White Paper: Preliminary Assessment of Iowa's Energy Position

Prepared for the Iowa Energy Plan, IEDA, and Iowa DOT

Prepared by TEConomy Partners, LLC

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TECONOMY PARTNERS LLC

Innovating Tommorow's Economic Landscape

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I. Introduction

This report, produced by TEConomy Partners, LLC addresses a component of the Task 1 deliverable of the Iowa Energy Plan – defined as providing an "assessment of current and future energy supply and demand in Iowa." The report, goes further, however, to examine the structure of the energy industry in Iowa and its role in employment and job growth within the state.

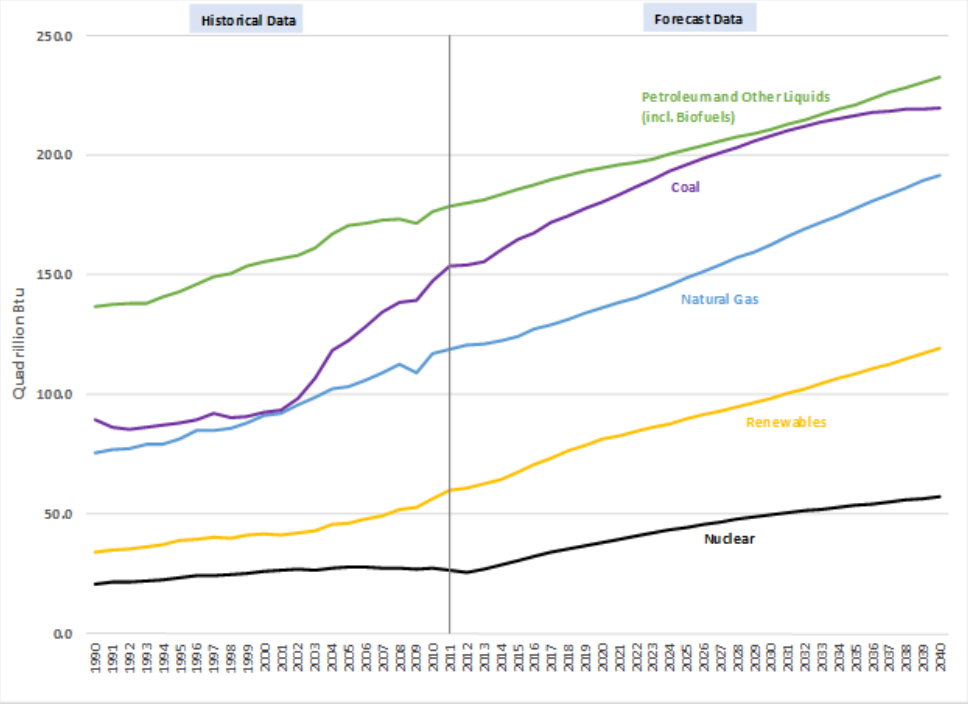
The report presented herein represents just one early component of a larger scale comprehensive Iowa Energy Plan, and will be followed up by TEConomy Partners' next phase of work in evaluating strengths, weaknesses, opportunities and threats (SWOT analysis) for Iowa in energy, and an assessment of energy research and development (R&D) and innovation core competencies in the state.

Led by the Iowa Economic Development Authority and the Iowa Department of Transportation, and comprising a working committee of stakeholders and citizens from across Iowa, support for the project is provided by a consulting team comprising Inova Energy Group, LLC (Inova) as the lead consultant, together with specialized project support from Elevate Energy (Elevate) and TEConomy Partners, LLC (TEConomy).

A. Energy as an Economic Engine

The State of Iowa has identified "energy" as an area of strategic importance to the state economy and for economic development. As shown in Figure 1, global and U.S. demand for energy and fuels, in all their forms, is unlikely to abate. Global demand projections indicate that more energy, in all its forms, will be needed to meet worldwide demand projections.

