. Results of this analysis are shown in Table I-5-18.

Table I-5-18. GHG savings over 40 years from urban trees planted during the policy implementation period

Year	Carbon Savings From Shading Effects ($MMtCO_2e$/year)	Carbon Sequestered In Cumulative Planted Trees ($MMtCO_2e$/year)	Total Carbon Savings ($MMtCO_2e$/year)
2009	0.003	0.017	0.020
2010	0.009	0.034	0.043
2011	0.018	0.052	0.070
2012	0.030	0.069	0.099
2013	0.045	0.086	0.131
2014	0.063	0.103	0.167
2015	0.085	0.121	0.205
2016	0.109	0.138	0.247
2017	0.136	0.155	0.291

Year	Carbon Savings From Shading Effects ($MMtCO_2e$/year)	Carbon Sequestered In Cumulative Planted Trees ($MMtCO_2e$/year)	Total Carbon Savings ($MMtCO_2e$/year)
2018	0.166	0.172	0.338
2019	0.200	0.189	0.389
2020	0.236	0.207	0.442
2021	0.272	0.207	0.479
2022	0.308	0.207	0.515
2023	0.345	0.207	0.551
2024	0.381	0.207	0.588
2025	0.417	0.207	0.624
2026	0.453	0.207	0.660
2027	0.490	0.207	0.696
2028	0.526	0.207	0.733
2029	0.559	0.207	0.766
2030	0.590	0.207	0.796
2031	0.617	0.207	0.823
2032	0.641	0.207	0.848
2033	0.662	0.207	0.869
2034	0.680	0.207	0.887
2035	0.695	0.207	0.902
2036	0.707	0.207	0.914
2037	0.717	0.207	0.923
2038	0.723	0.207	0.929
2039	0.726	0.207	0.932
2040	0.726	0.207	0.932
2041	0.726	0.207	0.932
2042	0.726	0.207	0.932
2043	0.726	0.207	0.932
2044	0.726	0.207	0.932
2045	0.726	0.207	0.932
2046	0.726	0.207	0.932
2047	0.726	0.207	0.932
2048	0.726	0.207	0.932
Cumulative totals	**18.140**	**7.13**	**25.27**

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Urban Forestry Costs

Data are available on the costs and cost savings of urban tree planting in the Midwest (McPherson 2006)[81]. The economic costs of tree planting take into account the cost of tree

[81] McPherson, Gregory. "Urban Forestry in North America" Renewable Resources Journal. Autumn 2006. http://www.fs.fed.us/ecosystemservices/pdf/urban-forestry-2006.pdf

planting and annual maintenance costs, including the costs of program administration and waste disposal. The economic benefits of tree planting include the cost avoided from reduced energy use. Data are also available on the estimated economic benefits of services (e.g., provision of clean air), hydrologic benefits (e.g., storm water control), and aesthetic enhancement. However, these co-benefits are not explicitly included in the analysis.

Costs and cost savings were estimated from published average annual costs and cost savings over 40 years, provided by public and private parties for a range of tree sizes. The cost estimate used in this analysis, $26.38/tree, was calculated as the average of small, medium, and large trees under public and private management. A cost savings of –$28.03/tree/year was also calculated as the average of small, medium, and large trees under public and private management. The average cost and cost savings values yield a net cost savings of –$1.65/tree (costs minus cost savings). Table I-5-19 shows estimated economic costs and cost savings for all categories.

Table I-5-19. Cost data for public and private entities in the Midwest planting small, medium, and large trees (40-year annual averages)

Tree Size	Private ($/tree)	Public ($/tree)	Average of Public and Private ($/tree)
Small (crabapple)			
Cost savings (energy saved)	$15.60	$18.64	$17.12
Costs*	$17.02	$26.87	$21.95
Medium (red oak)			
Cost savings (energy saved)	$20.31	$25.62	$22.97
Costs*	$20.66	$33.61	$27.14
Large (hackberry)			
Cost savings (energy saved)	$44.05	$43.93	$43.99
Costs*	$23.10	$36.99	$30.05
Average across small, medium, and large trees ($/tree)			
Cost savings (energy saved)			$28.03
Costs*			$26.38
Net costs			**–$1.65**

* Includes tree and planting, pruning, removal and disposal, pest and disease control, infrastructure repair, irrigation, cleanup, liability and legal costs, administration, and other.

The cost savings is estimated using 40-year averages; thus, it represents lifetime costs applicable in the year planted and every year thereafter during the time frame of this analysis (e.g., planting costs $80/tree in the year the tree is planted; however, the 40-year average cost is $10/tree). To estimate total cost savings, –$1.65/tree was multiplied by the cumulative number of trees planted each year (Table I-5-20). This corresponds to a cumulative cost saving (or NPV) of –$99 million from 2009 to 2020, with an estimated economic cost of –$21.84/t$CO_2$e. Over the 40-year period from 2009 to 2038, the NPV of this option is –$287 million, with an estimated economic cost of –$11.39/t$CO_2$e.

Table I-5-20. Summary of cost savings from urban tree planting during the policy implementation period

Year	Cumulative Number of Trees in Program	Total Carbon Savings ($MMtCO_2e$/year)	Net Costs	Discounted Costs
2009	1,093,208	0.058	–$1,803,794	–$1,803,794
2010	2,186,417	0.117	–$3,607,588	–$3,435,798
2011	3,279,625	0.175	–$5,411,381	–$4,908,282
2012	4,372,833	0.233	–$7,215,175	–$6,232,739
2013	5,466,042	0.292	–$9,018,969	–$7,419,928
2014	6,559,250	0.350	–$10,822,763	–$8,479,918
2015	7,652,458	0.408	–$12,626,556	–$9,422,131
2016	8,745,667	0.467	–$14,430,350	–$10,255,380
2017	9,838,875	0.525	–$16,234,144	–$10,987,907
2018	10,932,083	0.584	–$18,037,938	–$11,627,415
2019	12,025,292	0.642	–$19,841,731	–$12,181,102
2020	13,118,500	0.700	–$21,645,525	–$12,655,690
Total		**4.552**		**–$99,410,084**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Key Assumptions:

The agriculture analyses are based on the sequestration rate provided by CCX.

A once-off loan is required to incentivize the adoption of conservation tillage practices.

The GHG benefits of rotational grazing were estimated using the low end of the range provided by the CCX rangeland soil carbon management offset protocol. As a conservative estimate, the midpoint of this range was assumed (0.32 tCO_2e/acre/year). It was further assumed that this rate of accumulation occurred for the duration of the policy period.

Carbon credits will be generated through the CCX or a similar future program.

Key Uncertainties

The rate of soil carbon sequestration and time period for which sequestration occurs are areas of uncertainty and are ultimately dependent on site-specific conditions, such as soil quality, climatic conditions, and management practices.

Additional Benefits and Costs

Ancillary benefits from afforestation, such as avoided costs of pollution abatement, are not included in the cost savings. Improvements to barren lands accrued by returning to forestlands include increased local property values due to improved aesthetics, reduced amount and speed of runoff (reducing sedimentation, increasing water quality, and enhancing soil water retention), and improved wildlife habitat.

In addition to the numerous benefits articulated in the policy description, urban trees contribute to improved property values, add aesthetic values to residents and visitors, balance humidity, and reduce the intensity of stormwater runoff. Sociological studies suggest that neighborhoods that are more attractive and comfortable have lower crime rates.

Feasibility Issues

Once trees are planted, it could take 6–18 years before measurable carbon sequestration is achieved.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

AFW-6. Cellulosic Biofuel

Policy Description

Promote research and production of sustainable in-state fuels derived from cellulose (biomass) to displace the use of conventional petroleum-based fuels. Promote the in-state development of cellulosic feedstocks (including perennials) that can be utilized for the production of cellulosic fuels. Promote research into conversion technologies, such as thermochemical Fischer-Tropsch processes and enzymatic conversion, to facilitate their development.

Promote cellulosic biofuel production systems that improve the embedded energy content, life cycle, and carbon profile of biofuels. Focus on plant material feedstocks that favor energy production and are carbon neutral or negative and have multiple positive environmental benefits, such as maintaining carbon sequestration potential and soil productivity, and decreasing water and fossil fuel inputs during their production. This could help provide a strong economic market within the state and reduce GHG emissions through avoided fossil fuel consumption.

Note that this option is focused on the supply-side aspects of promoting biofuels, with an emphasis on the development of feedstocks and production technologies. The demand-side aspects of renewable fuels (including cellulosic biofuels) are being addressed under TLU-10 (Fuel Strategies [20% Low Carbon Fuel Standard]).

Policy Design

Goals: Increase in-state cellulosic feedstock production by 10 million dry tons by 2020.

Timing: Full implementation by 2020.

Parties Involved: State of Iowa, farmers, biofuel producers, distributors, fuel retailers, fuel wholesalers, business owners, and relevant agriculture and trade associations.

Other: None identified.

Implementation Mechanisms

- Tax incentives,
- State and federal cost-share programs for energy crop establishment,
- USDA value-added agriculture development grants,
- Federal Renewable Fuel Standard,
- Cellulosic fuel requirement standards and incentives,
- Research funding, and
- State fuel standards and incentives.

Related Policies/Programs in Place

None identified.

Type(s) of GHG Reductions

CO_2: Life-cycle emissions are reduced to the extent that biofuels are produced with lower embedded fossil-based carbon than conventional (fossil) fuel. Feedstocks used for producing biofuels can be made from crops or other biomass that contain carbon sequestered during photosynthesis (e.g., biogenic or short-term carbon).

Estimated GHG Reductions and Net Costs or Cost Savings

GHG Reduction Potential in 2012, 2020 (MMtCO_2e): 2.0 and 9.8, respectively.

Net Cost per tCO_2e: –$29.

Data Sources: Identified in methodology below.

Quantification Methods:

Biofuel GHG Reductions

For ethanol, the benefits for this option are dependent on developing in-state production capacity that achieves benefits beyond those of petroleum fuels.

The incremental benefit of cellulosic production targeted by this policy over gasoline is 9.79 tCO_2e reduced/1,000 gal. The emission factor value is based on the difference between the life-cycle CO_2e emission factor of gasoline (10.30 t/1,000 gal)[82] and the life-cycle CO_2e emission factor of cellulosic ethanol (1.38 t/1,000 gal).[83] Emission factors for gasoline and cellulosic ethanol are based on Argonne National Laboratory's (ANL's) Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model.[84] The cellulosic benefit value will be used along with the production in each year to estimate GHG reductions.

Table I-6-1 shows the number of cellulosic production plants that will need to go online in Iowa to achieve the goal of using 10 million short tons of feedstock annually. This analysis is primarily based on an NREL report regarding the capital costs of building a 69.3-million-gal/year cellulosic ethanol production plant that uses corn stover as the feedstock. The emissions reductions from this plant are calculated by multiplying the number of gallons produced in a given year by the emission reduction per gallon (9.79 tCO_2e/1,000 gal).

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[82] Argonne National Laboratory (ANL) Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model 1.8b emission factor for 50% conventional gasoline, 50% reformulated gasoline blend in g/mi x GREET model average fuel economy (100 mi/4.7 gal).

[83] Argonne National Laboratory (ANL) Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model 1.8b emission factor for mixed feedstock cellulosic E100 for flex-fuel vehicle in g/mi x GREET model average fuel economy (100 mi/4.7 gal).

[84] Download available from http://www.transportation.anl.gov/software/GREET.

Table I-6-1. Projected ethanol production and emission reductions

Year	Plants in Operation	Feedstock Used (million short tons annually)	Ethanol Produced (million gallons annually)	Emissions Reduction ($MMtCO_2e$)
2008	0	0.0	—	—
2009	0	0.0	—	—
2010	1	1.0	69	0.68
2011	2	2.0	139	1.35
2012	3	2.3	208	2.03
2013	4	3.1	277	2.70
2014	5	3.9	347	3.38
2015	6	4.6	416	4.05
2016	7	5.4	485	4.73
2017	8	6.2	554	5.40
2018	10	7.7	693	6.75
2019	12	9.2	832	8.10
2020	14.5	10.0	1,005	9.79
Total				**49.0**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Biofuel Costs

The costs of this option are estimated based on the capital and operating costs of cellulosic ethanol production plants. An NREL study estimated that total capital costs for a 70-million-gal/year cellulosic ethanol plant would be $200 million.[85] An EIA study cited a major biofuels manufacturer who estimated the costs of a first-of-its-kind 50-million-gal/year cellulosic ethanol plant to be $375 million.[86] An average of these costs was used in the estimate of capital costs. A new plant will need to be built for every 70 million gallons of annual ethanol production needed. It is assumed that the capital costs will be paid according to a cost recovery factor over the 20-year lifetime of the plant. O&M costs were also taken from the NREL study. The cost of biomass feedstocks made up a significant portion (approximately 60%) of variable costs. Therefore, the NREL estimate of feedstock costs ($30/ton) was replaced with a more current estimate of the cost of delivered biomass ($105/ton, which is the average of $74/ton for corn stover[87] and

[85] Aden, A., et al. Lignocellulosic Biomass to Ethanol Process Design and Economics Utilizing Co-Current Dilute Acid Prehydrolysis and Enzymatic Hydrolysis for Corn Stover. NREL/TP-510-32438. Golden, CO: National Renewable Energy Laboratory, June 2002. Accessed June 2008 at: http://www.nrel.gov/docs/fy02osti/32438.pdf.

[86] U.S. Department of Energy, Energy Information Administration. "Biofuels in the U.S. Transportation Sector." February 2007. Available at: http://www.eia.doe.gov/oiaf/analysispaper/biomass.html accessed July 2008.

[87] Edwards, William. "Estimating a Value for Corn Stover" Ag Decision maker File A1-70, December 2007. Available at: http://www.extension.iastate.edu/agdm/crops/html/a1-70.html. The maximum a livestock owner would pay for corn stover as feed, deflated to 2005$. Additional transportation costs of $14.75 were assumed, taken from Duffy, Mike. "Estimated Costs for Production, Storage and Transportation of Switchgrass," Ag Decision Maker File A1-22. Iowa State University Extension. February 2008. Available at: http://www.extension.iastate.edu/agdm/crops/html/a1-22.html.

$136/ton for switchgrass[88]). (See the Key Uncertainties section for a discussion of factors involved in feedstock costs.) The plant proposed by the NREL study produces some excess electricity, so the projected price of electricity from the Iowa common assumptions document is used to show the value of electricity sold to the grid by the plant. Another revenue source for the ethanol plant is the value of the ethanol produced. The wholesale price of ethanol was taken from AEO 2008 and was multiplied by the number of gallons produced annually.[89] (See the Key Uncertainties section for discussion of sensitivity to ethanol price.) In addition, it was assumed that a $1.01/gal federal tax credit for cellulosic ethanol is available from the Farm Bill (the Food, Conservation and Energy Act of 2008, H.R. 2419).[90] Table I-6-2 outlines the estimated cost and revenue streams for the policy. The total cost of the policy for 2008–2020, discounted to 2005 dollars, is estimated to be a net savings of $1,409 million.

Table I-6-2. Capital costs of constructing cellulosic ethanol plants

Year	Million Gallons of Ethanol Produced	Sale $/Gallon Ethanol (2005$)	Federal Subsidy ($/Gallon)	Annual Operating Costs ($MM)	Annualized Capital Costs ($MM)	Annual Revenue ($MM)	Net Costs/Savings (Discounted 2005$MM)	Net Costs/ Savings (Without Subsidy) ($MM)
2009	—	$1.85	$1.01	$0.0	$0.0	$0.0	$0.0	$0.0
2010	69	$1.72	$1.01	$133.1	$31.0	$195.6	–$24.8	$30.1
2011	139	$1.70	$1.01	$266.2	$61.9	$388.8	–$45.3	$59.2
2012	208	$1.69	$1.01	$399.2	$92.9	$579.4	–$62.0	$87.2
2013	277	$1.67	$1.01	$532.3	$123.8	$767.5	–$75.4	$114.1
2014	347	$1.65	$1.01	$665.4	$154.8	$953.1	–$85.7	$139.9
2015	416	$1.63	$1.01	$798.5	$185.8	$1,136	–$93.3	$164.5
2016	485	$1.69	$1.01	$931.6	$216.7	$1,353	–$119.5	$166.9
2017	554	$1.74	$1.01	$1,064	$247.7	$1,577	–$147.4	$164.4
2018	693	$1.80	$1.01	$1,331	$309.6	$2,010	–$196.1	$175.1
2019	832	$1.86	$1.01	$1,597	$371.5	$2,459	–$247.6	$176.6
2020	1,005	$1.91	$1.01	$1,930	$448.9	$3,027	–$312.0	$176.2
Total							**–$1,409**	**$1,454**

2005$MM = million 2005 dollars.

Key Assumptions:

The results presented in the analysis are contingent on the continuation of a federal subsidy on cellulosic ethanol across the entire policy period.

[88] The cost of energy crops was taken from Duffy, Mike. "Estimated Costs for Production, Storage and Transportation of Switchgrass," Ag Decision Maker File A1-22. Iowa State University Extension. February 2008. Available at: http://www.extension.iastate.edu/agdm/crops/html/a1-22.html. A profit margin of 20% was added to the $114 per ton to estimate the price paid by the end user.

[89] AEO 2008. Table A12.

[90] See Renewable Fuels Association. "Cellulosic Ethaol." Available at: http://www.ethanolrfa.org/resource/cellulosic/.

Emission factors for gasoline and cellulosic ethanol are based on the ANL GREET model.

The costs of this option are estimated based on the capital and operating costs of cellulosic ethanol production plants.

The wholesale price of ethanol was taken from AEO 2008. A federal tax credit for cellulosic ethanol of $1.01/gal was assumed.

Key Uncertainties

Sensitivity to oil and other fuel costs—The cost competitiveness of biofuels will depend on the cost of oil. Ethanol prices are sensitive to crude oil prices. In addition, as other fuel prices increase, transporting biomass to various ethanol plants will be more expensive.

Sensitivity to feedstock cost—The cost of the feedstock contributes a great deal of uncertainty to this option. The quantification assumed 50% switchgrass and 50% corn stover feedstock. For producers to grow switchgrass, it will have to have a competitive operation margin and be as profitable as other crops that they could grow or be competitive with pastureland rents. For example, a farmer growing corn with a yield of 145 bushels per acre could produce it at a cost of $4.17/bushel.[91] The current Chicago Board of Trade corn price is $5.65/bushel,[92] creating a profit of $215/acre. If this farmer also sold the corn stover for $57/ton, which is the average between the maximum livestock producers would be willing to pay for corn stover as feed and the cost of corn stover production and transportation,[93] then the profits increase to $253/acre. Assuming a switchgrass yield of 8 tons/acre, switchgrass would need to be selling at a $32 profit/ton to compete with the profits from corn. Producers will not grow energy crops unless they can make a profit. There is wide variability in potential income based on ethanol and oil prices. It will be difficult to produce a high volume of ethanol without a high contribution of biomass from energy crops.

Sensitivity to the wholesale price of ethanol—The cost or net revenue associated with production of cellulosic ethanol is extremely sensitive to the wholesale price of ethanol. The calculation was rerun using the current price of ethanol ($2.61 as of August 1, 2008,[94] deflated to 2005 dollars). The result is a net revenue of $68 million in 2010, a net revenue of $476 million in 2020, and a total net revenue for the policy period of 2008–2020 of $2,790 million, discounted to 2005

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[91] The figure 145 bushels/acre was taken from. Iowa State University Extension. "Estimated Costs of Crop Production in Iowa—2008." Ag Decision Maker File A1-20. January 2008. Available at: http://www.extension.iastate.edu/agdm/crops/pdf/a1-20.pdf.

[92] As of close on August 1, 2008, according to EthanolMarket.com, LLC. Available at: http://www.ethanolmarket.com/index.html.

[93] Edwards, William. "Estimating a Value for Corn Stover." Ag Decision Maker File A1-70. Iowa State University Extension. December 2007. Available at: http://www.extension.iastate.edu/agdm/crops/html/a1-70.html. Additional transportation costs of $14.75 were assumed, taken from Duffy, Mike. "Estimated Costs for Production, Storage and Transportation of Switchgrass." Ag Decision Maker File A1-22. Iowa State University Extension. February 2008. Available at: http://www.extension.iastate.edu/agdm/crops/html/a1-22.html.

[94] The daily state average fuel ethanol rack price for Iowa as of close of market on August 1, 2008, according to EthanolMarket.com. Available at: http://www.ethanolmarket.com/index.html,. Accessed August 4, 2008.

dollars. The uncertainty of future ethanol prices contributes a great degree of uncertainty to this policy quantification.

Carbon emissions from land-use change—Recent publications, such as Searchinger et al., 2008, have attempted to estimate the carbon emissions that result from land use being converted from forest to cropland to grow crops for fuel.[95] This is based on the argument that the conversion of current cropland from food/feed/fiber production in one part of the world will reduce the food/feed/fiber supply on the market and drive grassland or forest conversion to cropland in other parts of the world. There is still significant uncertainty regarding the value of carbon emissions resulting from land-use change. Additionally, conversion of cropland to fuel production may have impacts on food prices and supply.

Cost of cellulosic ethanol production—EIA has stated:

> "Capital costs for a first-of-a-kind cellulosic ethanol plant with a capacity of 50 million gallons per year are estimated by one leading producer to be $375 million (2005 dollars), as compared with $67 million for a corn-based plant of similar size, and investment risk is high for a large-scale cellulosic ethanol production facility. Other studies have provided lower cost estimates. A detailed study by the National Renewable Energy Laboratory in 2002 estimated total capital costs for a cellulosic ethanol plant with a capacity of 69.3 million gallons per year at $200 million."[96]

This NREL study uses an average of these two estimates throughout the policy period, but it is more likely that the earlier plants will have higher costs and later plants will be less expensive as understanding of cellulosic production increases.

It is uncertain if the federal subsidy on cellulosic ethanol will continue throughout the policy period.

Additional Benefits and Costs

Biochar—Biochar is a by-product of certain thermochemical energy production processes. The application of biochar to crop fields is believed to increase both soil productivity and soil carbon levels. The land application of biochar should be conducted, even though the level of GHG benefits is not fully understood and additional research is required.

Biorefineries may use excess agricultural waste products from the ethanol production process as an electricity source, decreasing their reliance on such sources as natural gas. This can provide economic and GHG benefits.

The electricity being sold to the grid is likely to replace electricity production already taking place and, therefore, could have significant GHG benefits. Since the emissions from the ethanol plant are already calculated into the life-cycle emissions of the fuel sold, electricity produced in

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[95] Searchinger, T., R. Heimlich, R.A. Houghton, F. Dong, A. Elobeid, J. Fabiosa, S. Tokgoz, D. Hayes, and T-H Yu. "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions From Land-Use Change." *Science* February 7, 2008;319(5867):1238-1240. Available at: http://www.sciencemag.org/cgi/content/abstract/1151861.

[96] U.S. Department of Energy, Energy Information Administration. "Biofuels in the U.S. Transportation Sector." February 2007. Available at: http://www.eia.doe.gov/oiaf/analysispaper/biomass.html. Accessed December 2007.

this manner is likely to have no emissions. The GHG benefits of this electricity sold may be significant, but were not calculated into this analysis.

The in-state production of biofuels provides an energy security benefit through reduced reliance on foreign oil.

Feasibility Issues

Implementation of this option requires additional research and development in cellulosic ethanol production methods, development of feedstock collection and delivery infrastructure, and successful negotiations with cellulosic technology leaders to establish pilot and commercial-scale plants in the state. Sourcing of feedstocks and the size and location of facilities (crushing and biodiesel production) must be addressed for optimization and planning. Trade-offs between food and fuel crops will be an important issue.

There may be an overlap among agricultural options that seek to increase and maintain crop acreage in no-till production or in conservation management programs. This could be in conflict with the higher levels of crop production proposed in this option.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

AFW-7. Improved On-Farm (or First Point of Purchase) Energy Use and Efficiency

Policy Description

Renewable energy can be produced and used on site at agriculture operations. For example, installing solar or wind power, using hydropowered generators for irrigation, and converting diesel farm equipment to more efficient or renewable energy technology will reduce CO_2 emissions. The use of energy-efficient products, such as improved grain dryers, heat exchangers (dairy), electric motors, and energy-efficient building design, should also be promoted.

Policy Design

Goals:

- *Renewable energy*—Increase renewable energy use at agriculture operations by 10% by 2020.
- *Energy efficiency*—Increase the energy efficiency of on-farm operations by 30% by 2020.

Timing: As stated above.

Parties Involved: Farmers and land managers.

Other: None identified.

Implementation Mechanisms

Mechanisms to encourage the use of renewable energy and energy efficiency measures could include energy audit programs, incentives, or subsidies. Potential technologies that could be used to improve on-farm efficiencies include efficient grain dryers and more efficient electric motors. Other technologies are considered in this analysis, but it is likely that they have similar costs.

Related Policies/Programs in Place

None identified.

Type(s) of GHG Reductions

CO_2: Improved efficiency can reduce electricity and fuel consumption and the associated GHGs.

Estimated GHG Reductions and Net Costs or Cost Savings

Table I-7-1. GHG reduction potential in 2012, 2020 ($MMtCO_2e$) and net cost per tCO_2e:

Policy Options	2012	2020	Cost- Effectiveness ($/tCO_2e$)
Renewable energy	0.02	0.08	$26
Energy efficiency	0.2	0.9	–$103

$/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Data Sources:

Renewable energy—Iowa Renewable Resource Energy Guide[97] may be valuable in estimating the costs of various renewable energy technologies on a small scale. If this policy is intended to install on-farm renewable energy on a large scale, then different cost estimates will be used, such as the 2006 EIA report *Assumptions for the Annual Energy Outlook 2006: With Projections to 2025*.[98]

Energy efficiency—Consumption of distillate fuel by the agriculture sector in Iowa was projected from historical data provided by EIA.[99] The petrodiesel emissions factor used is consistent with the California Climate Action Registry (10.05 tCO_2e/1,000 gal).[100] The costs of efficient pump technology come from the "2003 Farm and Ranch Irrigation Survey"[101] and EPA.[102] Fuel savings estimates for tire inflation come from the AgTech Center.[103] Agricultural sector electricity consumption was derived from the National Agricultural Statistics Service,[104] and historical electricity prices were from EIA.[105] In addition, Roger Wolf and Heath Elson at the Iowa Soybean Association were contacted to get estimates on the costs of an energy efficiency program in Iowa.

Quantification Methods:

Renewable Energy GHG Benefits

Potential renewable energy options available for Iowa farmers include wind, solar photovoltaics, solar thermal heating, and geothermal energy. Methane utilization is considered under AFW-4 and will not be covered here. A reasonable mix of these technologies will be based on Iowa's specific circumstances and will be informed by the statewide energy portfolio. Table I-7-2 shows

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97 Iowa Department of Natural Resources. *Iowa Renewable Energy Resource Guide*. Available at: http://www.iowadnr.com/pub.html

98 U.S. Department of Energy, Energy Information Administration. *Assumptions to the Annual Energy Outlook 2006: With Projections to 2030*. DOE/EIA-0554(2006). March 2006. Available at: http://tonto.eia.doe.gov/ftproot/forecasting/0554(2006).pdf.

99 U.S. Department of Energy, Information Administration. "Colorado Total Distillate Sales/Deliveries to Farm Consumers." 1984–2006. Accessed on 4/25/08 at: http://tonto.eia.doe.gov/dnav/pet/hist/kd0vfmsia1a.htm.

100 California Climate Action Registry (CCAR). "The General Reporting Protocol." March 2007. Available at: http://www.climateregistry.org/.

101 U.S. Department of Agriculture, National Agricultural Statistics Service. "2003 Farm and Ranch Irrigation Survey." Table 20—Energy Expenses for On-Farm Pumping of Irrigation Water by Water Source and Type of Energy: 2003 and 1998. Available at: http://www.agcensus.usda.gov/Publications/2002/FRIS/tables/fris03_20.pdf.

102 Weddington, J., and P. Canessa. "Diesel Pumping Efficiency Program." Submitted to U.S. EPA, Region 9. October 31, 2006. Available at: http://www.pumpefficiency.org/ - dpep.

103 Alberta Government. "Farmers Can Save Big Money on Fuel." Agtech Innovator #2. April 2001. Available at: http://www1.agric.gov.ab.ca/$Department/newslett.nsf/all/agin147.

104 U.S. Department of Agriculture, National Agricultural Statistics Service. "Iowa Agriculture: A Profile." 2005 data. Accessed on April 25, 2008, at http://www.nass.usda.gov/Data_and_Statistics/Quick_Stats/.

105 U.S. Department of Energy, Energy Information Administration. "Current and Historical Monthly Retail Sales, Revenues, and Average Retail Price by State and by Sector (Form EIA-826)." Table accessed on 4/25/08, at www.eia.doe.gov/cneaf/electricity/page/sales_revenue.xls.

the assumed generation mix used in this analysis. Table I-7-3 shows the assumed capacity factors and levelized costs estimate used for each of these technologies. These numbers come from consultation with the CRE Subcommittee.

Table I-7-2. Assumed mix of generation

Year	Share of Wind	Share of Solar Thermal	Share of Solar PV	Share of Geothermal
2009	98%	1%	1%	0%
2010	98%	1%	1%	0%
2011	97%	1%	1%	0%
2012	96%	2%	2%	1%
2013	94%	2%	2%	1%
2014	93%	3%	3%	2%
2015	92%	3%	3%	2%
2016	92%	3%	3%	2%
2017	92%	3%	3%	2%
2018	91%	3%	3%	3%
2019	91%	3%	3%	3%
2020	91%	3%	3%	3%

PV = photovoltaics.

Table I-7-3. Assumed capacity factors

Quantification Items	Wind	Solar Thermal	Solar PV	Geothermal
Capacity factor	35%	35%	30%	75%
Levelized costs (2005$/MWh)	28	114	181	54

PV = photovoltaics; 2005$/MWh = 2005 dollars per megawatt-hour.

The GHG benefits were quantified on the basis of emission differences between the renewable portfolio and the grid electricity that it is replacing. The analysis assumes that renewable energy will be used to replace 10% of on-farm electricity. The BAU projections of electricity use come from the Iowa I&F using the electricity consumption estimates for 2005–2020. The share being consumed in on-farm use was calculated by multiplying the national agricultural electricity use by Iowa's share of total agricultural emissions.

Renewable Energy Costs

The costs/benefits of incentivizing each technology were considered. Costs were based on the portfolio of technologies considered and the different costs of each, as seen in Table I-7-3. The costs and GHG benefits of the renewable energy option are shown in Tables I-7-4 and I-7-5.

Table I-7-4. GHG benefits of renewable energy option

Year	BAU Iowa Agriculture Electricity Use (MWh)	Percentage of New Renewables	Additional Renewable Generation (MWh)	$MMtCO_2e$ Reduced From Renewable Generation
2009	931,905	0.7%	6,213	0.004
2010	945,697	1.3%	12,609	0.009
2011	959,693	2.0%	19,194	0.013
2012	973,897	2.7%	25,971	0.018
2013	988,311	3.3%	32,944	0.023
2014	1,002,938	4.7%	46,804	0.032
2015	1,017,781	6.0%	61,067	0.042
2016	1,032,844	6.7%	68,856	0.048
2017	1,048,130	7.7%	80,357	0.055
2018	1,063,643	8.7%	92,182	0.064
2019	1,079,385	9.3%	100,743	0.070
2020	1,095,359	10.0%	109,536	0.076
Cumulative Savings (2009–2020)				**0.453**

BAU = business as usual; MWh = megawatt-hour; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Table I-7-5. Costs of renewable energy option

Year	Cost of Wind Generation	Cost of Solar Thermal Generation	Cost of Solar PV Generation	Cost of Geothermal Generation	Total Costs
2009	$170,476	$7,082	$11,245	$0	$188,804
2010	$345,999	$14,375	$22,823	$0	$383,196
2011	$520,231	$30,633	$48,637	$4,146	$603,647
2012	$695,181	$53,292	$84,612	$11,219	$844,304
2013	$870,768	$82,623	$131,182	$21,348	$1,105,920
2014	$1,221,391	$138,726	$220,258	$40,438	$1,620,814
2015	$1,573,082	$208,849	$331,593	$65,952	$2,179,476
2016	$1,769,882	$235,488	$373,890	$81,801	$2,461,061
2017	$2,060,988	$274,820	$436,337	$104,142	$2,876,286
2018	$2,359,131	$315,264	$500,550	$129,424	$3,304,369
2019	$2,572,562	$344,540	$547,032	$152,323	$3,616,456
2020	$2,790,976	$374,613	$594,780	$177,448	$3,937,817
Cumulative Costs					**$23,122,151**

PV = photovoltaics.

Energy Efficiency GHG Benefits

This analysis also considered various technologies for reducing on-farm energy consumption, such as education programs to explain the importance of correct tire inflation, improving the efficiency of electrical and diesel water pumps, improving the efficiency of lighting, and providing incentives for more efficient tractors. Other options, such as efficient grain dryers and more efficient electric motors, could provide GHG benefits and will be utilized when farms undertake the energy audit. The GHG benefits—calculated on the basis of emissions avoided because of new technologies—could come in the form of fuel savings or reduced electricity consumption. The total GHG benefit was calculated on the basis of emissions factors of the various fuels (CO_2e/Btu or gal) or electricity (CO_2e/kWh). The BAU projections of electricity use come from the Iowa I&F, using estimates for electricity consumption between 2005 and 2020. The share being consumed in on-farm use was calculated by multiplying national agricultural electricity use by Iowa's share of total agricultural emissions. By dividing the amount of fuel sold for agricultural use in Iowa by the cost of a gallon of diesel fuel in 2006, the BAU fuel use was determined (both figures from USDA). No growth in diesel fuel consumption was assumed because of conflicting growth estimates. The savings for the energy efficiency technologies considered did not meet the goal of the policy, so an energy audit program was also included. This program will provide state funding for energy audits to improve the energy efficiency of farms across Iowa. It is assumed that these audit programs will find energy efficiency gains at a similar cost/benefit to that of the efficiency technologies considered in this analysis.

Efficiency Costs

This analysis will be done by examining the cost of installing or optimally using various technologies (e.g., more efficient pumps). To maximize pump efficiency, pumps must be tested and replaced periodically, which requires a capital investment. Table I-7-6 shows the costs and GHG benefits of one energy efficiency program considered—improving the efficiency of diesel water pumps. This is the type of efficiency improvement that could be recommended from the energy audit.

Table I-7-6. Example of one energy efficiency program (diesel pumps)

Year	Gallons Saved (Pumping)	Cost of Retrofitting	Fuel Savings	Net Cost (Pumps)	tCO_2e Saved
2009	24,462	$32,794	$53,811	($21,017)	246
2010	27,520	$36,894	$60,538	($23,644)	276
2011	30,578	$40,993	$67,264	($26,271)	307
2012	33,636	$45,092	$73,991	($28,898)	338
2013	36,693	$49,192	$80,717	($31,526)	369
2014	39,751	$53,291	$87,444	($34,153)	399
2015	42,809	$57,390	$94,170	($36,780)	430
2016	45,867	$61,490	$100,897	($39,407)	461
2017	48,924	$65,589	$107,623	($42,034)	491
2018	51,982	$69,688	$114,349	($44,661)	522
2019	55,040	$73,788	$121,076	($47,288)	553
2020	58,098	$77,887	$127,802	($49,915)	584

tCO_2e = metric tons of carbon dioxide equivalent.

By using estimates of the total number of pumps potentially available in Iowa, the total costs of this project can be determined. This total cost figure will be balanced against the fuel/electricity savings that occur with such an efficiency investment. The diesel pump program includes the costs of testing ($200/test, one test assumed every 5 years) and the cost of retrofitting older pumps to be more efficient ($24,913).[106] Since this results in an efficiency improvement of 41%, on average, it will save more than 23,000 gallons during the lifetime of the pump.

The cost of the energy audit program is assumed to be $500,000 annually for staffing/travel costs and $1,000 for every energy audit performed.[107] The number of energy audits performed depends on the amount of energy savings required to meet the energy efficiency goal for the year. Since each of the energy efficiency programs considered in this analysis (e.g., efficient pumps, tire inflation, and lighting) has negative net costs, the money spent on the energy audit program is recouped throughout the period. Table I-7-7 shows the GHG savings for each year attained by the example programs. Table I-7-8 shows the amount of savings still required to meet the policy goal, which is assumed to come from the energy audit. Costs and savings from the energy efficiency programs are discounted back to 2005 dollars.

Table I-7-7. GHG benefits of example energy efficiency programs

Year	$MMtCO_2e$ Saved, Example Programs	Goal, $MMtCO_2e$ Saved	Percentage Attained With Example Programs*
2010	0.07	0.121	58%
2011	0.08	0.183	43%
2012	0.09	0.244	35%
2013	0.09	0.306	31%
2014	0.10	0.430	24%
2015	0.11	0.555	20%
2016	0.12	0.619	19%
2017	0.12	0.714	17%
2018	0.13	0.810	16%
2019	0.14	0.875	16%
2020	0.15	0.941	16%
Total		**5.86**	

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

* Technologies considered include diesel and electric water pumps, efficient tire inflation, more efficient tractors, and improved lighting in buildings.