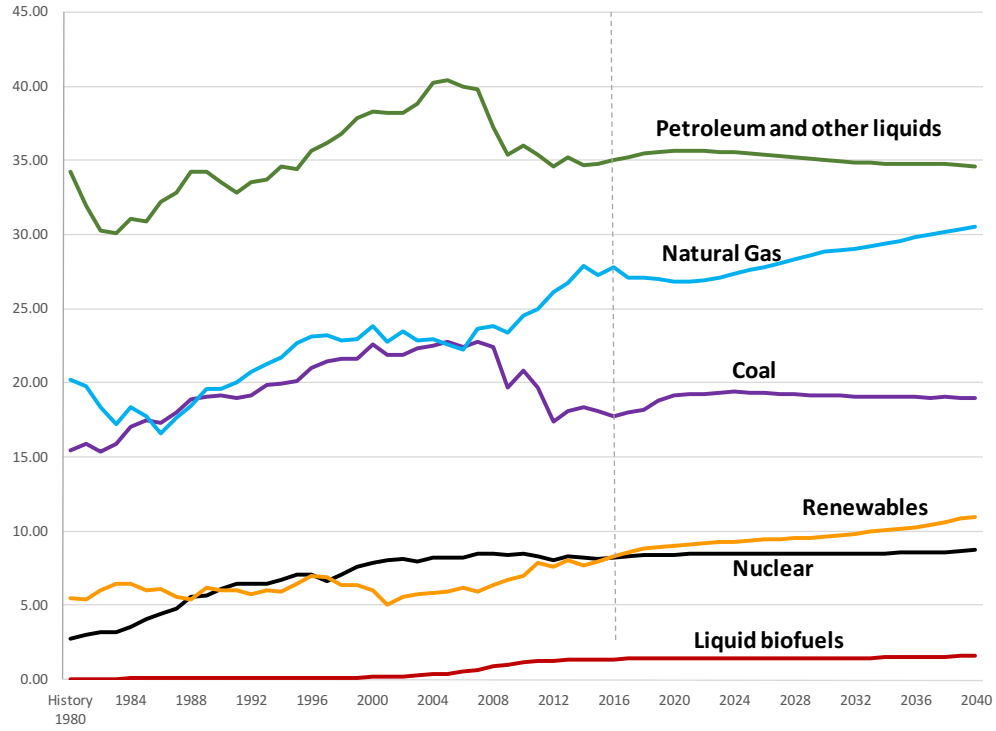
Figure 1: Global Energy Demand, Recent Trends and Predictions by Source[1]



[1] Source: U.S. Energy Information Administration (EIA) International Energy Statistics database (as of November 2012). More recent data does exist yet as the EIA is changing its data release process. The next is likely to be published in the second quarter or 2016.

Domestically, U.S. economic growth projections, in combination with other actors such as energy-efficiency measures and changing production profiles, lead to a much flatter projection for growth. In the U.S. natural gas and renewables are projected to see a rise in energy demand while most other sources are flat. Between 2016 and 2040, the U.S. Energy Information Administration projects overall U.S. demand to increase 7.1%.

Figure 2: U.S. Energy Demand, Recent Trends and Predictions by Source



Both developed and developing nation economies depend on energy to power economic and societal activity. Because the demand for energy is assured moving into the future, energy may be seen as providing a relatively secure asset for those nations, regions and states having robust energy resources or the infrastructure and know-how needed to drive the further development of energy technologies and solutions to meet global and domestic needs.

Energy is, however, a highly dynamic sector that is influenced by both global and local economic trends, and also by strategic concerns over dependence on foreign fuel imports, environmental concerns over emissions, and the policy decisions of governments. In addition, energy extraction, conversion and generation, distribution and use represent an integrated value-chain with substantial opportunities for advanced technology deployment and innovation. Opportunities for technology-based economic development exist for those states able to attract and grow R&D activity and innovation commercialization in energy and energy-related technologies.

There are, therefore, multiple pathways that a state may follow in pursuing energy-based economic development:

- A state may exploit its natural fuel assets (such as oil, gas or biomass) to generate cost-effective power to give industry and commerce a competitive advantage.
- A state may export unrefined fuels or energy or it may further convert fuels into higher value-added liquid fuels, chemicals or materials for export.

- A state may build a robust R&D sector focused on academic and commercial research in energy and associated technologies, attracting-in external research funds.
- A state may build a significant manufacturing sector producing technologies for resource discovery, resource extraction, energy generation, energy transmission, and energy conservation. It may leverage its research assets to develop new energy products, technologies and services for sale in the domestic and international marketplace.
- A state may seek to undertake energy conservation and efficiency measures in order to increase energy resource availability for export, reduce energy imports, lessen environmental impacts of energy consumption, and generate jobs in providing energy efficiency services and products.

Iowa, in seeking to develop a statewide energy strategy, is interested in examining all of the above. The State seeks to have a detailed profile developed of energy's role in the Iowa economy, to identify trends likely to effect the impact of energy on the Iowa economy, to understand the key assets of the state in terms of the energy value chain, and potential opportunities to generate technology-based economic development through R&D and commercialization of energy innovations. The State is also seeking to identify opportunities to conserve energy and reduce any negative externalities associated with energy development, generation or use.