[106] Weddington, J., and P. Canessa. "Diesel Pumping Efficiency Program." Submitted to U.S. EPA, Region 9. October 31, 2006. Available at: http://www.pumpefficiency.org/About/literature/Final%20Diesel%20Pumping%20Efficiency%20Report,%20USEPA.doc.

[107] This estimate comes from personal communication with Heath Elson, Iowa Soybean Association (ISA). ISA conducted an energy audit program in Iowa where consultants were paid $500 to work with local farmers on reducing field energy use. This estimate was doubled to account for auditing potential building/storage energy use.

Table I-7-8. Costs and savings from energy efficiency programs

Year	Percent of Goal From Energy Audit	Cost of Energy Audit Program	Cost Savings of Energy Audit Program	Discounted Net Costs of Energy Audit Program	Discounted Costs of Entire Energy Efficiency Program
2010	42%	$8,048,478	–$10,641,739	–$2,031,887	–$13,510,406
2011	57%	$10,768,907	–$21,795,508	–$8,228,220	–$20,377,883
2012	65%	$12,133,210	–$33,039,140	–$14,857,454	–$27,586,987
2013	69%	$12,955,093	–$44,370,991	–$21,263,517	–$34,488,863
2014	76%	$14,210,678	–$68,616,494	–$35,070,475	–$48,714,317
2015	80%	$14,910,092	–$93,036,760	–$47,962,997	–$61,954,301
2016	81%	$15,048,387	–$104,718,654	–$52,428,348	–$66,701,939
2017	83%	$15,305,566	–$122,967,540	–$59,950,216	–$74,446,377
2018	84%	$15,504,723	–$141,349,810	–$66,738,337	–$81,402,439
2019	84%	$15,564,727	–$153,345,106	–$69,588,454	–$84,370,601
2020	84%	$15,617,900	–$165,433,156	–$72,063,699	–$86,918,403
Total					**–$610,836,227**

Key Assumptions: The technologies considered as examples provide a reasonable picture of the costs and benefits of energy efficiency improvements in the state.

Key Uncertainties

Renewable energy—The costs and capacity factors of the various renewable energy sources considered could all change, based on fluctuations in the energy market and possible technological improvements.

Energy efficiency—It is uncertain whether the energy efficiency gains being found in the energy audit program are realistic. It is possible that some of the energy efficiency investments needed to reach the goal of increasing on-farm efficiency by 30% will be quite expensive. If that is the case, then the cost estimates will not be accurate.

Additional Benefits and Costs

Renewable energy—The benefits from distributed generation are not accounted for in this analysis. Lower transmission losses and reduced investment in electrical infrastructure can serve to make distributed renewable generation more cost-effective when implemented across the state.

- Reduced grid demand, and therefore a reduction in other non-GHG pollutants related to electricity generation.

Energy efficiency—Reduced non-GHG pollution caused by the combustion of diesel fuel.

- Many of the strategies discussed in this section are shown to save water, labor hours, and equipment wear.

Feasibility Issues

Renewable energy—Implementing renewable projects on a small scale (e.g., on-farm operations) can often be difficult and expensive. This may be a limiting factor in the implementation of this option.

Energy efficiency—Improving the availability of information to farm operators regarding adjustments in equipment or practices (i.e., tire pressure) may not have a large impact on fuel savings.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

AFW-8. Waste Management Strategies

Policy Description

Reduce the volume of waste from residential, commercial, and government sectors through programs that reduce the generation of wastes. Reducing generation at the source reduces landfill emissions and upstream production emissions.

Increase recycling or reuse of waste to limit GHG emissions associated with landfill methane generation and with the production and transport of products and packaging from virgin materials (noting that different recycled materials will exhibit different costs and benefits on a life-cycle basis). Increase recycling programs, create new recycling programs, provide incentives for recycling construction materials, develop markets for recycled materials, and increase average participation and recovery rates for all existing recycling programs.

Increase organics management programs, such as composting, to reduce GHG emissions associated with landfilled organic waste.

Policy Design

Three approaches are possible: (1) recycling, (2) waste prevention, and (3) market-driven approach—i.e., producer responsibility (voluntary and mandatory systems).

Goals:

- *Waste prevention*—Achieve a 5% per capita decrease in waste production (compared to that in 2005) from residential, commercial, and government sectors by 2020.
- *Reuse and recycling*—Increase the statewide recycling rate average to 50% by 2020 compared to the amount of waste produced. (If waste is minimized, then there will be less material to recycle.)
- *Extended producer responsibility*—Reach an agreement with manufacturers, producers, and retailers to reduce by 10% the quantity of packaging on the market and pursue more environmentally friendly packaging.
- *Life-cycle product stewardship*—Work with U.S. industry to achieve life-cycle product stewardship so that products are designed for reuse, repair (not planned obsolescence), and recycling. Alternatively, shift the responsibility for managing discarded products and packaging from local government to producers of products [nonquantified goal].

Timing: As stated above.

Parties Involved: Municipal solid waste (MSW) site owners and managers, recycling managers, and waste collectors.

Other: In 2005, Iowa diverted 29.3% of generated MSW from landfills (Table I-8-1). The recycling rate was 27.1%, and the composting rate was 2.1%. Compostable organics comprised 9.8% of the total waste generated, setting the upper bound for the composting goal.[108]

Table I-8-1. 2005 baseline waste generation and diversion

Item	2005
Total generation (tons)	3,775,550
Iowa population	2,955,587
MSW generation per capita (tons per person)	1.28
Landfill disposal (tons)	2,679,700
Total diversion (tons)	1,108,531
Diversion %	29.3%
Recycling (tons)	1,028,077
Recycling %	27.1%
Composting (tons)	80,454
Composting %	2.1%

MSW = municipal solid waste.

Data needed to estimate the future generation of MSW in Iowa are not available from the resources on the IA DNR Web site. Therefore, the Center for Climate Strategies (CCS) assumed that the per capita MSW generation rate would follow the same trend as the national MSW generation rate. Table I-8-2 identifies the average annual increase in per capita MSW generation as 0.14%.[109] This results in an increase in waste generation from 1.28 tons/person/year in Iowa in 2005 to 1.30 tons/person/year in 2020.

Table I-8-2. National MSW generation rates

Year	Generation (tons)	Population	Generation (tons per capita/year)	Generation (pounds per capita/day)	Annual % Change in Generation Per Capita
1990	205,210,000	249,907,000	0.82	4.50	
2000	238,260,000	281,422,000	0.85	4.64	0.31%
2002	239,390,000	287,985,000	0.83	4.55	–0.91%
2004	249,180,000	293,660,000	0.85	4.65	1.04%
2005	248,150,000	296,410,000	0.84	4.59	–1.34%
2006	251,340,000	299,398,000	0.84	4.60	0.27%
Average Annual Change 1990–2006					**0.14%**

MSW = municipal solid waste

[108] Iowa Department of Natural Resources (IA DNR). "Economic Impacts of Recycling in Iowa." December 2007. Accessed on March 7, 2008 from; http://www.iowadnr.com/waste/recycling/files/ecofullreport.pdf. The 2005 baseline data is estimated from Table 7.1 of the "Economic Impacts of Recycling in Iowa" report.

[109] EPA. U.S. Municipal Solid Waste Stream 1960-2006. Accessed on May 23 at http://www.epa.gov/epaoswer/non-hw/muncpl/pubs/06data.pdf.

Waste Prevention

- The route to waste prevention requires a combination of initiatives by manufacturers and retailers, governmental intervention, and better informed consumers.
- Waste prevention and recycling are at different ends of the spectrum. Recycling programs do not further the goals of waste prevention.
- The incentive for manufacturers, producers, and consumers to minimize waste is greatly reduced when the emphasis is on municipal recycling programs.
- There is insufficient awareness and understanding of the benefits and methodology of waste prevention. The emphasis in the public and private sectors is predominantly on "end-of-pipe" waste treatment, rather than on prevention.
- With waste prevention, GHG emissions associated with waste disposal are avoided along with all the emissions associated with extraction, manufacturing, and transport. Waste prevention is genuinely sustainable resource management.
- Manufacturing take-back programs create an incentive for waste minimization.
- Consumer education on waste-related purchase behavior has little impact because consumers have a tendency to rank price, convenience, and brand name as more critical than environmental considerations.
- EPA estimates that for each person participating in a pay-as-you-throw program, GHG emissions are reduced by an average of 0.312 tCO_2e.[110]

Recycling

- Goals of ever higher recycling targets will have higher costs. There is increasing demand for more materials to be added to recycling programs, which will further escalate costs and add to risks of being able to market the materials collected.
- High recycling rates inadvertently justify high consumption rates. Statutory recycling targets do not prevent waste, but force the focus on recycling.
- Providing garbage collection more frequently than recycling collection encourages disposal rather than recycling.
- The development of integrated waste management facilities, such as commercial material recovery facilities (MRFs) and biodegradable waste composting facilities are complex and expensive, and siting such facilities is problematic if not impossible.
- Flow control will become an issue if Iowa establishes waste rules and regulations that are more stringent, onerous, and more costly than those of surrounding states.
- The overriding goal should be on climate change; the potential of source reduction or recycling to achieve the goal of reducing GHG emissions should be evaluated.
- As the principal generator of waste, industry is a crucial stakeholder in the effective implementation of waste reduction and recycling.

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[110] U.S. EPA. 2003. "Program Snapshot – Pay-as-you-throw: A Cooling Effect on Climate Change." March 2003. Report No. EPA 530-F-03-008. Available at: http://www.epa.gov/osw/nonhaz/municipal/pubs/ghg/climpayt.pdf.

Implementation Mechanisms

- Assist in the creation and expansion of sustainable markets to support diversion and recycling efforts.
- Introduce appropriate financial, legal, and policy incentives and sanctions to induce waste generators to prevent waste and recycle.
- Focus local government efforts to require multifamily recycling.
- Focus local government efforts to require construction and demolition recycling.
- Make recycling more convenient and cost-effective when compared to waste disposal, e.g., implement curbside single-stream recycling systems and food waste collection.
- Implement incentives for customers to reduce waste through meaningful unit-based pricing systems for waste disposal in all regions with large populations.
- Establish composting programs for yard waste and food waste in all regions with combined large populations.
- Pilot commercial MRFs through which all commercial waste will be processed before residuals are disposed of (not front-end).
- Require mandatory life-cycle product stewardship (extended producer responsibility) that is designed, financed, and managed by manufacturers of consumer goods.
- Hold manufacturers responsible for the waste and environmental impacts of their products and packaging (producer responsibility), rather than passing that responsibility on to the consumer.
- Place a tax on plastic bags.
- Establish statewide landfill bans for select materials that can be reused, recycled, or otherwise recovered.
- Expand the materials collected through the Bottle Bill and increase financial incentives for collectors.
- Educate the community about the consequences of generating waste and responsible consumerism.
- Clearly define waste reduction and establish as a priority.
- Distribute information on how to reduce unwanted mail and catalogs.
- Encourage use of reusable shopping bags.
- Promote "simple living" and local purchasing.
- Promote an economic environment that favors the use of recycled materials.

Related Policies/Programs in Place

Waste Management Programs: Iowa runs several programs to promote waste reduction, recycling, and composting. These programs include IA DNR's Solid Waste Alternatives

Program, Pollution Prevention Services Program, and Iowa Waste Exchange, as well as the Iowa Waste Reduction Center at the University of Northern Iowa.

Landfill Diversion Goals: Iowa adopted the goal of diverting 50% of waste from landfills by 2000 from 1988 levels.

Type(s) of GHG Reductions

CO_2: Upstream energy use reductions—The energy and GHG intensity of manufacturing a product is generally less when using recycled feedstocks than when using virgin feedstocks.

CH_4: Diverting biodegradable wastes from landfills will result in a decrease in methane gas releases from landfills.

Estimated GHG Reductions and Net Costs or Cost Savings

GHG Reduction Potential in 2012, 2020 ($MMtCO_2e$): 1.49 and 4.06, respectively.

Net Cost per tCO_2e: –$8.

Data Sources: Data on current waste generation and recycling rates were taken from the IA DNR 2007 report *Economic Impacts of Recycling in Iowa*.[111] IA DNR reports the composting of yard trimmings and food wastes as a part of the recycling stream in this report. GHG emission reductions were modeled using EPA's WAste Reduction Model (WARM).[112]

Quantification Methods:

The waste management profile in Iowa presented in the Policy Design section was used as a baseline to project BAU and policy scenarios, which form the basis for this quantitative analysis. The average annual increase in per capita waste generation is assumed to be 0.14% (Table I-8-2). The share of waste management comprised of recycling and composting is assumed not to change throughout the policy period. Therefore, the assumed recycling rate was 27.1%, and the assumed composting rate was 2.1%.[113] The population projection for Iowa through 2020 is

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[111] Iowa Department of Natural Resources. *Economic Impacts of Recycling in Iowa: Final Report*. December 2007. Accessed on March 7, 2008 from; http://www.iowadnr.com/waste/recycling/files/ecofullreport.pdf. The 2005 baseline data is estimated from Table 7.1 of the report.

[112] U.S. Environmental Protection Agency. "WAste Reduction Model (WARM)." Version 8, May 2006. Available at: http://www.epa.gov/climatechange//wycd/waste/calculators/WARM_home.html. EPA created WARM to help solid waste planners and organizations track and voluntarily report GHG emission reductions from several different waste management practices. WARM is available as a Web-based calculator and as a Microsoft Excel spreadsheet. WARM calculates and totals GHG emissions of baseline and alternative waste management practices—source reduction, recycling, combustion, composting, and landfilling. The model calculates emissions in tons of carbon equivalent (tCe), tCO_2e, and energy units (MMBtu) across a wide range of material types commonly found in MSW. For an explanation of the methodology, see the EPA report *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*, EPA530-R-02-006, May 2002. Available at http://epa.gov/climatechange/wycd/waste/SWMGHGreport.html.

[113] All organic material that is "recycled" is considered to be "composted," as a result of modeling constraints, As recycling and composting have different implications in the analysis of the GHG benefits and cost-effectiveness of this option, the two management methods are treated separately, with the total diversion equal to the target of 35%. Please note that the term "diversion" refers to the combination of recycling and composting.

consistent with the projection used by the Iowa I&F. Table I-8-3 outlines the projected BAU waste management scenario for Iowa.

Table I-8-3. BAU waste management, 2005–2020

Quantification Factors	2005	2010	2012	2015	2020
MSW generation per capita (tons/person)	1.28	1.29	1.29	1.30	1.30
Iowa population (from I&F)	2,955,587	3,009,907	3,016,485	3,026,380	3,020,496
MSW generation (tons)	3,775,550	3,871,850	3,891,152	3,920,286	3,940,048
MSW recycled (tons, 27.2% of generation, not including organics)	1,024,636	1,050,770	1,056,008	1,063,915	1,069,278
Organic composting (tons, 2.1% of generation)	80,185	82,230	82,640	83,259	83,678
MSW disposed in landfills (tons)	2,670,730	2,738,850	2,752,504	2,773,113	2,787,092

MSW = municipal solid waste; I&F = Iowa Inventory and Forecast.

The policy scenario was determined by applying the Subcommittee targets to the BAU waste management projection in Table I-8-3. Interim targets for 2012 were estimated, assuming that recycling and composting each makes up a constant proportion of the goal. The 2012 targets for recycling and composting are 35.5% and 3.5%, respectively. The 2020 targets for recycling and composting are 45.0% and 5.0%, respectively. The waste reduction goal (5% decrease in waste per capita by 2020) is applied by assuming a constant reduction in the difference between the BAU projected annual increase in the generation per capita rate and the 2005 baseline generation per capita rate. Table I-8-4 outlines the policy waste management scenario.

Table I-8-4. Policy waste management, 2005–2020

Quantification Factors	2005	2010	2012	2015	2020
MSW generation per capita (tons/person)	1.28	1.28	1.27	1.25	1.22
Iowa population (from I&F)	2,955,587	3,009,907	3,016,485	3,026,380	3,020,496
MSW generation (tons)	3,775,550	3,847,020	3,816,478	3,770,379	3,665,543
MSW recycled (tons)	1,024,636	1,214,823	1,380,346	1,527,600	1,773,022
Organic composting (tons)	80,185	107,197	132,280	156,551	197,002
MSW disposed in landfills (tons)	2,670,730	2,524,999	2,303,851	2,086,229	1,695,519

MSW = municipal solid waste; I&F = Iowa Inventory and Forecast.

Table I-8-5 displays the incremental changes in waste management, or the difference between the BAU and policy scenarios. These numbers represent the changes in waste management as a result of this option. They are the basis for the GHG benefit and cost-effectiveness measurements.

Table I-8-5. Incremental changes in waste management, 2005–2020

Quantification Factors	2005	2010	2012	2015	2020
MSW generation (tons, source reduction)	—	24,830	74,675	149,907	274,505
Recycling (tons)	—	164,053	324,338	463,685	703,743
Organic composting (tons)	—	24,967	49,640	73,292	113,324
Landfill disposal (tons)	—	–213,851	–448,653	–686,884	–1,091,573

MSW = municipal solid waste.

GHG Benefits

GHG benefits were determined by using WARM,[114] which uses information for specific material inputs and disposal/diversion methods to estimate GHG emission reductions based on BAU and policy scenarios. Table I-8-6 describes the 2005 data inputs for the WARM.[115] These numbers will represent the baseline scenario.

Table I-8-6. Baseline WARM model inputs for Iowa, 2005

Material	Tons Generated	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted
Aluminum cans	28,411	21,979	6,432		N/A
Steel cans	31,418	10,516	20,902		N/A
Copper wire					N/A
Glass	99,872	63,428	36,444		N/A
HDPE	26,438	5,000	21,438		N/A
LDPE	610	610			N/A
PET	25,139	11,740	13,399		N/A
Corrugated cardboard	330,237	149,625	180,612		N/A
Magazines/third-class mail	186,775		186,775		N/A
Newspaper	325,214	240,000	85,214		N/A
Office paper	55,004	2,750	52,254		N/A
Phonebooks					N/A

[114] U.S. Environmental Protection Agency. WAste Reduction Model (WARM)." Version 8, May 2006. Available at: http://www.epa.gov/climatechange//wycd/waste/calculators/WARM_home.html. EPA created WARM to help solid waste planners and organizations track and voluntarily report GHG emission reductions from several different waste management practices. WARM is available as a Web-based calculator and as a Microsoft Excel spreadsheet. WARM calculates and totals GHG emissions of baseline and alternative waste management practices—source reduction, recycling, combustion, composting, and landfilling. The model calculates emissions in tCe, tCO_2e, and energy units (MMBtu) across a wide range of material types commonly found in MSW. For an explanation of the methodology, see the EPA report *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*, EPA530-R-02-006, May 2002. Available at: http://epa.gov/climatechange/wycd/waste/SWMGHGreport.html

[115] Iowa Department of Natural Resources. *Economic Impacts of Recycling in Iowa: Final Report*. December 2007. Accessed on March 7, 2008, from; http://www.iowadnr.com/waste/recycling/files/ecofullreport.pdf. The 2005 baseline data are estimated from Table 7.1 of the report.

Material	Tons Generated	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted
Textbooks					N/A
Dimensional lumber	344,525	167,665	176,860		N/A
Medium-density fiberboard					N/A
Food scraps	225,595	N/A	225,095		500
Yard trimmings	101,573	N/A	34,300		67,273
Grass		N/A			
Leaves		N/A			
Branches		N/A			
Mixed paper (general)	349,636	153,214	196,422		N/A
Mixed paper (primarily residential)					N/A
Mixed paper (primarily from offices)					N/A
Mixed metals	250,620	178,000	72,620		N/A
Mixed plastics	298,059	16,959	281,100		N/A
Mixed recyclables					N/A
Mixed organics	44,301	N/A	31,620		12,681
Mixed MSW	1,007,566	N/A	1,007,566		N/A
Carpet	575	575			N/A
Personal computers	51,281	634	50,647		N/A
Clay bricks		N/A		N/A	N/A
Concrete	5,382	5,382		N/A	N/A
Fly ash				N/A	N/A
Tires					N/A
Totals	**3,788,231**	**1,028,077**	**2,679,700**	—	**67,773**

N/A = not applicable; HDPE = high-density polyethylene; LDPE = low-density polyethylene; PET = polyethylene terephthalate; MSW = municipal solid waste.

The WARM was run for the years 2012 and 2020 to produce GHG reduction estimates for the policy target years. GHG benefits are assumed to increase linearly between policy initiation (2010) and between modeled years. The proportional generation and recycling are assumed to stay the same throughout the policy period. The exceptions, however, are those categories for which source reduction is an acceptable input for the policy scenario. It is assumed that source reduction offsets landfilled waste, with the amount of waste recycled generally increasing for these categories. The breakdown of source reduction for each waste category is shown in Table I-8-7.[116] Tables I-8-8 and I-8-9 display the BAU and policy WARM modeling for 2020.

[116] This breakdown is similar to the one used for the Minnesota CCS process, adjusted to prevent more tons from being "source reduced" than would have been generated under BAU. Also, it is assumed that no more than 75% of any given material may be source reduced.

Table I-8-7. Share of source reduction for WARM input

Source Reduced Category	2012	2020
HDPE	4.5%	9.0%
LDPE	0.5%	0.2%
PET	25.0%	7.1%
Corrugated cardboard	30.0%	34.5%
Magazines/third-class mail	30.0%	34.5%
Office paper	10.0%	14.5%

HDPE = high-density polyethylene; LDPE = low-density polyethylene; PET = polyethylene terephthalate.

Table I-8-8. 2020 BAU WARM inputs

Material	Tons Generated	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted
Aluminum cans	29,550	22,860	6,690		N/A
Steel cans	32,677	10,937	21,740		N/A
Copper wire					N/A
Glass	103,874	65,970	37,905		N/A
HDPE	27,498	5,200	22,297		N/A
LDPE	634	634	—		N/A
PET	26,146	12,210	13,936		N/A
Corrugated cardboard	343,472	155,621	187,850		N/A
Magazines/third-class mail	194,260	—	194,260		N/A
Newspaper	338,247	249,618	88,629		N/A
Office paper	57,208	2,860	54,348		N/A
Phonebooks					N/A
Textbooks					N/A
Dimensional lumber	358,332	174,384	183,948		N/A
Medium-density fiberboard					N/A
Food scraps	234,636	N/A	234,116		520
Yard trimmings	105,644	N/A	35,675		69,969
Grass		N/A			
Leaves		N/A			
Branches		N/A			
Mixed paper (general)	363,648	159,354	204,294		N/A
Mixed paper (primarily residential)					N/A
Mixed paper (primarily from offices)					N/A
Mixed metals	260,664	185,134	75,530		N/A
Mixed plastics	310,004	17,639	292,365		N/A
Mixed recyclables					N/A

Material	Tons Generated	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted
Mixed organics	46,076	N/A	32,887		13,189
Mixed MSW	1,047,945	N/A	1,047,945		N/A
Carpet	598	598	—		N/A
Personal computers	53,336	659	52,677		N/A
Clay bricks		N/A		N/A	N/A
Concrete	5,598	5,598	—	N/A	N/A
Fly ash				N/A	N/A
Tires					N/A
Totals	**3,940,048**	**1,069,278**	**2,787,092**	**—**	**83,678**

N/A = not applicable; HDPE = high-density polyethylene; LDPE = low-density polyethylene; PET = polyethylene terephthalate; MSW = municipal solid waste.

Table I-8-9. 2020 policy WARM inputs

Material	Baseline Generation	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted
Aluminum cans	29,550		29,550	—		
Steel cans	32,677		23,889	8,788		
Copper wire						
Glass	103,874		103,874	—		
HDPE	27,498	24,831	2,667	—		
LDPE	634	476	159	—		
PET	26,146	19,610	6,537	—		
Corrugated cardboard	343,472	94,830	248,642	—		
Magazines/third-class mail	194,260	94,830	—	99,430		
Newspaper	338,247		338,247	—		
Office paper	57,208	39,929	6,247	11,032		
Phonebooks						
Textbooks						
Dimensional lumber	358,332		358,332	—		
Medium–density fiberboard						
Food scraps	234,636			189,354		45,282
Yard trimmings	105,644			—		105,644
Grass						
Leaves						
Branches						
Mixed paper, broad	363,648		348,053	15,595		
Mixed paper, residential						
Mixed paper, office						

Material	Baseline Generation	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted
Mixed metals	260,664		260,664	—		
Mixed plastics	310,004		38,525	271,479		
Mixed recyclables						
Mixed organics	46,076			—		46,076
Mixed MSW	1,047,945			1,047,945		
Carpet	598		598	—		
Personal computers	53,336		1,440	51,896		
Clay bricks						
Concrete	5,598		5,598	—		
Fly ash						
Tires						
Totals	**3,940,048**	**274,505**	**1,773,022**	**1,695,519**	**—**	**197,002**

HDPE = high-density polyethylene; LDPE = low-density polyethylene; PET = polyethylene terephthalate; MSW = municipal solid waste.

The resulting output for the 2012 and 2020 WARM runs predict the GHG reductions for these years to be 1.49 and 4.06 $MMtCO_2e$, respectively. The cumulative GHG reductions are calculated to be 26.5 $MMtCO_2e$. Table I-8-10 displays a summary of the waste diversion, reduction, and GHG benefits of this option.

Table I-8-10. Overall policy results—GHG benefits

Year	Avoided Emissions ($MMtCO_2e$)	Incremental Waste Diversion (tons)	Source Reduction (tons)	Incremental Recycling (tons)	Incremental Composting (tons)	Avoided Landfill Emplacement (tons)
2009	—	—	—	—	—	—
2010	0.50	213,851	24,830	164,053	24,967	–213,851
2011	0.99	426,527	49,721	326,960	49,845	–426,527
2012	1.49	448,653	74,675	324,338	49,640	–448,653
2013	1.81	528,008	99,690	370,793	57,525	–528,008
2014	2.13	607,418	124,767	417,242	65,409	–607,418
2015	2.45	686,884	149,907	463,685	73,292	–686,884
2016	2.77	767,848	174,850	511,698	81,299	–767,848
2017	3.09	848,798	199,782	559,711	89,305	–848,798
2018	3.41	929,736	224,701	607,723	97,312	–929,736
2019	3.74	1,010,661	249,609	655,734	105,318	–1,010,661
2020	4.06	1,091,573	274,505	703,743	113,324	–1,091,573
Totals	**26.5**	**7,559,956**	**1,647,037**	**5,105,682**	**807,236**	**–7,559,956**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

Cost-Effectiveness

Source reduction—The amount of waste managed in Iowa under the policy scenario is reduced, due to the goal requiring a zero percent increase in the per capita waste generation rate by 2020. The cost-effectiveness estimate for source reduction in Iowa comprises three elements: the cost of program implementation, the avoided costs of waste collection and disposal.

The cost of program implementation is assumed to be $1.00 per capita per year.[117] The cost figure uses a population projection consistent with that used for the Iowa I&F. These funds are assumed to cover any education and marketing programs necessary to implement the source reduction goal.

Source reduction is expected to save money by reducing the amount of waste that has to be collected and disposed of in landfills. The avoided collection cost is $80/ton,[118] and the avoided landfill disposal fee is $40/ton.[119]

The analysis assumes that costs begin to be incurred in 2010. The estimated cost savings result in an NPV of –$112 million. Cumulative GHG reductions attributed to recycling are 10.3 $MMtCO_2e$, and the estimated cost-effectiveness is –$11/$tCO_2e$, as shown in Table I-8-11.

Table I-8-11. Cost analysis for source reduction

Year	Tons Reduced	Avoided Landfill Tipping Fee (2006$MM)	Program Costs (2006$MM)	Net Source Reduction Costs (2006$MM)	Discounted Costs (2006$MM)	GHG Reductions ($MMtCO_2e$)	Cost-Effective-ness ($/$tCO_2e$)
2009	—	$0	$0	$0	$0	0.0	
2010	24,830	$3	$3	$0	$0	0.1	
2011	49,721	$6	$3	–$3	–$3	0.3	
2012	74,675	$9	$3	–$6	–$5	0.4	
2013	99,690	$12	$3	–$9	–$7	0.6	
2014	124,767	$15	$3	–$12	–$9	0.8	
2015	149,907	$18	$3	–$15	–$11	0.9	
2016	174,850	$21	$3	–$18	–$13	1.1	
2017	199,782	$24	$3	–$21	–$14	1.3	
2018	224,701	$27	$3	–$24	–$15	1.4	
2019	249,609	$30	$3	–$27	–$17	1.6	
2020	274,505	$33	$3	–$30	–$17	1.8	
Total				**–$164**	**–$112**	**10.3**	**–$11**

2006$MM = million 2006 dollars; GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

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[117] The source reduction program cost is a preliminary estimate consistent with costs assumed in similar options considered by CCS projects in Washington and Colorado.

[118] East Central Iowa Council of Governments. *Evaluation of Recycling Programs*. March 2003. Average of case studies from Cedar Rapids, Marion, Iowa City, and Central City. Accessed on May 23, 2008, at: http://www.iowadnr.com/waste/pubs/files/ecicogfinal.pdf.

[119] Average of tip fee of landfills in Iowa reporting a per-ton tip fee. IA DNR, Iowa Tip Fee Survey Results. Last updated July 2007. Accessed on May 23, 2008, from: http://www.iowadnr.com/waste/sw/files/tp_survey.pdf.

Recycling—The net cost of increased recycling rates in Iowa was estimated by adding the increased costs of collection for two-stream recycling, revenue obtained for the value of recycled materials, and avoided landfill tipping fees. The additional cost for separate curbside collection of recyclables is \$133/ton.[120] The capital cost of additional recycling facilities in Iowa is \$148 million.[121] Annualized over the 10-year policy period at 5% interest, the capital cost is \$9.6 million/year. The avoided cost for landfill tipping is \$40/ton, plus a \$10 tip fee paid to the hauler.[122] CCS also factored in the commodity value of recycled materials with a value of \$156/ton.[123] Table I-8-12 provides the results of the cost analysis. The analysis assumes that costs begin to be incurred in 2010. The estimated cost savings result in an NPV of –\$188 million. Cumulative GHG reductions attributed to recycling are 16 $MMtCO_2e$, and the estimated cost-effectiveness is –\$12/tCO_2e.

Composting—Composting is included in the total recycling volume in the *Economic Impacts of Recycling in Iowa: Final Report*. However, as WARM considers the sole form of diversion for yard trimmings and food waste to be composting, the tons of these items that are "recycled" are assumed to be composted. The net costs for increased composting in Iowa were estimated by adding the additional costs for collection (same calculation as recycling) and the net cost for composting operations. The net cost for composting operations is the sum of the annualized capital and operating costs of composting, increased collection fees, revenue generated through the sale of compost, and the avoided tipping fees for landfilling. Information on the capital and operating costs of composting facilities was received from Cassella Waste Management during the analysis of a similar option in Vermont.[124] These data are summarized in Table I-8-13.

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[120] East Central Iowa Council of Governments. *Evaluation of Recycling Programs*. March 2003. Average of case studies from Cedar Rapids, Marion, Iowa City, and Central City. Accessed on May 23, 2008, at: http://www.iowadnr.com/waste/pubs/files/ecicogfinal.pdf.

[121] Based upon the ratio of capital cost per household used in the Vermont analysis. Vermont capital cost a result of personal communication between P. Calabrese (Cassella Waste Management) and S. Roe (CCS).

[122] Average of tip fee of landfills in Iowa reporting a per-ton tip fee. Iowa Department of Natural Resources. Iowa Tip Fee Survey Results. Last updated July 2007. Accessed on May 23, 2008, from: http://www.iowadnr.com/waste/sw/files/tp_survey.pdf. Tip fee to hauler based on personal communication from J. Ketchum (Vermont waste management) and S. Roe (CCS), November 20. 2007.

[123] Iowa Department of Natural Resources. *Economic Impacts of Recycling in Iowa: Final Report*. December 2007. Accessed on March 7, 2008 from; http://www.iowadnr.com/waste/recycling/files/ecofullreport.pdf. The 2005 baseline data are estimated from Table 7.1 of the report.

[124] P. Calabrese (Cassella Waste Management), personal communication with S. Roe (CCS) June 5, 2007. Because the cost was not originally specified in terms of 2007\$, assume the cost to be valid for 2005.

Table I-8-12. Cost analysis results for recycling

Year	Tons Recycled	Annual Collection Cost ($MM)	Annual Capital Cost ($MM)	Annual Recycled Material Revenue ($MM)	Landfill Tip Fees Avoided ($MM)	Net Policy Cost (Recycling) ($MM)	Discounted Costs ($MM)	GHG Reductions ($MMtCO_2e$)	Cost-Effective-ness ($/tCO_2e$)
2009	—	$0	$0	$0	$0	$0	$0	—	
2010	164,053	$22	$10	$26	$8	–$2	–$2	0.4	
2011	326,960	$43	$10	$51	$16	–$14	–$13	0.7	
2012	324,338	$43	$10	$51	$16	–$14	–$12	1.1	
2013	370,793	$49	$10	$58	$19	–$18	–$14	1.2	
2014	417,242	$55	$10	$65	$21	–$21	–$16	1.4	
2015	463,685	$62	$10	$72	$23	–$24	–$18	1.5	
2016	511,698	$68	$10	$80	$26	–$28	–$20	1.7	
2017	559,711	$74	$10	$87	$28	–$31	–$21	1.8	
2018	607,723	$81	$10	$95	$30	–$35	–$23	2.0	
2019	655,734	$87	$10	$102	$33	–$38	–$24	2.1	
2020	703,743	$93	$10	$110	$35	–$42	–$25	2.3	
Total						**–$269**	**–$188**	**16.0**	**–$12**

$MM = million dollars; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Table I-8-13. Capital and operating costs of composting facilities

Annual Volume (tons)	Capital Cost ($1,000)	Operating Cost ($/ton)
<1,500	$75	$25
1,500–10,000	$200	$50
10,000–30,000	$2,000	$40
30,000–60,000+	$8,000	$30

CCS assumed that the composting facilities to be built within the policy period would tend to be from the largest category (a capital cost of $8 million, and an O&M cost of $30/ton) shown in Table I-8-13. The composting volumes in 2012 and 2020 shown in Table I-8-14 suggest the need for three additional large composting operations by 2020. To annualize the capital costs of these facilities, CCS assumed a 15-year operating life and a 5% interest rate. Other cost assumptions include an assumed landfill tipping fee of $40/ton,[125] an additional source-separated organics collection fee of $113/ton (as used above in the recycling element), a compost facility tipping fee of $15/ton,[126] and a compost value of $11.75/ton.[127]

[125] East Central Iowa Council of Governments. *Evaluation of Recycling Programs*. March 2003. Average of case studies from Cedar Rapids, Marion, Iowa City, and Central City. Accessed on May 23, 2008 at: http://www.iowadnr.com/waste/pubs/files/ecicogfinal.pdf.

[126] Emerson, Dan. *Latest Trends in Yard Trimmings* Composting. 2005. Accessed on May 23, 2008, from: http://hs.environmental-expert.com/resultEachArticle.aspx?cid=6042&codi=5723&idproducttype=6.

Table I-8-14 presents the results of the cost analysis for composting. GHG reductions were assumed not to begin until 2010, and the cumulative reductions estimated were 0.16 $MMtCO_2e$. An NPV of $80 million was estimated, along with a cost-effectiveness of $489/$tCO_2e$.

Table I-8-14. Cost analysis results for composting

Year	Annual O&M Cost ($MM)	Annualized Capital Cost ($MM)	Annual Collection Cost ($MM)	Avoided Landfill Tipping Fees ($MM)	Value of Composted Material ($MM)	Tons of Waste Composted	Total Annual Composting Cost ($MM)	Discounted Costs ($MM)	GHG Reductions ($MMtCO_2e$)	Cost-Effective-ness ($/t)
2009	$0	$0	$0	$0	$0	—	$0	$0	—	
2010	$1	$0	$3	$1	$0	24,967	$3	$3	0.00	
2011	$1	$1	$7	$1	$1	49,845	$7	$6	0.00	
2012	$1	$1	$7	$1	$1	49,640	$7	$6	0.01	
2013	$2	$1	$8	$1	$1	57,525	$8	$7	0.01	
2014	$2	$1	$9	$2	$1	65,409	$9	$7	0.01	
2015	$2	$1	$10	$2	$1	73,292	$10	$8	0.01	
2016	$2	$1	$11	$2	$1	81,299	$11	$8	0.02	
2017	$3	$1	$12	$2	$1	89,305	$12	$8	0.02	
2018	$3	$2	$13	$2	$1	97,312	$14	$9	0.02	
2019	$3	$2	$14	$3	$1	105,318	$15	$9	0.03	
2020	$3	$2	$15	$3	$1	113,324	$16	$9	0.03	
Totals								**$80**	**0.16**	**$489**

$MM = million dollars; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/t = dollars per metric ton.

The overall cost analysis, as seen in Table I-8-15, yields an NPV of –$220 million and a cost-effectiveness of –$8.3, based on the cumulative emission reductions of 26.5 $MMtCO_2e$.