The State of Iowa recognizes that the energy sector is a highly important sector and resource for the state, and seeks to enhance the sector further to grow the Iowa economy. There is an energy sector momentum in Iowa upon which to build – with the renewable energy story, in particular, being a stand-out performer. The growth of the biofuels industry in Iowa, together with substantial growth in wind energy (in terms of both energy generation and technology/systems manufacturing), are very much indicative of the ability of the energy sector to generate new businesses, wealth, jobs and government revenues in the State. Iowa now seeks to further refine its approach to energy-based economic development and energy-sector efficiencies through the development of a formal statewide energy strategy. The State recognizes that achieving the full-realization of energy economic development promise in the State will require a prioritization of strategic activities and investments, backed by a robust understanding of energy assets, opportunities and challenges in the State, thus serving to guide State actions. To advance effective public and private actions in Iowa focused on energy, it is critical for the State and key stakeholders to have reliable information, identifying the near term growth opportunities in energy development for Iowa, together with a detailed and objective understanding of its assets and gaps. Based on this objective analysis a strategic action plan can then be developed to promote the growth and development of specific energy-based platforms most likely to generate economic growth for the State.

TEConomy Partners, LLC is responsible for major elements of the Iowa Energy Plan work pertaining to development of a quantitative understanding of Iowa's current position in energy, producing projections for energy sector development under potential development scenarios, and developing a SWOT (strengths, weaknesses, opportunities, and threats) assessment focused on energy resources and infrastructure, the current energy industry in Iowa, the energy sector workforce, and R&D and innovation within the energy sector and associated fields.

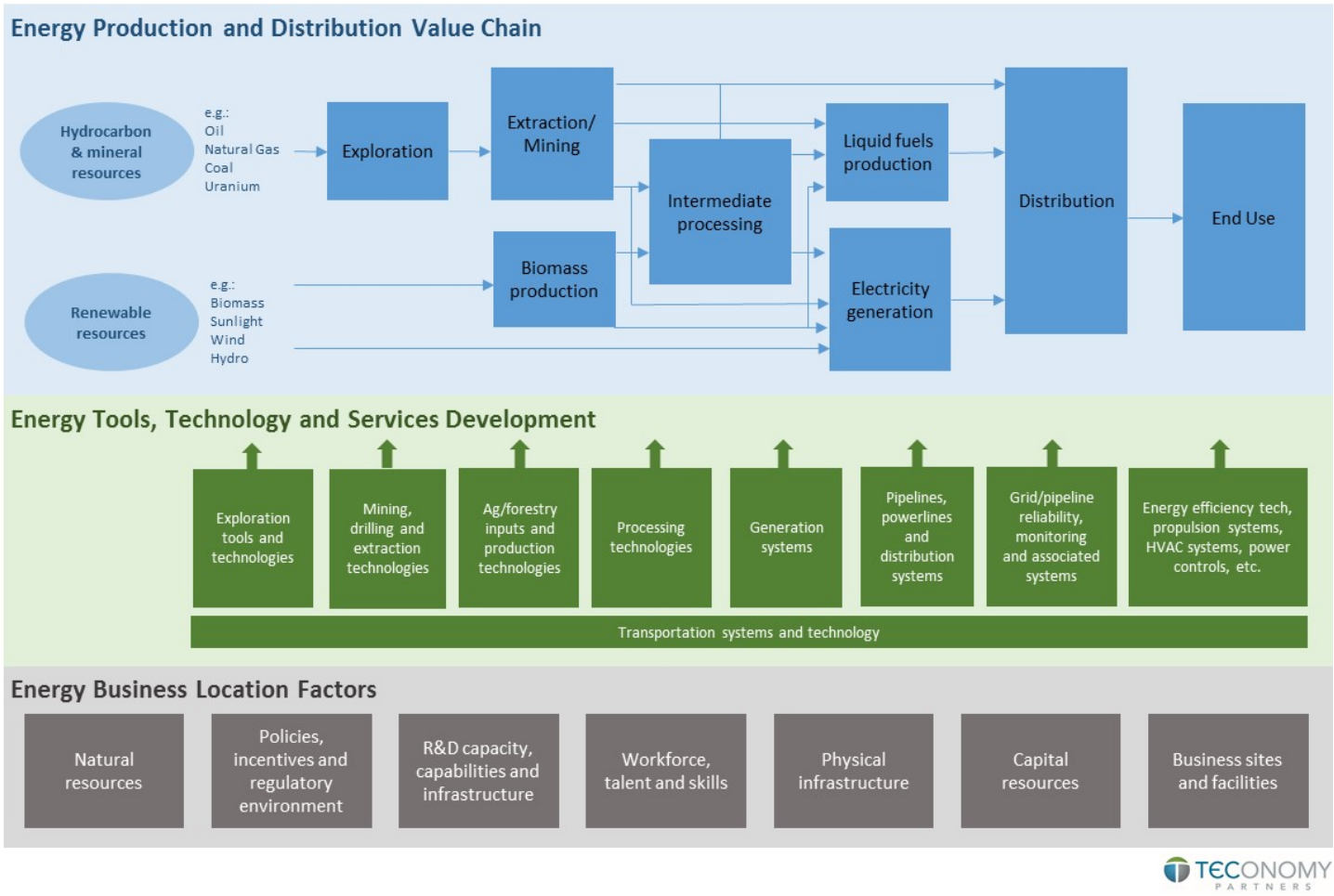
This report represents an introductory white paper focused on defining the energy sector in Iowa and summarizing key quantitative data regarding the current status of energy supply, demand, and the key components of the energy value-chain within the State.