[127] The 2004 price of $10/yard was obtained from a case study of the City of Davenport, Iowa: "Compost Products & Spreaders: Made in the Quad Cities USA." Available at: http://www.cityofdavenportiowa.com/department/division.asp?fDD=28-375. Assuming a dry solids content of 55% and a bulk density of 0.5 tons/yard, the value of composted material was calculated to be $11/ton of initial feedstock.

Table I-8-15. Overall policy results—cost-effectiveness

Year	Net Program Cost: Source Reduction ($MM)	Net Program Cost: Recycling ($MM)	Net Program Cost: Composting ($MM)	Total Net Program Cost ($MM)	Discounted Cost ($MM)	Cost-Effectiveness ($/tCO$_2$e)
2009	$0	$0	$0	$0	$0	
2010	$0	–$2	$3	$1	$1	
2011	–$3	–$14	$7	–$10	–$9	
2012	–$6	–$14	$7	–$13	–$11	
2013	–$9	–$18	$8	–$18	–$15	
2014	–$12	–$21	$9	–$24	–$19	
2015	–$15	–$24	$10	–$29	–$22	
2016	–$18	–$28	$11	–$35	–$25	
2017	–$21	–$31	$12	–$40	–$27	
2018	–$24	–$35	$14	–$45	–$29	
2019	–$27	–$38	$15	–$51	–$31	
2020	–$30	–$42	$16	–$56	–$33	
Total					**–$220**	**–$8.3**

$MM = million dollars; $/tCO$_2$e = dollars per metric ton of carbon dioxide equivalent.

Key Assumptions:

For the MSW management input data to WARM, the key assumption is that none of the goals would be achieved via existing programs in place. To the extent that those programs will fully or partly achieve the goals of this policy, the GHG reductions estimated would be lower (no additional penetration from the current Iowa recycling and composting campaigns has been incorporated into the BAU assumptions for this analysis). Therefore, the most important assumption relates to the assumed BAU projection for solid waste management. This BAU forecast is based on current practices and does not factor in the effects of further gains in recycling or composting rates during the policy period. The BAU assumptions are needed to tie into the assumptions used to develop the GHG forecast for the waste management sector, which does not factor in these changes in waste management practices during the policy period (2008–2020). To the extent that these gains in recycling and composting would occur without this policy, the benefits and costs are overstated.

The other key assumptions relate to the use of WARM in estimating life-cycle GHG benefits and the use of the stated assumptions regarding costs for increased source reduction, recycling, and organics recovery (composting in this example) programs.

Another important assumption is that under BAU, the waste directed to landfilling would include methane recovery (75% collection efficiency) and utilization. The need for this assumption is partly based on limitations of WARM (which doesn't allow for management of landfilled waste into controlled and uncontrolled landfills), but is also based on the overall direction of the policy options of AFW-8.

Additionally, transportation emissions for WARM are taken as default. This analysis has not considered the impacts of reduced exports as a result of the goals in this option's Policy Design section.

The cost estimates do not include cost savings that would be achieved by avoiding the need for additional waste-to-energy (WTE) plants.

Key Uncertainties

A large portion of the benefits yielded by the goals set forth in this option are derived from the indirect, life-cycle emission reductions that result from recycling and source reduction. The change in direct landfill emissions as a result of full implementation of the goals in this option would be an *increase* of 39,097 tCO_2e in 2012 and a *reduction* of 69,451 tCO_2e in 2020. The GHG benefits from reduced transportation resulting from a decrease in generation would be 211 tCO_2e in 2012 and 711 tCO_2e in 2020.[128]

Additional Benefits and Costs

None identified.

Feasibility Issues

- Sufficient political commitment;
- Budget constraints;
- Sufficient regulatory and financial incentives;
- Inconsistent enforcement;
- Insufficient data;
- Low landfill disposal costs, resulting in less interest in waste prevention/recycling;
- Resistance to change; and
- Sufficient local capacity for collected recyclables.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

[128] Assumes default distances from EPA WARM of 20 miles from the source of the waste to each management facility.

AFW-9. Landfill Methane Energy Programs

Policy Description

Use the renewable energy within landfill gas (LFG) (methane) to make electric power, space heat, or liquefied natural gas. Methane gas generation by landfills is a GHG reduction strategy that may benefit from a cap-and-trade system, encouraging landfills to install flares at a minimum and possibly achieve electric generation if the economic incentives are sufficient.

Policy Design

Goals:

- *Control*—Increase the number of landfills that recover methane as an energy source wherever it is economically feasible to do so. By 2020, ensure that all large landfills are fully controlling the release of methane, such that 50% of the LFG being generated is controlled by 2020. This can be done through development of additional landfill-gas-to-energy (LFGTE) projects. For sites where LFGTE is not feasible, implement flaring controls to achieve the goal.
- *Technology research and evaluation*—Since conversion technologies hold promise for environmentally managing waste and producing energy, annually examine the experience and costs of emerging technologies for waste management with the goal of determining the feasibility of the technology for Iowa [nonquantified goal].
- *Education*—Begin to educate the public about the impact and costs of various WTE technologies [nonquantified goal].

Timing: Fully implement policies to achieve the above goals by 2020.

Parties Involved: Municipal and county governments, private solid waste management companies, local economic development agencies, IA DNR, nongovernmental organizations, and public interest groups.

Other:

Iowa currently has 4 landfill operations that are recovering methane (2 generate electricity). EPA's Landfill Methane Outreach Program (LMOP) identifies 17 facilities that may have the opportunity to recover methane. These landfills have the potential to capture an additional 35% of methane beyond the baseline methane capture of 40%.

Methane Energy Programs

- The capture of one ton of methane from LFG is equivalent to reducing approximately 20 tCO_2e. (Benefits of LFG energy and LMOP are available at: www.epa.gov/lmop/benefits.htm.)

- According to LMOP landfills generate about 22.6% of methane emissions in the United States. Methane is the second most important GHG.[129]
- If landfilling of organic materials is to be continued, future landfills must be fully controlled bioreactors where most of the methane generated is captured and used to produce energy.[130]
- Actual emissions of methane from landfills are sensitive to dozens of site-specific factors and can vary over a wide range, but CCS does not have either the direct measurement data or the detailed site data that would be required to conduct more than an approximate estimate of methane emissions from Iowa landfills (from a North Carolina study).

Waste-to-Energy Mass Burn

- Incineration, the combustion of organic material, such as waste, with energy recovery is the most common WTE implementation.
- Other than removing oversized items and household hazardous waste, little preprocessing is necessary.
- Depending on the plant's location, size, and other factors, the capital costs range from $110,000 to $140,000 per daily ton of capacity. Therefore, a plant that processes 1,000 tons of MSW per day may cost $110–$140 million. In addition to the capital costs, a 1,000-ton-per-day plant would engage about 60 personnel. Other costs are services, materials and supplies, and the cost of disposal of ash.[131]
- Tipping fees at WTE plants, based on 15 respondents, ranged from $40/ton in North Carolina (one facility) to $98/ton (3 facilities).[132]
- Experts and local community groups are concerned with modern incinerators because of fine particulate emissions, metal, trace dioxins and acid gas emissions, toxic fly ash, and bottom ash management, as well as waste resource ethics, such as the destruction of valuable resources and low energy efficiency.
- Incineration or combustion in any form is rejected in the zero-waste movement as a viable, sustainable, or ethical solution to waste management. Lack of public acceptability remains a barrier to emerging waste management technologies.

Emerging Technologies for MSW (Gasification, Plasma Arc, Thermal Depolymerization, Ethanol Production From Waste, and Anaerobic Digestion)

- Currently, long-term experience with alternative technologies is unavailable. Waste conversion technologies have very high costs, and the vast majority have not been proven on

[129] U.S. Environmental Protection Agency. 2008. Landfill Methane Outreach Program. “An Overview of Landfill Gas Energy in the United States.” Available at: http://www.epa.gov/lmop/docs/overview.pdf.
[130] Themelis, N., and P. Ulloa. “Capture and Utilisation of Landfill Gas: What Is the Potential for Additional Utilisation of Landfill Gas in the USA and Around the World?” In *Biomass*. Available at: http://www.seas.columbia.edu/earth/wtert/sofos/Themelis_Capture and Utilisation of Landfill Gas.pdf.

[131] Waste-to-Energy Research and Technology Council. "The ABC of Integrated Waste Management (IWM)." Available at: http://www.seas.columbia.edu/earth/wtert/faq.html.

[132] Simmons, P., N. Goldstein, S.M. Kaufman, N.J. Themelis, and J. Thompson, Jr. “The State of Garbage in America.” April 2006;*BioCycle* 47(4):26.

a commercial scale or as full-scale plants using MSW. More than 90% of these technologies are still in the experimental, development, small-scale, or pilot project stage—i.e., they are not mature technologies. Experts agree that they are not currently a reliable, cost-effective alternative.

- Only gasification and plasma arc can handle the entire MSW waste stream with limited residuals. Most other processes require preprocessing or pretreatment by separating out incompatible and recyclable materials, homogenizing, and shredding. This means that materials must either be separated at the source or processed through an MRF.
- Some processes produce an ash containing constituents of lead, cadmium, and mercury that need to be managed in an environmentally responsible manner.
- Proponents for conversion technologies report that they produce not only energy but also usable products and by-products, such as slag. The slag bonds metals, halogen, and sulfur atoms with silicate to make leaching of the materials difficult. The profitability of products and by-products depends on viable markets and the value of the products produced. There are risks with constructing such facilities with a goal of profiting from products and by-products.

Current Projects in Iowa

Gasification Project in Greve (1,200 tons per day of refuse-derived fuel) ($1,996):

- $170 million capital costs,
- $35.6 million O&M costs, and
- $16.3 million/year in revenues.

Plasma Arc–Green Power Systems:

- $182 million capital costs, and
- $18 million/year revenue.

Implementation Mechanisms

Incentives could be provided to industries that relocate close their operations close enough to existing landfill sites to use the methane and electricity generated from those facilities.

Cost incentives, such as carbon credits, could make methane capture and utilization more attractive.

Related Policies/Programs in Place

Methane Gas Conversion Property Tax Exemption: Under Iowa's Methane Gas Conversion Property Tax Exemption, property used for methane gas collection and conversion into energy and connected with or in conjunction with a publicly owned sanitary landfill is exempt from property tax. If other fuels are burned as well, the exemption is equal to the ratio of methane in the overall fuel mix.

Type(s) of GHG Reductions

CO_2, N_2O, CH_4: Displaces emissions from fossil fuel combustion.

CH_4: Methane reductions via collection and control (via flaring, or preferentially via energy utilization).

Estimated GHG Reductions and Net Costs or Cost Savings

GHG Reduction Potential in 2012, 2020 ($MMtCO_2e$): 0.2, 0.8, respectively.

Net Cost per tCO_2e: $0.9.

Data Sources: Data on current landfill operations using methane recovery for energy generation (direct or electric) are taken from the EPA LMOP Web site.[133] Baseline LFG emissions are consistent with the Iowa I&F.[134] CCS used the results of LFGTE cost modeling performed with EPA's LFGcost model to estimate the costs for this policy element.[135]

Quantification Methods:

GHG Benefits

Since the goal stated in the above Policy Design section requires control of methane emissions specifically from uncontrolled landfills, CCS used the emission estimates for uncontrolled landfills from the I&F as the baseline emission scenario. In 2005, 20.5% of methane emissions in Iowa were controlled through an LFGTE project, according to the Iowa I&F. Therefore, the incremental methane emission recovery goal in Iowa will be 29.5% in 2020.

As emissions from uncontrolled landfills are controlled, three GHG benefits are realized: (1) the conversion of landfill methane to CO_2, (2) the displacement of grid-based electricity, and (3) the displacement of fossil fuel combusted for direct heat.[136] The first benefit is calculated by multiplying the baseline methane emissions from uncontrolled landfills from the Iowa I&F by the LFG control goal specified in the Policy Design section. The second benefit (offset electricity) is found by converting the methane captured from tCO_2e units to cubic meters of gas. and then calculating the electricity generated and the emissions offset through avoided grid-based generation. The third GHG benefit is calculated by multiplying the fraction of captured LFG combusted for direct use by the quantity of LFG captured under this policy option, assuming that an equal amount of natural gas is not combusted for direct heat use. The estimated GHG benefits in 2012 and 2020 are 0.2 and 0.8 $MMtCO_2e$, respectively. The cumulative GHG benefit through 2020 is estimated to be 4.8 $MMtCO_2e$. Table I-9-1 depicts the results of these calculations.

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[133] U.S. Environmental Protection Agency, Landfill Methane Outreach Program. LMOP Database—Iowa. Available at: http://www.epa.gov/landfill/proj/xls/lmopdataia.xls.

[134] IA I&F, available at: http://www.iaclimatechange.us.

[135] U.S. Environmental Protection Agency, Landfill Methane Outreach Program. Landfill Gas Energy Cost Model (LFGcost), Version 1.4. Model run performed by B. Strode on June 24, 2008. For more information on LFGcost, visit http://www.epa.gov/lmop/res/index.htm.

[136] Assumed to be natural gas.

Table I-9-1. Overall policy results—GHG benefit

Year	Methane Control Goal	Methane Emissions From Uncontrolled Landfills (tCO_2e)	GHG Benefit: CH_4 Reduction From CH_4 Control ($MMtCO_2e$)	Methane Controlled (m^3CH_4)	Electricity Generated (MWh)	GHG Benefit: Avoided Electricity Production ($MMtCO_2e$)	Electricity Emissions Factor from EEC SC (tCO_2e/ MWh)	GHG Benefit: Avoided Natural Gas Combustion for Direct Use ($MMtCO_2e$)	Total GHG Benefit ($MMtCO_2e$)
2008	0.0%	1,748,943	—	—	—	—	0.49	—	—
2009	2.5%	1,776,269	0.0	1,663,490	3,380	0.00	0.47	0.0	0.1
2010	4.9%	1,804,022	0.1	3,378,962	6,866	0.00	0.47	0.0	0.1
2011	7.4%	1,832,209	0.1	5,147,634	10,460	0.00	0.47	0.0	0.2
2012	9.8%	1,860,836	0.2	6,970,749	14,165	0.01	0.46	0.0	0.2
2013	12.3%	1,889,910	0.2	8,849,577	17,982	0.01	0.72	0.0	0.3
2014	14.8%	1,919,438	0.3	10,785,415	21,916	0.02	0.71	0.1	0.4
2015	17.2%	1,949,428	0.3	12,779,584	25,968	0.02	0.71	0.1	0.4
2016	19.7%	1,979,886	0.4	14,833,434	30,142	0.02	0.70	0.1	0.5
2017	22.1%	2,010,821	0.4	16,948,345	34,439	0.02	0.70	0.1	0.6
2018	24.6%	2,042,238	0.5	19,125,723	38,863	0.03	0.69	0.1	0.6
2019	27.0%	2,074,147	0.6	21,367,003	43,418	0.03	0.69	0.1	0.7
2020	29.5%	2,106,554	0.6	23,673,651	48,105	0.03	0.69	0.1	0.8
Totals		**24,994,701**	**3.8**	**145,523,567**	**295,704**	**0.2**		**0.8**	**4.8**

tCO_2e = metric tons of carbon dioxide equivalent; GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; m^3CH_4 = cubic meters of methane; MWh = megawatt-hours; EEC = Energy Efficiency and Conservation; SC = Subcommittee; tCO_2e = metric tons of carbon dioxide equivalent.

Cost-Effectiveness

Using the results from an LFGcost model run, the costs of this option are estimated (Table I-9-2) based on whether the methane is converted to usable energy by a small engine, through direct use, or a large engine (800 kilowatts and greater).[137] To develop an overall cost for this policy option, CCS used the following assumptions on the mix of projects that would be implemented to achieve the policy's goals: 17% of methane is reduced via standard engine/generator set projects (it was assumed that these projects already have implemented gas collection, which is therefore not a part of the capital cost); 20% of methane is controlled by direct-use projects (the number of projects is assumed to be limited by the location of end users); and the remaining 63% is assumed to be controlled by small-engine/generator-set projects.[138]

[137] U.S. Environmental Protection Agency, Landfill Methane Outreach Program. Landfill Gas Energy Cost Model (LFGcost), Version 1.4. Model run performed by B. Strode on June 24, 2008. For more information on LFGcost, visit: http://www.epa.gov/lmop/res/index.htm.

[138] U.S. Environmental Protection Agency, Landfill Methane Outreach Program. LMOP Database. Available at: http://www.epa.gov/lmop/proj/xls/opprjslmopdata.xls.

Table I-9-2. LFGcost modeling results

EPA LFGcost Modeling Data	Scenario 1: Direct Use (0.5-mi. pipeline)	Scenario 2: Small Engine (<800 kW)	Scenario 3: Standard Engine (>800 kW)
Total capital	$613,382	$1,186,832	$3,025,746
Average annual O&M	$105,925	$150,655	$394,579
Annualized costs	$197,337	$327,528	$845,504
Annual revenue	$95,445	$155,117	$788,670
Annual average reductions ($MMtCO_2e$)	0.03	0.03	0.10
Project reductions ($MMtCO_2e$)	0.45	0.45	1.47
Cost-effectiveness ($/$tCO_2e$)	–$1.2	$2.44	$0.09
Net present value (NPV)	–$524,612	$1,087,597	$137,003
Blended Cost-Effectiveness (Iowa)			
Baseline share of CH_4 control in Iowa	20%	63%	17%
Fractional cost-effectiveness ($/$tCO_2e$)	–$0.24	$1.54	$0.02
Average Cost-Effectiveness ($/$tCO_2e$)	**$1.32**		

EPA = U.S. Environmental Protection Agency; LFG = landfill gas; kW = kilowatts; O&M = operations and maintenance; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; CH_4 = methane.

Note: Assumes 8% interest rate over 10 years, 15-year project life, and cost of LFG collection and flaring included in total cost.

The modeling assumptions were based on the average opening and closing year of landfills in Iowa (1997 and 2029, respectively), average annual acceptance for large landfills (114,090 tons), and average annual acceptance for small landfills (36,334 tons). It was assumed that large landfills will use large engines, and small landfills will use either small engines or direct heat technology. The average depth of the landfills was assumed to be 50 feet (LFGcost Default). The assumed number of wells for small landfills was 17, and the number of wells for large landfills was 62.[139] The default values for the revenue from energy sold were used ($0.045/kWh, $4.50/MMBtu).

The average cost-effectiveness ($1.32/$tCO_2e$) is multiplied by the GHG benefit calculated in the GHG Benefit section for each year to determine the cost-effectiveness of this policy option (Table I-9-3). The NPV of costs incurred through the implementation of this option is $4.3 million, and the discounted cost-effectiveness is $0.9/$tCO_2e$ (assumes no escalation of costs during the policy period).

[139] Consistent with the LFGcost model run completed by CCS for the North Carolina Climate Action Plan Advisory Group process.

Table I-9-3. Overall policy results—cost-effectiveness

Year	Avoided Emissions ($MMtCO_2e$)	Annual Costs ($MM)	Discounted Costs ($MM)	Cost-Effective-ness ($/$tCO_2e$)
2008	—	$0.0	$0.0	
2009	0.1	$0.1	$0.1	
2010	0.1	$0.1	$0.1	
2011	0.2	$0.2	$0.2	
2012	0.2	$0.3	$0.2	
2013	0.3	$0.4	$0.3	
2014	0.4	$0.5	$0.3	
2015	0.4	$0.6	$0.4	
2016	0.5	$0.6	$0.4	
2017	0.6	$0.7	$0.5	
2018	0.6	$0.8	$0.5	
2019	0.7	$0.9	$0.5	
2020	0.8	$1.0	$0.6	
Totals	**4.8**	**$6.3**	**$4.2**	**$0.9**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $MM = million dollars; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

Key Assumptions:

The analysis does not factor in the closure of specific landfills or the adoption of LFG controls at specific landfills. Modeling GHG emissions and reductions at individual sites is beyond the scope of this analysis. However, the approach used is consistent with the methods used to develop the GHG forecast for the waste management sector.

Each of the cost inputs above contains key assumptions; additional study of these inputs could reduce the associated uncertainty in the cost estimates.

Key Uncertainties

As stated above, the GHG reduction potential of this option comprises direct and indirect benefits. The direct benefits of the goal are estimated to reduce GHG emissions by 0.2 tCO_2e in 2012 and 0.6 tCO_2e in 2020, for a cumulative reduction of 3.8 tCO_2e. The indirect GHG benefits related to this option are the offset energy use from electricity and natural gas (in the case of direct use LFGTE). These indirect benefits are estimated to total 0.01 tCO_2e in 2012, and 0.14 tCO_2e in 2020, for a cumulative indirect benefit of 1.0 tCO_2e.

A key source of uncertainty related to cost-effectiveness is the price of energy that may produce a source of revenue for LFGTE projects. For the above analysis, the default assumptions of $0.045/kWh of electricity and $4.50/MMBtu of natural gas were used. Note that these figures will not necessarily be the retail price of energy, but the actual price that an MSW facility would be paid by the utility for the additional energy. Thus, this price is likely lower than the retail energy prices. The electricity purchase prices that would be needed for the electricity projects (projected to incur a net cost over time by the LFGcost model under the default energy prices) are $0.067/kWh for large facilities (over 800 kW rated capacity) and $0.097 for small facilities.

In 2008, severe flooding in Iowa greatly increased pressure on the state's landfill system. According to Subcommittee experts, previously closed sites, such as the Linn County Bluestem Landfill Site #1, have recently received large amounts of waste. Because this influx of solid waste will most likely affect the future quantity of LFG generated at these landfills, the GHG benefits yielded by this policy option may increase, although the effect on cost-effectiveness is unknown.

Additional Benefits and Costs

None identified.

Feasibility Issues

There is a danger of overcommitting on infrastructure to recover value.

Discussions during meetings of the AFW Subcommittee yielded concern about whether Iowa would be able to meet the goal of 50% LFG control by 2020, given the current waste disposal patterns. Table I-9-4 displays the 2007 disposal schedule for the landfills identified by EPA as Operational, Candidate, or Potential LFGTE projects.[140]

[140] U.S. Environmental Protection Agency,, Landfill Methane Outreach Program. LMOP Database—Iowa. Available at: http://www.epa.gov/landfill/proj/xls/lmopdataia.xls. 2000 through 2007 landfill disposal data published by the Iowa Department of Natural Resources at: http://www.iowadnr.com/waste/sw/data.html.

Table I-9-4. Landfill disposal data from identified EPA LMOP landfill projects

Landfill	2007 Total Tons Landfilled	Project Status	Cumulative % of Total 2007 MSW Landfilled	Year Opened	Year Closed	WIP (tons)	Average Annual Acceptance Rate (tons, 2000–2007)
Linn–Bluestem Landfill Site #1	—	Operational LFGTE	0.0%	1980	2003	3,800,000	—
Polk–Metro Park East Sanitary Landfill	489,589	Operational LFGTE	17.6%	1972	2025	22,213,605	466,037
Scott–Scott Area Sanitary Landfill	156,724	Operational LFGTE	23.2%	1977	2030	2,277,600	122,479
Winnebago–Central Disposal Landfill	150,450	Operational LFGTE	28.6%	1981	2054	4,528,000	259,720
Black Hawk–Black Hawk County Sanitary Landfill	137,872	Candidate	33.5%	1990	2060	1,821,820	117,805
Johnson–City of Iowa City Sanitary Landfill	124,094	Candidate	38.0%	1971	2025	3,000,000	104,352
Dubuque–Dubuque Metropolitan Sanitary Landfill	98,406	Candidate	41.5%	1976	2012	2,500,000	91,703
Webster–North Central Iowa Regional Sanitary Landfill	90,932	Candidate	44.8%			1,000,000	75,759
Woodbury–City of Sioux City Sanitary Landfill	64,175	Candidate	47.1%	1981	2007	1,144,000	44,718
Marion–South Central Iowa Solid Waste Agency	61,812	Candidate	49.3%	1977	2092	858,000	61,856
Des Moines–Des Moines County Sanitary Landfill	59,025	Candidate	51.4%	1965	2017	2,597,642	56,332
Dickinson–Dickinson Sanitary Landfill	56,895	Candidate	53.5%	1978			84,500
Sioux–Northwest Iowa Area Sanitary Landfill	55,172	Candidate	55.4%	1974	2012	1,092,500	57,803
Boone–Boone County Sanitary Landfill	54,086	Potential	57.4%	1978	2032	718,624	48,499
Muscatine–Muscatine County Sanitary Landfill	35,564	Potential	58.7%	1980	1995	1,212,640	47,801
Marshall–Marshall County Sanitary Landfill	33,482	Potential	59.9%	1975	2060	726,000	32,689
Winneshiek–Winneshiek County Sanitary Landfill	4,128	Candidate	60.7%	1973	2015	1,000,000	24,229
Jasper–City of Newton Sanitary Landfill	24,029	Potential	61.6%	1976	2011	840,000	28,261
Clinton–Clinton County Sanitary Landfill-East	16,453	Candidate	62.2%	1974		3,697,808	14,437
Fayette–Fayette County Sanitary Landfill	10,052	Candidate	62.5%	1984	2014	275,484	10,367

MSW = municipal solid waste; WIP = waste in place; LFGTE = landfill-gas-to-energy.

As Table I-9-4 shows, on the basis of 2007 Iowa landfill data, there should be sufficient waste deposited in these landfills to meet the goal set forth in this option. However, note that collection efficiency, topographical differences, waste heterogeneity, and other factors make waste in place an imprecise proxy for the quantity of LFG that can be collected at each site.

Status of Group Approval

Approved.

Level of Group Support

Unanimous.

Barriers to Consensus

None

Appendix J
Cross Cutting Issues
Policy Options

Summary List of Policy Options

Policy No.	Policy Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Status of Option
		2012	2020	Total 2009–2020			
CC-1	GHG Inventories, Forecasting, Reporting, and Registry	*Not Quantified*					Unanimous
CC-2	Statewide GHG Reduction Scenarios	*Not Quantified*					Approved (4 objections)
CC-3	State and Local Government GHG Emissions (Lead by Example)	*Not Quantified*					Unanimous
CC-4	Public Education and Outreach	*Not Quantified*					Unanimous
CC-5	Tax and Cap Policies—Lead Transferred to the CRE SC	*Not Quantified*					Transferred
CC-6	Seek Funding for Implementation of ICCAC Options	*Not Quantified*					Unanimous
CC-7	Adaptation and Vulnerability	*Not Quantified*					Unanimous
CC-8	Participate in Regional and Multistate GHG Reduction Efforts	*Not Quantified*					Unanimous
CC-9	Encourage the Creation of a Business-Oriented Organization To Facilitate Investment in Climate-Related Business Opportunities and To Share Information and Strategies, Recognize Successes, and Support Aggressive GHG Reduction Goals	*Not Quantified*					Unanimous

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/$tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; ICCAC = Iowa Climate Change Advisory Council; CRE = Clean and Renewable Energy; SC = Subcommittee.

CC-1. GHG Inventories, Forecasting, Reporting, and Registry

Policy Description

Greenhouse gas (GHG) emission inventories and forecasts are essential for understanding the magnitude of all emission sources and sinks (both man made [anthropogenic] and natural), the relative contribution of various types of emission sources and sinks to total emissions, and the factors that affect trends over time. Inventories and forecasts help to inform state leaders and the public on statewide trends and mitigation opportunities, and in verifying GHG reductions associated with implementation of action plan initiatives.

GHG reporting supports tracking and management of emissions. It can help sources identify emission reduction opportunities, reduce risks associated with possible future GHG mandates through early participation, and construct periodic state GHG inventories. GHG reporting is a precursor for sources to participate in GHG reduction programs, and/or a GHG emission registry, as well as to secure "baseline protection" (i.e., credit for early reductions).

A GHG registry enables recording of GHG emissions in a central repository with "transaction ledger" capacity to support tracking, reductions management, and "ownership" of documented *emission* reductions; it offers recognition opportunities; and/or provides a mechanism for regional, multi-state, and cross-border cooperation. Properly designed registry structures also provide a foundation for possible future trading programs.

Policy Design

The Iowa Climate Change Advisory Council (ICCAC) presents the option that the state institute a formal GHG inventory and forecast function within the Iowa Department of Natural Resources (IDNR) and in conjunction with the Iowa Office of Energy Independence (OEI), to be assisted by other state agencies as needed. IDNR should play a central role in the development and maintenance of the GHG inventory, forecast, reporting, and registry functions because the mission of OEI focuses the agency on both energy and GHG emission reductions. Construction of GHG expertise within OEI will assist the agency in developing energy and GHG emission reduction strategies as it administers its programs.

Deleted: recommends

The ICCAC notes that Iowa has joined the effort to develop a national GHG registry through The Climate Registry. Being a charter state in this effort should help ensure that Iowa's needs and priorities are addressed in the course of The Climate Registry's development. To the extent that Iowa's needs may not be fully met by The Climate Registry, Iowa should consider developing supplemental or ancillary registry capacities.

Key elements of program design include:

Inventory and Forecasting

- The statewide inventory and forecasting function must include all anthropogenic emission sources and sinks within the state.

- As much as possible, the forecasting function should incorporate current and projected GHG emission trends based on business as usual, with additional scenarios that incorporate modified trends based on projected impacts of climate change.

Reporting and Registry

- The state should require mandatory reporting of GHG emissions by public and private organizations having net GHG emissions exceeding *de minimis* levels. *De minimis* levels should be set at levels that maintain consistency with existing and developing regional and national programs. By making reporting mandatory, Iowa businesses will gain advantage over competitors in non-reporting states through growing recognition of GHG emission sources and potential solutions.
- Optional reporting, or opt-ins, should be allowed for sources with GHG emissions below *de minimis* levels.
- Provision should be made for optional reporting of carbon sinks, including processes for aggregation and reporting of small-quantity sinks.
- Reporting should use the scoping approaches developed by the World Resources Institute in the GHG Protocol for segregation of direct and indirect emissions and to maintain the ability to denote ownership of emissions and emission reductions for potential crediting processes. (See: http://www.ghgprotocol.org/standards)
- Certification criteria for registry acceptance should be developed in accordance with existing and developing regional and national programs.
- Reporting should occur annually on a calendar-year basis for all six traditional GHGs as recognized by the Intergovernmental Panel on Climate Change.
- Every effort should be made to maximize consistency with federal, regional, and other states' GHG reporting programs.
- GHG emissions reports should be verified through self-certification and agency spot checks; to qualify for future registry purposes, reports should undergo third-party verification.
- Project-based emissions reporting should be allowed, when properly identified as such and when quantified with equally rigorous consistency.
- The reporting program should provide for appropriate public transparency of reported emissions.
- The reporting program should provide safeguards to allow baseline protection for sources.

Goals:

- Develop an inventory and forecasting capacity for statewide, anthropogenic emission sources and sinks.
- Develop a consistent protocol for use in preparing the statewide emission and sink inventory and forecasts.
- Develop a consistent protocol for use in implementing reporting requirements.

- Develop a periodic, consistent, and complete forecast of future GHG emissions in at least 5- and 10-year increments extending at least 20 years into the future.
- Annually provide a statewide GHG emissions inventory and forecast, as required by Iowa Code 455B.152(2a).
- Biennially provide a summary of progress toward meeting the ICCAC GHG emission reduction scenarios.
- Develop a mandatory GHG emission reporting program for sources with GHG emissions exceeding the *de minimis* threshold.
- Adopt established protocols and software to record and properly document GHG emissions and emission reductions for Iowa sources and sinks.

Timing: This function should be implemented as soon as possible when resources become available.

Parties Involved: IDNR, OEI, other state agencies as appropriate, all anthropogenic GHG emission sources and sinks.

Other: Not applicable.

Implementation Mechanisms

Inventory: The state has already embarked on a very limited process to update the top-down statewide emission inventory. A much more robust inventory capacity is needed and will be developed, subject to available resources.

Forecasting: Forecasting will become a vital component of the ICCAC decision-making process. As such, provision should be made in ICCAC's mission to work with IDNR to facilitate the update of the forecasts on a biennial basis through ICCAC, subject to available resources. The forecasting should include adjustments for predicted changes in the Iowa economy, brought about in reaction to future climatic changes.

Registry and Reporting: Legislation may be required to institute a mandatory reporting requirement for entities with annual GHG emissions exceeding a *de minimis* threshold. The program should also lay out requirements for entity (facility/source) definition, offset[*] definition, emission quantification and verification requirements, emission reduction documentation requirements, opt-in provisions for small sources, and an aggregation function for small offset providers.

The above initiatives are not currently adequately funded, so will need additional resources to implement.

[*] An offset is a verifiable reduction in GHGs. Offsets can be bought and sold and can be used to achieve compliance with GHG limits.

Related Policies/Programs in Place

Inventory: The state has already embarked on a process to update the top-down statewide emission inventory.

Forecasting: Using 2005 data for the Iowa inventory and forecast.

Registry and Reporting: Governor Culver signed Iowa on to The Climate Registry on July 5, 2007. As currently configured, The Climate Registry provides a voluntary platform for submission of GHG emissions.

Type(s) of GHG Reductions

Not applicable.

Estimated GHG Savings and Net Costs or Cost Savings

Not applicable.

Key Uncertainties

Adequacy of funding for implementation. Development of national or regional programs and what their substantive elements might be. Accuracy of reporting submitted.

Additional Benefits and Costs

IDNR estimated program costs = 2 full-time-equivalent positions and $195,500, based on the state's fiscal year 2009 budget.

These systems will enhance the state's ability to track progress in reducing GHG emissions and will provide businesses a uniform reporting system.

Feasibility Issues

None identified at this time.

Status of Group Approval

Approved

Level of Group Support

Unanimous

Barriers to Consensus

None.

CC-2. Statewide GHG Reduction Scenarios

Policy Description

To date, Iowa has not adopted any mandatory statewide GHG reduction goals. Iowa Code Reference 455B.152(3)(a) and (b) and 455B.152(4), which the Iowa legislature passed in 2007, requires the IDNR to establish a GHG inventory and a voluntary GHG gas registry for tracking, managing, and crediting entities in the state that reduce their generation of GHGs. Under the same legislation, the ICCAC is required to recommend a baseline year from which to calculate future GHG reductions, and to develop multiple scenarios to reduce GHG emissions in Iowa by 2050, including interim years with targeted goals. A 50% reduction scenario by 2050 was specified in the legislation, and the ICCAC in its January 1, 2008, interim report recommended an additional scenario of 90% reduction by 2050, with subsequent scenarios to be determined for interim years of 2012 and 2020. The baseline year for Iowa is recommended in the Interim Report to be 2005.

Governor Culver issued the Green Government Executive Order (Executive Order 06) on February 21, 2008, which sets the goal of reducing "the use of electricity, natural gas, fuel oil and water in all state office buildings by at least 15% overall in the next 5 years, taking into account growth in the state workforce and/or changes in building operations." This follows Governor Vilsack's Executive Order 41 to reduce electricity and natural gas by 15% by 2010 from the year 2000 baseline. These executive orders are establishing policy goals of greater than 1.5% per year reductions in the use of fossil fuels for state building operations in the near term, and presumably they will result in similar GHG reductions for state buildings if fully implemented.

Legislation in 2007 also produced the Iowa OEI and the Iowa Plan for Energy Independence. The plan "shall provide cost effective options and strategies for reducing the state's consumption of energy, dependence on foreign sources of energy, use of fossil fuels, and GHG emissions. The options and strategies developed in the plan shall provide for achieving energy independence from foreign sources of energy by the year 2025." In addition, the Midwestern Governors Association adopted the Energy Security and Climate Stewardship Platform for the Midwest, which specifies an energy efficiency goal of at least 2% per year reduction in natural gas and electricity use to be achieved by 2015.

Transitioning from the fossil fuel age to a new mix of energy sources like energy conservation, efficiency, cellulosic biofuels, and wind power is already creating "green collar" jobs and invigorating the economy in Iowa. Early action alternatives have much greater effect in mitigating future climate change and its impacts compared to later reductions. Reductions for developed countries in the range of 25%–40% by 2020 and 80%–95% by 2050 were discussed in the initial Bali round of the Framework Convention on Climate Change in December 2007. It is recognized that "substantial deviation from baseline" will also be necessary for developing economies in Latin America, the Middle East, East Asia, and centrally planned Asia.

Policy Design

During 2008, the ICCAC has evaluated the catalog of preferred options in terms of their potential to reduce GHG emissions in Iowa and their relative cost effectiveness. Following the construction of the baseline for Iowa emissions, the ICCAC has estimated the opportunities available and reductions considered most effective for the state to implement. The final report will be forwarded to the General Assembly of Iowa and to Governor Culver by December 31, 2008.

Additionally, a performance tracking mechanism should be established to measure progress over time in achieving the established GHG reduction goals.

Goals: Development of two scenarios by the ICCAC:

- Target GHG reductions of 1% below 2005 levels by 2012 and 11% below 2005 levels by 2020, culminating in a statewide GHG emission reduction of 50% below 2005 levels by 2050 from the 2005 baseline;
- Target GHG Reductions of 3% below 2005 levels by 2012 and 22% below 2005 levels by 2020, culminating in a statewide GHG emission reduction of 90% below 2005 levels by 2050 from the 2005 baseline.