B. Defining the Energy Sector

In performing this analysis, TEConomy Partners has deployed a definition of the energy sector which is quite broad, encompassing a wide range of energy and energy-related subsectors across the energy value chain. Figure 2 shows the general structure of this value chain divided into three principal paths:

- The energy production and distribution value chain
- The development and production of energy technologies and associated services
- The supporting assets and infrastructure that influence the effectiveness of a state for energy sector activities and development (energy business location factors).

Figure 2: The Energy Value-Chain, Associated Technology Areas and Key Location Factors Impacting Value-Chain Development



Development of a comprehensive energy strategy requires consideration be given to the evaluation of conditions, assets, business trends, etc. associated with the key elements depicted on Figure 2. Clearly the energy sector is not geographically uniform across the United States, and some states will have significant assets in some areas but not in others. Iowa, for example, has relatively limited in-state fossil fuel resources, but does have substantial natural resources available for energy generation in terms of wind and biomass. Similarly, the R&D base and industry base and their associated core competencies varies geographically, and analysis is thus required to determine assets within Iowa. The overall strategy

to be developed by Inova Energy Group, their subcontractor Elevate Energy, and TEConomy Partners will address key elements pertaining to the energy value chain and energy industry and innovation ecosystem within Iowa.

Assessing any economic sector, including the energy sector,first requires that it be defined. TEConomy Partners has developed an industry definition of the energy sector which comprises individual detailed, 6-digit North American Industrial Classification System (NAICS) industry sectors with these then aggregated into related groups (called "energy subsectors"). Table 1 lists the NAICS included in the analysis of the energy industry.

C. Structure of This Report

This white paper is structured as follows:

- First Iowa's economy and basic demographics are presented to provide the reader with context regarding the size of the economy, state population and other characteristics.
- Second, TEConomy Partners presents an assessment of the energy sector's economic development profile in the State in terms of employment across the industry as defined in Table 1 and outlines which sectors are growing or declining in importance as defined by employment volume.
- Third, an assessment is provided of employment compensation in the energy sector versus other sectors of the Iowa economy.
- Fourth, data is presented on energy supply in Iowa and the types of energy generated. Data are also provided for the states adjoining Iowa to, again, help place data in context.
- Fifth, data is provided profiling the consumption of energy by energy type in the State. Data are also provided for the states adjoining Iowa.
- Sixth, some preliminary scenarios are presented regarding the future energy profile in the state extrapolating from recent trends. *It should be noted that only relatively simplistic scenarios are shown in this white paper, and more detailed and sophisticated scenario projections will be made as more research is completed over the course of the full energy project.*

Table 1: Industry NAICS Codes Included in Definition of Energy Sector in Iowa and Subsectors to which these NAICS are Assigned