Timing: Early action will be necessary to meet the scenarios for 2012 and 2020.

Parties Involved: The ICCAC will report to the General Assembly and Governor Culver. Initiation of legislation and/or executive action will be necessary for some specific alternatives. It is anticipated that Iowa business and industry, Regents Universities, community colleges, and numerous NGOs will also be involved in implementation.

Other: None.

Implementation Mechanisms

It is anticipated that if the preferred options are fully implemented, it would set the state on the course of the 90% reduction goal by 2050. The ICCAC should divide the policy options into groups requiring action by the Governor's Office (through Executive Order), the General Assembly (through state legislation), other state government entities (e.g., the OEI), and nongovernmental organizations (NGOs). During 2009, ICCAC members may be involved with further design and development of these policy options and related implementation strategies.

Legislative and/or executive action will be needed for short-, mid- and long-term scenarios that are elements of the options proposed by the ICCAC. There is a need to develop a strategic system of incentives and disincentives. This should include provisions to establish appropriate enforceability provisions where needed.

Related Policies/Programs in Place

The Midwestern Regional GHG Reduction Accord.

Type(s) of GHG Reductions

All GHG's.

Estimated GHG Savings and Net Costs or Cost Savings

See cumulative tables.

Key Uncertainties

Some of the key uncertainties are whether legislative action and funding occurs to implement pertinent elements of the CAP, whether implementation of the elements of the plan will be timely or adequate, and what the nature and elements of any potential federal and/or regional programs and requirements might be.

Additional Benefits and Costs

Reducing GHG emissions will have ancillary positive air quality and public health benefits due to reduced levels of other pollutants. New technologies will most likely be developed with broader applicability.

Feasibility Issues

Identified in individual options.

Status of Group Approval

Approved.

Level of Group Support

4 objections.

Barriers to Consensus

Several members were concerned that specific timetables for implementation and economy-wide impacts were not analyzed sufficiently.

CC-3. State and Local Government GHG Emissions (Lead by Example)

Policy Description

State of Iowa property belongs to all Iowans, and its expansion and upkeep is funded by Iowans' tax dollars. The same is true for each Iowan's public school and city or county government. The majority of Iowans believe strong action is required to reduce GHG emissions. Government buildings, office equipment, and vehicles are present in every Iowa community and are among the biggest energy consumers in the state. As such, they represent a very significant opportunity for changing the course of Iowa's energy use.

State and local governments should be at the forefront of energy efficiency and renewable energy. By installing the most efficient technology and tapping local power sources, governments can reduce their own GHG emissions, create a significant opportunity for businesses to create and install efficient and/or renewable technologies, create a tested pool of Iowa-specific best practices, build communities' sense of pride in their governments (perhaps boosted by tax decreases and economic benefit), and spur residents and businesses to pursue energy efficiency and renewable energy.

Policy Design

Goals: Iowa is already considered a leader in energy efficiency and renewable energy. However, given the substantial costs and benefits, state and local governments must take further action.

The Governor should consider instituting a "Governors Challenge" to the state agencies and the people of Iowa. Under the challenge, each state agency should produce an annual GHG budget. In addition to the assessing its own GHG emissions, Iowa should assist cities and counties in completing similar assessments so community governments do not waste their limited resources.

State and local governments should take immediate actions to reduce their energy use and increase efficiency. For example, all existing buildings should be assessed for upgrades, and all cost-effective measures should be implemented; and all existing vehicles should be properly maintained so they perform at their highest capacity.

State and local governments should consider efficient possibilities in all procurements, for example:

- All new buildings and renovations should meet sustainable design or development standards, as will be developed in the State Building Code Update.
- Newly purchased vehicles should have the highest practical fuel and GHG efficiency.
- All new office equipment and appliances should be ENERGY STAR-certified where applicable.

State and local governments (with technical assistance from the state) should assess the renewable energy resources in their vicinities to see if they are economically feasible for development. Twenty percent of state and local governments' electricity should come from renewable sources by 2020, either from their own production or purchased from their energy company.

The state should hold an annual contest to have Iowans submit ideas for how state government could exceed its GHG emission reduction scenarios. For example, testing an idea, such as a carbon-neutral legislative session, would reduce GHG emissions, draw attention to the state's other energy efforts, and create excitement about reducing emissions.

The ICCAC should hold workshops for state employees on various themes for lowering their carbon footprints; this could be done in collaboration with the actions described in policy option CC-4 (Public Education and Outreach).

Timing: Various, depending on the initiative, but starting as soon as possible.

Parties Involved: All levels of government operating in Iowa.

Implementation Mechanisms

- Legislative and/or executive action will be needed for short-, mid- and long-term Scenarios developed by the ICCAC, and/or other elements of the CAP.
- Review of agencies' and communities' GHG budgets, recognition of leaders, and accountability for progress in reducing GHG emissions.
- Implementation of all cost-effective energy efficiency measures.
- Procurement of low-GHG products.
- Assessment of renewable energy potential followed by implementation.
- An annual contest sponsored by the state for Iowans to submit ideas for how state government could go above and beyond current scenarios in reducing its GHG emissions. For example, testing an idea, such as a carbon-neutral legislative session, would reduce GHG emissions, draw attention to the state's other energy efforts, and create excitement about reducing emissions.
- ICCAC workshops for state employees on various themes for lowering their carbon footprints.
- Using the rulemaking process of the State Building Commissioner to update the State Building Code with sustainable design and development standards.
- Use of state employee incentives and disincentives.
- Legislative implementation (tax credits, taxes, subsidies, command-and-control legislation), executive action, cap-and-trade markets, and voluntary measures are all anticipated.

Related Policies/Programs in Place

Executive Order 06 established a Green Government Initiative. The Governor's order sets goals to improve energy efficiency in three areas (buildings, materials, and biofuels), and will establish separate task forces to address these issues.

The Energy Excellent Buildings Task Force will focus on "greening" new and existing state office buildings and facilities, including leased space. The goal of the task force will be to reduce the use of electricity, natural gas, fuel oil, and water in all state office buildings by at least 15% overall in the next 5 years, taking into account growth in the state work force or changes in building operations.

The goal of the Sustainable Materials Task Force will be to promote resource efficiency.

The state will be assigning an energy manager within each agency.

The Biofuels Task Force will focus on at least three issue areas: increasing the use of biofuels by state agencies to the maximum amount feasible, reducing the number of vehicle miles traveled by state employees, and increasing the fuel efficiency of the state vehicle fleet.

In addition, the order requires a thorough review and audit of executive branch agencies' current practices related to energy efficiency and conservation. Using the audit data, the steering committee will develop a Master Plan on how to "green" state government, and track progress of state agencies.

Several Iowa communities' mayors have signed the U.S. Conference of Mayors Climate Protection Agreement. Under the Agreement, participating cities commit to take following three actions:

- Strive to meet or beat the Kyoto Protocol scenarios in their own communities, through actions ranging from anti-sprawl land-use policies, to urban forest restoration projects, to public information campaigns;
- Urge their state governments, and the federal government, to enact policies and programs to meet or beat the greenhouse gas emission reduction target suggested for the United States in the Kyoto Protocol—7% reduction from 1990 levels by 2012; and
- Urge the U.S. Congress to pass bipartisan greenhouse gas reduction legislation, which would establish a national emission trading system."

The mayors have signed on in the following Iowa communities: Altoona, Ames, Audubon, Aurelia, Bellevue, Carlisle, Cedar Falls, Cedar Rapids, Charles City, Clive, Coralville, Crystal Lake, Davenport, Decorah, Des Moines, Dubuque, Fairbank, Fairfield, Grafton, Hiawatha, Iowa City, Lawler, Lawton, Neola, Rake, Sageville, Shenandoah, Sioux City, Spirit Lake, Steamboat Rock, Wapello, West Des Moines, Windsor Heights, Woolstock.

Type(s) of GHG Reductions

Not applicable.

Estimated GHG Savings and Net Costs or Cost Savings

Not applicable.

Key Uncertainties

Key uncertainties are whether there will be adequate resources and staff to implement the options and whether there will be a sustained commitment from state and local political leaders.

Additional Benefits and Costs

Improved energy efficiency should lead to lower relative energy costs. Climate leadership by state and local governments should help lead the way to national action, improved development of renewable energy sources, and widespread utilization of energy efficiency initiatives. Improving energy efficiency will also provide a boost to the economy.

Feasibility Issues

None identified at this time.

Status of Group Approval

Approved

Level of Group Support

Unanimous

Barriers to Consensus

None

CC-4. Public Education and Outreach

Policy Description

The goal of climate change education extends well beyond the goal of conventional education, because it seeks not only to impart cognitive knowledge, but also to translate knowledge into positive action. Failure to appreciate this distinction has led to stagnation and lack of successful approaches in creating a public that is literate about issues relevant to climate change. According to the seminal work of Hungerford and Volk (1990),[1] there are three levels of environmental awareness:

- *Simple Awareness*—Knowing about the existence and importance of an environmental issue, but being unfamiliar with its complexities and having little relationship to personal change or action.
- *Personal Conduct Knowledge*—Understanding an environmental issue that lends itself to changes in personal conduct, but does not require detailed comprehension.
- *Environmental Literacy*—The outcome of a sound program of environmental education in which the learner progresses to deeper knowledge, and can apply it to address complex environmental issues and make wiser decisions.

Public education and outreach programs should address the public's responsibility to maintain clean air, pure water, and fertile soil for their children and future generations. Adding to the challenge is that environmental information absorbed by the public stems from a diverse and unconnected smattering of sources that includes television, radio, print media, environmental groups, government publications, the Internet, the classroom, personal readings, chatting with friends, and other experiences. In general there is no quality control for the information. In the end, those seeking to learn about environmental issues are often left with little more than a collection of factoids, numerous and often conflicting opinions, and very little understanding—not enough to get beyond the "simple awareness" level cited above. Undoubtedly, excellent resources are available for public environmental education, but they may be lost in the background noise emanating from the cacophony of messages from disparate other sources.

There is not much detailed information about the level of climate change awareness in Iowa. The available evidence, however, suggests that it may not extend much past "simple awareness," because there doesn't appear to be significant change in personal conduct with respect to steps that would mitigate climate change. For example, optimizing energy efficiency is a major strategy for reducing GHG emissions, but a recent comprehensive study commissioned by the Iowa Utility Association shows enormous untapped potential in realizing that goal for Iowa.

[1] Hungerford, H.R. and T.L. Volk (1990). Changing learner behavior through environmental education. *Journal of Environmental Education* Spring; 21(3):8–21. Available at: http://eric.ed.gov:80/ERICWebPortal/custom/portlets/recordDetails/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=EJ413973&ERICExtSearch_SearchType_0=no&accno=EJ413973.

There is an urgent need for a comprehensive, objective, and authoritative climate change education campaign for Iowa that will improve the knowledge base and motivate individuals, communities, and organizations to take action to will reduce their GHG emissions**.**

Policy Design

Goals: The goal of the proposed education campaign will be to move Iowans beyond "simple awareness" about climate change to "personal conduct knowledge." Progressing to "climate change literacy," the highest level of awareness, is a loftier goal, certainly worthy of achievement, but beyond the scope of the work proposed here. Even the more modest goal of achieving "personal conduct knowledge" is very ambitious, and will require a multi-year stepwise approach.

To achieve this goal, the state should consider forming a consortium on *Climate Change Education & Empowering Citizens Through Positive Actions*. The consortium would be led by the three Regents Universities, but would also involve private colleges, community colleges, and numerous other Iowa organizations involved in education, outreach, and concern about climate change and future generations.

The ICCAC has identified six target audiences for the education campaign: state government, policy makers, industrial and economic sectors, future generations, community leaders and community-based organizations, and the general public. State government is being addressed in large part under CC-3 (State and Local Government GHG Emissions [Lead by Example]). The consortium will assist this effort in the first year by hosting workshops on energy efficiency and renewable energy for state workers. Similarly, the consortium will address the needs of policy makers through a series of seminars and workshops to educate and promote conversations about climate change and effective solutions. With regard to an education plan for targeted industrial and economic sectors, the consortium will seek collaboration with the utilities and the Market Advisory Group established under CC-5 (Cap-and-Tax Policies [transferred to Clean and Renewable Energy Subcommittee]). The task of educating future generations will require comprehensive discussion with the Iowa Department of Education to assess the feasibility and promote the inclusion of integrating climate change into educational curricula and post-secondary degree programs.

The goal of educating community leaders, community-based organizations, and the general public across Iowa requires a far more extensive approach that the consortium proposes to achieve in a three-step plan. At the moment there is very little detailed information about what Iowans know and don't know about climate change, or about their willingness to take significant steps to reduce its impacts. Telephone surveys are somewhat useful, but there is often a large disparity between what people say on the phone and what they actually know and do in real life. A far better means to weigh public attitudes is to engage the public in face-to-face dialogue in a town meeting format. The consortium will address this need in Step 1. The subsequent steps in the education campaign will be guided by the findings determined in step 1.

Step 1: Baseline Information: Analysis of Educational Needs and Preference for Positive Actions (Year 1)

In this step the Iowa State University (ISU) Extension Service will engage numerous Iowa communities in conversations about climate change. This will guarantee broad coverage, since the ISU Extension serves every county in the state. We propose to adopt the approach the ISU Extension applied to promote public dialogue on the issue of the bioeconomy (*The Bioeconomy in Iowa: Local Conversations*, 2007), which covered 92 counties with an audience of more than 950 Iowans.

The county meetings on climate change will have two goals.

- To gain a multifaceted perspective on the attitudes Iowans have about climate change, the degree to which they agree or disagree with the science, factors that influence their opinions, whether they perceive climate change as a threat to future generations, what aspects they wish to learn more about, and a host of other issues.
- To present a large menu of possible individual and community-based actions to mitigate climate change, and to glean from the participants the actions they are most willing to undertake.

As recommended by the ICCAC, special attention will be given to low-income communities. The information gathered at the county meetings will provide grist for a climate change education plan tailor-made for Iowans. One tangible outcome of the analysis will be a white paper on “Climate Change Education and Seeking Solutions Through Positive Actions,” which will provide the knowledge base for conducting Step 2.

Each participant at the county meetings will be asked to complete a survey prior to the meeting to gauge their knowledge about climate change and actions that could mitigate climate change. This survey will provide baseline data for evaluating the project.

Step 2: Enact Education Campaign (Year 2)

This step would promote multiple forums for educating Iowans about climate change, and empowering individuals to take personal action to mitigate climate change. The ISU Extension will again play a pivotal role in this step, hosting another series of statewide town meetings to launch the plan. We would invite the participation of numerous other organizations as well. Such organizations would include (but are not limited to): Iowa private colleges, community colleges, 4-H Clubs, Chambers of Commerce, the utilities and natural gas providers, Interfaith Power & Light, school boards, Boy/Girl Scouts, and I-RENEW.

The work of these organizations would be supported as needed by training sessions, printed materials, videos and Web casts, a Web site dedicated to the campaign, and other outreach resources. Empowering citizens will be given a high priority, and teams will be trained to present specific issues and address designated target audiences. The content presented would depend on the findings of Step 1, but could include such subject areas as reducing your carbon footprint, weatherizing homes for the elderly, planning and building community bike trails, designing new homes and retrofitting old homes to optimize energy efficiency, installing ground-source heat pumps, and improving energy efficiency in school buildings. We would add an interactive component to the education/empowerment campaign by installing a Wiki Web site to promote dialogue with the Iowa public. All citizens and communities that conduct positive actions will be encouraged to report those actions at town meetings or on the project Web site.

Step 3: Impact Assessment, Recognizing Success, Public Dissemination (Year 3)

This step will ensure that the work of the education campaign is quantified, rewarded, and disseminated to the wider public, both statewide and nationally. Another set of town meetings hosted by the Extension Service will facilitate this step. A post-education-campaign survey will be conducted and compared to the baseline survey completed in Step 1 to measure the degree to which the campaign succeeded in moving the public from "simple awareness" to "personal conduct knowledge." All citizen and community actions reported at the county meetings will be entered into the project's database for cataloguing and assessment. A carbon footprint calculator will be applied to quantify reductions in GHG emissions based on the reported actions. The results of the assessment will be documented in a written report and posted on the Internet.

Competitions will be set up among counties for the most successful and creative actions conducted to mitigate climate change. A team of judges will be appointed to select the winners, who will receive awards at the State Capitol with much fanfare. A set of case studies based on the individuals and communities entering the competition will be prepared, and a book featuring their work will be published and posted on the Internet. The successes of the education campaign will be aggressively publicized via radio, television, print media, Web site postings, and other effective ways to disseminate the results.

Evaluation of the Project

The project will be evaluated in multiple ways. Surveys gauging knowledge about climate change and actions that can be taken to mitigate it will be administered before and after the education campaign. The analysis will provide an assessment of the extent to which citizens progressed from "simple awareness" to "personal conduct knowledge." The number of participants at the county meetings will be tallied, as well as the number of individuals and communities conducting positive actions to reduce GHG emissions. The carbon footprint calculator will quantify reductions in GHG emissions resulting from those positive actions, and the number of "hits" on the Wiki Web site will be tracked.

Timing: The education campaign will take 3 years, with each of the three steps conducted in consecutive years. It would be preferable to begin Step 1 in early 2009.

Parties Involved: The University of Northern Iowa, Iowa State University, University of Iowa, private colleges, junior colleges, 4-H Clubs, Chambers of Commerce, the utilities and natural gas providers, Interfaith Power & Light, school boards, Boy/Girl Scouts, and I-RENEW. This list is by no means exhaustive, and other collaborations will be sought as the campaign evolves.

Other: None currently identified.

Implementation Mechanisms

The proposed Climate Change Public Education and Outreach Program is ready to be implemented, as detailed in the three-step plan described above. Each of the three Regents

Universities has agreed to participate and is prepared to begin the project as soon as funding is secured.

The education campaign will focus on individual and community-wide efforts to lower the carbon footprint of participating members. Carbon emission reductions will be achieved by promoting measures, such as implementing ENERGY STAR appliances, bicycling and walking as alternatives to car transport, installing geothermal heat pumps, and designing new homes and retrofitting old homes to optimize energy efficiency.

The campaign will implement a Web-based carbon footprint calculator so that participants can quantify reductions in GHG emissions from their reported reduction actions. The cumulative emission reductions will be summed for an overall measure of the metric tons of equivalent carbon dioxide (tCO_2e) saved. This calculation will most likely underestimate total carbon reductions, as it is not expected that all reductions actions will be measured or reported.

At this time it is not possible to calculate the costs per tCO_2e saved. However, they can be estimated by asking the participants who log on to the calculator to estimate the costs of implementing their reduction measures. The cumulative sum of the reported implementation costs, plus the costs of the education campaign itself, can provide an estimated overall cost. This cost can be divided by the estimated tons of equivalent CO_2 saved.

Once funding is in hand, the Regents Universities will seek collaboration among the other organizations described above in the Parties Involved section.

Related Policies/Programs in Place

Currently, no related programs are in place in the state that cover education and outreach areas to the same depth and breadth as the proposed three-step plan described here. Numerous straw policy options from other ICCAC subcommittees have educational components, which are currently unfunded as well.

Type(s) of GHG Reductions

Not applicable.

Estimated GHG Savings and Net Costs or Cost Savings

Not applicable.

Key Uncertainties

Key uncertainties include whether funding will be available to implement the CAP, the level of participation and receptivity of audiences, and how well participants absorb the proposals and ultimately act on them.

Additional Benefits and Costs

The costs for staffing are estimated to be approximately $300,000/year, plus a $135,000/year cost share for implementing entities.

The main benefit will be a means for empowering individuals and communities to do their part in reducing GHGs. Many Iowans would be willing to lower their carbon footprint, but lack understanding of the issues and information about positive actions that can be undertaken. The campaign will seek to bridge the gaps in understanding and know-how.

It is expected that the benefits will extend well beyond the timeframe of the campaign and the number of people who actually participate in it. The statewide dissemination effort described in Step 3 will demonstrate the success of the campaign and encourage other individuals and communities to participate. An educated and informed public will most likely ensure that the momentum built during the 3-year campaign will be self-sustaining after the campaign has officially ended.

Feasibility Issues

None identified at this time.

Status of Group Approval

Approved

Level of Group Support

Unanimous

Barriers to Consensus

None

CC-5. Tax and Cap Policies

Policy Description

The lead for developing this policy option was transferred by the ICCAC to the Clean and Renewable Energy Subcommittee.

CC-6. Seek Funding and Financing for Implementation of ICCAC Options

Policy Description

Funding must be obtained to implement some ICCAC options. In Iowa there are two organizations that fund projects related to the ICCAC goals: the Iowa Power Fund and the Iowa Energy Center, both described below. Out-of-state and federal funding sources should also be considered. For all sources of funding, success would be enhanced through partnerships with other organizations and agencies.

Policy Design

Goals: Establish financing mechanisms and obtain funding necessary to implement the ICCAC's options.

Timing: Seek funding beginning in 2009 for implementation of the ICCAC's options. A schedule can be created after the ICCAC prioritizes which grants or foundations will be approached.

Parties Involved: Key partners in seeking financing and funding mechanisms could include federal and state policy makers, NGOs, business representatives, academic community, financial investment managers, citizens, and others.

Other: None currently identified.

Implementation Mechanisms

The ICCAC will need to determine who is responsible for writing grant proposals or approaching foundations for funding, as well as prioritizing which organizations should be approached first. The ICCAC may also consider hiring a grant writer, if necessary.

Related Policies/Programs in Place

The Iowa legislature created both the ICCAC and Iowa Power Fund Board in 2007. Although the two organizations are separate, they share similar goals of GHG reduction and control of climate change through increased energy efficiency and use of renewable energy. The Iowa Power Fund consists of an appropriation of $25 million per year for 4 years. The funds are to be used to increase Iowa's research, development, and use of sources of renewable energy, improve efficiency, and reduce GHG emissions. Applications can come from businesses, individuals, government entities, nonprofit organizations, and academic institutions. Projects are evaluated on their originality, impact, and amount of cost shared by others. More details are available on the OEI's Web site at http://www.energy.iowa.gov.

Another Iowa source of funding is the Iowa Energy Center, which provides two funding options. The conference and small demonstration grants provide up to $7,500, and proposals are accepted throughout the year. Pre-proposals for larger projects must be submitted annually; if accepted a full proposal is requested. More details are available on the Iowa Energy Center Web site at http://www.energy.iastate.edu.

Type(s) of GHG Reductions

Not applicable.

Estimated GHG Savings and Net Costs or Cost Savings

Not applicable.

Key Uncertainties

The key uncertainties are whether there will be adequate resources and staff to implement the CAP options, whether there will be a sustainable commitment from state and local political leaders, and whether funds will be forthcoming from the Midwestern Governors GHG Accord process for the states.

Additional Benefits and Costs

Many grants require cost sharing. Partnering with other organizations may help secure these matching funds, as well as lead to mutually beneficial networking and sharing of ideas.

Feasibility Issues

Although finding the time to write grants and securing cost share will be a challenge, it should be within the powers of the members of the ICCAC.

Status of Group Approval

Approved

Level of Group Support

Unanimous

Barriers to Consensus

None

CC-7. Adaptation and Vulnerability

Policy Description

Because of the existing buildup of GHGs in the atmosphere that has already occurred or is underway, Iowa will experience effects of climate change for years to come, even if immediate action is taken to reduce its future GHG emissions. While Iowa may be less dramatically affected than coastal or arid regions of the country, the state will need to adapt to different sets of vulnerabilities, which may include such impacts as increased public health risks, urban infrastructure demands, and refugee movement. Thus, it is essential that the state develop a plan to manage the projected impacts of global climate change affecting Iowa, while broader mitigation efforts to lower atmospheric concentrations worldwide are being developed and implemented. Part of our adaptation must include strategies for mitigating and addressing human suffering, so that no one segment of the population or any of Iowa's natural resources or natural heritage sites suffers catastrophically.

Policy Design

Iowa should develop, adopt, and implement a Climate Change Adaptation Plan that includes identification of scenarios covering (1) potential short-, mid-, and long-term impacts of climate change that may affect the state, and (2) implementation mechanisms for addressing these impacts.

That being said, given that the effects of climate change are already happening, the state cannot simply wait for a report before taking action to adapt to these known and predictable changes. Each segment of the Iowa economy and community, and appropriate representatives of each of Iowa's natural heritage areas should begin immediately to develop action plans to offer assistance to those most dramatically affected, mitigation of those impacts where feasible, specific initiatives to draw down their GHG emissions, and most important, strategies for remaining viable and robust by adaptation to changing circumstances.

These action plans should be collated and redacted into a single coherent State of Iowa Adaptation Plan that avoids contradictions, increases efficiencies, minimizes redundancies, and fills in the gaps. The state Climate Change Adaptation Plan should include at least the following key elements:

- Comprehensive identification of potential short-, mid-, and long-term impacts associated with climate change in Iowa.
- Recommended steps to minimize risk to humans, natural and economic systems, water resources, temperature-sensitive populations and systems, energy systems, transportation systems, communications systems, vital infrastructure and public facilities, and natural lands (such as wetlands, forests, and farmland), and all other identified and affected sectors or areas of concern throughout the state.
- Coordination of response efforts through the appropriate state, local, and federal agencies, organizations, or other entities or initiatives.

- Characterization of the potential risks and costs of inaction; characterization of the potential costs, benefits, and co-benefits associated with specific policy and program actions; and establishment of time- and program-based goals.
- Use of cost-effectiveness analysis to guide and inform the development and implementation of the state Climate Change Adaptation Plan. The analysis should include an examination of the benefits and costs of adaptation measures or responses relative to a status quo or no-action approach, and the resources needed to implement adaptation measures in the plan. The results of the cost-effectiveness analysis should also be used to set priorities for addressing short-, mid-, and long-term impacts of climate change on Iowa's citizens, ecosystems, and economy.
- Creation of a scientific strategy that engages the public, educational institutions, and state agencies in the monitoring of climate and ecological trajectories in Iowa to improve updates to the Adaptation Plan.
- Adaptation measures that also mitigate GHG emissions should be given priority in the state Climate Change Adaptation Plan.
- The Plan should be reviewed and updated every 5–10 years to expand or refine it as necessary, to improve its implementation, and to incorporate new information as it becomes available.

Goals:

- Develop a comprehensive state Climate Change Adaptation Plan that identifies opportunities to address adaptation issues and risks to Iowa citizens and recommends tangible, implementation measures to mitigate them.
- Conduct cost-effectiveness analyses comparing the potential costs of a status quo approach, as opposed to implementing the options proposed in the Climate Change Adaptation Plan.
- Prioritize options in the Adaptation Plan, based on the certainty and severity of adverse impacts to citizens, ecosystems, and local economies.
- Ensure that development of the plan (1) involves all affected agencies and entities at all levels of government; (2) engages all affected sectors and interests; and (c) provides for periodic review and update concerning adaptation risks, responses, and opportunities in the state.

Timing: The smaller local groups should begin immediately. “Low-hanging fruit” opportunities should be addressed as rapidly as feasible (even before the Climate Change Adaptation Plan is established, if possible), and proactive adaptation initiatives should commence within the next 2–3 years. The Climate Action Adaptation Plan should be in place by the first intermediate timeline of 5 years. Parallel public education and outreach efforts regarding adaptation should commence immediately.

Parties Involved: The following constituencies should be called upon to create action plans: state and local governments; school districts and institutions of higher learning; hospitals, clinics, and hospices; agriculture organizations; NGOs, including such environmental organizations as

The Nature Conservancy Iowa, and the Sierra Club; religious congregations; and social service organizations.

The Governor and the Iowa legislature should pursue the possible establishment of a Commission on Adaptation to Climate Change, including proper funding. The commission should then involve and coordinate with all appropriate state and local agencies, organizations, and institutions (e.g., universities) to ensure that all potential impacts are identified and to ensure the successful development and implementation of the plan. The role of ICCAC, if any, needs to be defined.

Implementation Mechanisms

- Review available reports from state and national adaptation plans.
- Develop a catalog of adaptation policy options.
- Prioritize options and recommend possible standards and codes.
- Provide public education and outreach programs.
- Coordinate with existing state agencies to establish and maintain a Web-based resource for adaptation to the most pressing vulnerabilities.

Related Policies/Programs in Place

Federal, state, and local emergency response plans for natural disasters. The need to coordinate with these agencies to evaluate potential increases in violent weather (due to climate change) is essential for our citizens. Such an initiative is already emanating from Iowa State University, where professors are leading the drive for a "Climate Science and Impacts Initiative."

The state is taking steps to address the aftermath of the recent tornadoes and floods in Iowa through the "Rebuild Iowa" effort.

IDNR has hired a staff person within the Conservation and Recreation Division to prepare a strategy for dealing with the ecological climate change effects on water, soils, forests and prairies, fisheries, and wildlife.

Type(s) of GHG Reductions

Not applicable.

Estimated GHG Savings and Net Costs or Cost Savings

Not applicable.

Key Uncertainties

There is uncertainty about the nature, magnitude, and geographic variability of impacts that will result from climate change in Iowa. There is also uncertainty regarding impacts on public health and on wildlife and migration patterns.

Additional Benefits and Costs

Adaptation will most likely entail significant costs for such items as increased flood protection facilities and greater fortification of buildings of all kinds.

Feasibility Issues

It is probably not feasible to move towns entirely out of floodplains. It will also be difficult to devise measures to improve adaptability to the increased numbers and severity of tornadoes.

Status of Group Approval

Approved

Level of Group Support

Unanimous

Barriers to Consensus

None

CC-8. Participate in Regional and Multistate GHG Reduction Efforts

Policy Description

Regional approaches undertaken in collaboration with partner states or other organizations can offer broader and more economically efficient opportunities to reduce GHG emissions across Iowa's economy. Iowa has already joined several organizations, including the Midwestern Greenhouse Gas Accord, the Midwestern Governors Energy Security and Climate Stewardship Platform, and the multistate Climate Registry initiatives. These developments should be continued and should form the basis for Iowa's own programs. To the extent that Iowa's needs may not be fully met by these initiatives, Iowa should consider developing supplemental or ancillary registry capacity or opportunity. (See CC-1.)

Policy Design

Goals:

- Work to develop these regional programs so that Iowa's interests are protected, while meeting Iowa's goals of developing capacity to reduce the state's GHG emissions effectively.
- Ensure the cost-effective reduction of GHG emissions in a manner that maximizes public benefits, induces innovation in energy efficiency and sustainable energy technologies, and avoids inequitable impacts.
- Maximize economic and employment opportunities, while minimizing transitional job losses.
- Iowa needs to establish GHG reduction scenarios and time frames consistent with the other member states' own scenarios, help to develop a market-based and multisector cap-and-trade mechanism, and continue to develop other mechanisms and policies to achieve the proposed reduction scenarios.
- Establish links to other jurisdictions and systems to create economies of scale, increasing efficiency and diversity.
- Address the ability to integrate and potential actions taken by federal programs.

Timing: Iowa should move forward in the 2009 legislative session to address any needed regional initiatives associated with implementation of the Midwestern Regional GHG Accord.

The GHG Accord was signed on November 15, 2007. Various time lines within the Accord have a target completion of 30 months after the signature date.

The Energy Security and Climate Stewardship Platform for the Midwest was also signed on November 15, 2007. The dates mentioned in the Platform include 2012, 2015, 2020, 2025, 2030, and 2050.

Parties Involved: Currently, six states (Iowa, Illinois, Kansas, Michigan, Minnesota, and Wisconsin) and one Canadian province (Manitoba) are signatory to the Accord. In addition, three other states (Indiana, Ohio, and South Dakota) have signed as observers to participate in regional cap-and-trade issues.

Implementation Mechanisms

Iowa needs to work with other states through the Midwestern GHG Accord to develop and implement an approach to reducing GHG emissions within the region, recognizing that each state will have unique problems to address. These efforts should include consulting on a regional cap-and-trade policy, and/or a carbon tax system.

Related Policies/Programs in Place

- The Midwestern Regional Greenhouse Gas Reduction Accord.
- The Energy Security and Climate Stewardship Platform for the Midwest.

Type(s) of GHG Reductions

Not applicable.

Estimated GHG Savings and Net Costs or Cost Savings

Not applicable.

Key Uncertainties

Potential federal and/or regional program elements that will be forthcoming are uncertain.

Additional Benefits and Costs

Costs will be associated with implementing the Midwestern Regional GHG Accord and any potential new federal programs. Reducing GHG emissions will have the ancillary benefit of improving Iowa's economy and energy security.

Feasibility Issues

It is more difficult to tailor larger national or regional program elements to Iowa-specific needs.

Status of Group Approval

Approved

Level of Group Support

Unanimous

Barriers to Consensus

None

CC-9. Encourage the Creation of a Business-Oriented Organization to Facilitate Investment in Climate-Related Business Opportunities and to Share Information and Strategies, Recognize Successes, and Support Aggressive GHG Reduction Goals

Policy Description

Numerous economic and business opportunities can arise from implementing a comprehensive GHG reduction strategy for Iowa. A variety of job creation possibilities are implicit in new approaches to transportation, land use, green construction, recycling and reuse, and energy-efficient products and services. The state should work with public and private entities to identify, promote, and finance these opportunities for economic development and job creation. Iowa should also work to keep existing green jobs in Iowa and prevent them from moving out of state.

The growth of the "green industry" has the potential to benefit low- to mid-skill workers who can no longer depend on traditional manufacturing jobs. Since green jobs require applied technical skills, they generally pay decent wages. Unlike blue-collar jobs, many green-collar jobs require local employees and cannot be outsourced.

Another component of economic development is the promotion of buying locally produced foods, goods, and products. Consumer support for the local economy helps sustain Iowa businesses, jobs, and tax base, while reducing the consumption of fuel (and CO_2 emissions) in the transportation of foods and products over great distances.

Policy Design

In Iowa, the opportunities for creating green jobs are numerous, including designing and constructing green buildings; weatherizing existing buildings; retrofitting older buildings with energy-efficient appliances and technologies; expanding the construction, maintenance, and operation of common-carrier and public transportation networks and systems; designing, constructing, and operating windmills, biomass generators, and solar collectors; and research and development of a wide array of new practices and technologies that can abate GHG production.

A business-oriented organization should be established or assigned responsibility to help promote these opportunities related to climate change in Iowa. Promotion of consumption of locally produced foods and goods will also strengthen Iowa's economy.

Goals: Targeted business promotion and job creation should be a part of Iowa's effort to mitigate GHG emissions. Iowa should build upon its momentum to make every effort to establish itself as a leader in developing green industries.

OEI administers the Iowa Power Fund, a $100 million effort over 4 years to support research, development, commercialization, and deployment of biofuels, renewable energy technologies, and energy-efficient technologies while seeking to cut GHG emissions. One criterion on which proposals for the Fund are judged is their ability to create economic opportunity in Iowa and future green collar jobs. OEI coordinates their efforts with the Iowa Department of Economic

Development (IDED), the State of Iowa Facilities Improvement Corporation, the Renewable Fuel Infrastructure Program, the Value-Added Agricultural Products and Processes Financial Assistance Program, the Enterprise Zone Program, and High-Quality Job Creation Program.

Timing: As soon as possible to build on OEI projects.

Parties Involved: Universities, IDED, Chambers of Commerce, energy utilities, existing green businesses and industries, energy conservation experts, and individual businesses across the state.

Other: None currently identified.

Implementation Mechanisms

A group of Iowa experts from across the state and across disciplines should be assembled to develop a vision and strategies for developing and attracting businesses that will flourish in a carbon-constrained world. The group should be tasked with developing key criteria that will be used in evaluating potential business developments in Iowa. Sample criteria might include:

- Will the business benefit from the carbon-constrained economy?
- How will the potential business fare in a changing climate?
- Will the business be based upon locally available materials?
- Will the business be structured to allow reduction of commuting requirements for employees?
- Will the business be able to function in relation to existing businesses through the principles of Industrial Ecology?
- A GHG emission per dollar of product metric could be developed and used to scale economic assistance.

The group should be tasked with providing recommendations to the Iowa legislature for the 2010 session.

Related Policies/Programs in Place

Iowa Power Fund, IDED programs, university research.

Type(s) of GHG Reductions

Not applicable.

Estimated GHG Savings and Net Costs or Cost Savings

Not applicable.

Key Uncertainties

There is uncertainty about whether, and if so, who, will lead this initiative on behalf of the business community, and how much business participation can be counted upon. There is also uncertainty about the future of biofuels.

Additional Benefits and Costs

This endeavor could create more opportunities for new technology development. There can be synergy among companies working on these types of similar ventures. While economic and employment opportunities should be significant, significant costs will also most likely be associated with implementation of some of the CAP elements. There is a significant promise that development of green cellulosic crops could spur Iowa's economy.

Feasibility Issues

Restructuring and retraining the work force to implement a new reduced-carbon energy economy will be challenging. Iowa will need to gauge the cost-effectiveness of selected solutions along the way.

Status of Group Approval

Approved

Level of Group Support

Unanimous

Barriers to Consensus

None