NAICS Code	Industry Title	Energy SubsectorSubsector
325190	Other Organic Chemicals	Biodiesel Production
325193	Ethyl Alcohol Manufacturing	Ethanol Production
211111	Crude Petroleum and Natural Gas Extraction	Extraction/Resource Development
211112	Natural Gas Liquid Extraction	Extraction/Resource Development
212111	Bituminous Coal and Lignite Surface Mining	Extraction/Resource Development
213111	Drilling Oil and Gas Wells	Extraction/Resource Development
213112	Support Activities for Oil and Gas Operations	Extraction/Resource Development
213113	Support Activities for Coal Mining	Extraction/Resource Development
424710	Petroleum Bulk Stations and Terminals	Petroleum Products & Wholesale
424720	Petroleum and Petroleum Products Merchant Wholesalers (except Bulk Stations and Terminals)	Petroleum Products & Wholesale
454311	Heating Oil Dealers	Petroleum Products & Wholesale
454312	Liquefied Petroleum Gas (Bottled Gas) Dealers	Petroleum Products & Wholesale
454319	Other Fuel Dealers	Petroleum Products & Wholesale
333611	Turbine and Turbine Generator Set Units Manufacturing	Other Renewable Energy & Storage
335911	Storage Battery Manufacturing	Other Renewable Energy & Storage
335912	Primary Battery Manufacturing	Other Renewable Energy & Storage
221111	Hydroelectric Power Generation	Power Generation
221112	Fossil Fuel Electric Power Generation	Power Generation
221113	Nuclear Electric Power Generation	Power Generation
221119	Other Electric Power Generation	Power Generation
221121	Electric Bulk Power Transmission and Control	Power Transmission/Distribution
221122	Electric Power Distribution	Power Transmission/Distribution
221210	Natural Gas Distribution	Power Transmission/Distribution
221330	Steam and Air Conditioning Supply	Power Transmission/Distribution
237120	Oil and Gas Pipeline and Related Structures Construction	Power Transmission/Distribution
237130	Power/Communication Line and Related Structures Construction	Power Transmission/Distribution
335311	Power, Distribution, and Specialty Transformer Manufacturing	Power Transmission/Distribution
486110	Pipeline Transportation of Crude Oil	Power Transmission/Distribution
486210	Pipeline Transportation of Natural Gas	Power Transmission/Distribution
486910	Pipeline Transportation of Refined Petroleum Products	Power Transmission/Distribution
486990	All Other Pipeline Transportation	Power Transmission/Distribution
324110	Petroleum Refineries	Refineries

Note: The Other Renewable Energy and Storage subsector only includes NAICS sectors where a dominant proportion of the sector is involved in energy-related activities. For example, NAICS: 334413 - Semiconductor and related device manufacturing includes solar photovoltaic cells, but the vast majority of employment and output in this sector is related to computer-related components, not renewable energy technology.

D. Iowa in a National Socio-Economic Context

The following statistics serve to highlight the size and structure of the Iowa economy.

Table 2: Contextual Statistics

Data Variable	Iowa Statistics	Context
Land area	55,857 square miles	Iowa comprises 1.58% of the U.S. total area of 3,531,905 square miles
Population Estimate, July 1, 2015,	3,123,899	Iowa comprises 0.97% of the total U.S. population which is 321,418,820
Population, percent change - April 1, 2010 to July 1, 2015	2.5% growth	U.S. saw 4.1% growth. (Iowa's population has grown at only 61% of the national rate)
Labor Force Participation Rate (In civilian labor force, total, percent of population age 16 years+, 2010-2015)	70.0%	U.S. rate is 63.6% (Iowa has a higher labor force participation rate than the nation)
Median household income (in 2014 dollars)	$52,716	U.S. median household income is $53,482. So Iowa's is just slightly lower than the national figure.
Total employer establishments, 2013	80,581	U.S. has 7,488,353 employer establishments. Iowa has 1.08% of the national number, about in line with Iowa's percent of U.S. population.
Unemployment rate (December 2015)	3.4%	U.S. rate was 5.0% Iowa is performing better on unemployment that the nation, with a rate 32% lower than the nation.
Total Private Sector Employment	1,314,600 jobs	Iowa accounts for 1.1% of the U.S. total private sector employment in 2015.
Total Manufacturing Employment	216,100 jobs	Iowa accounts for 1.8% of the U.S. total manufacturing employment in 2015.
Total Gross State Output	$169.7 billion	Iowa accounts for 1.0% of U.S. GDP in 2014.

II. Energy Supply and Demand in Iowa

An energy strategy needs a starting point, a baseline measure of the energy sector in Iowa against which expectations for growth can be set and metrics for measuring development progress calibrated. TEConomy Partners accessed a broad range of information and data resources in order to develop a data-driven assessment of Iowa's current energy profile.[2]

A. Iowa's Energy Profile - Production

Iowa is a net importer of energy, consuming more than double the amount of energy than it produces (see Table 3). Based on this energy balance, Iowa is effectively importing more raw energy than it produces.

Table 3: Iowa Total Energy Consumption and Production, 2013

Total Energy	Iowa Consumption	Iowa Production	Difference (Importation)
	1,516.5 trillion Btu	730.5 trillion Btu	786 trillion Btu

Source: Data from U.S. Energy Information Administration

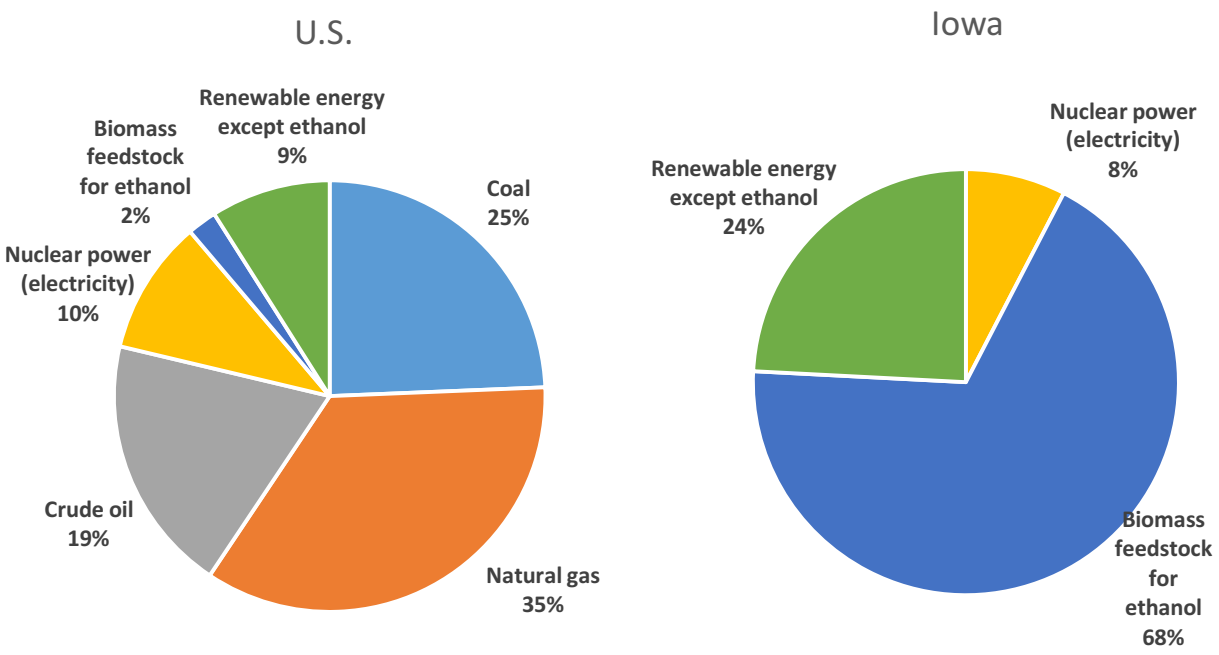
While clearly Iowa is not yet one of them, there are several U.S. states that have total production that exceeds total consumption (net energy exporting states), including: Alaska; Colorado; Kentucky; Louisiana; Montana; New Mexico; North Dakota; Oklahoma; Texas; Utah; West Virginia, and Wyoming. Each of these exporting states benefits from significant reserves of fossil fuels, something Iowa lacks. From an economic development standpoint, it may be concluded that:

***Conclusion 1:* Iowa currently consumes more raw energy than it produces, and also imports more raw energy than it produces. Thus, from a basic economic policy standpoint, increasing energy production in Iowa will enhance Iowa's balance of trade and benefit the Iowa economy. Similarly, investments in energy efficiency will have benefits in terms of lowering the leakage of funds outside of the state that pay for imported energy.**

In terms of energy production, Iowa has a significantly less diversified production profile than the U.S. overall. As shown on Figure 3, Iowa's production of energy (defined as energy produced from domestic Iowa assets – i.e. not imported coal, natural gas, fuel oil, etc.) comprised three primary production sources: Biomass feedstocks for ethanol (68%), renewable energy except ethanol (24%) and nuclear power (8%). The clear difference between Iowa and the U.S. overall is attributable to the lack of fossil fuel resources in Iowa – whereas for the U.S. overall domestically produced feedstocks of coal, natural gas and crude oil dominate the production profile.

[2] Data for the following tables and figures in Chapter II are from the U.S. Energy Information Administrations, State Energy Data Systems (SEDS) database, 2000-2013 (most currently available).

Figure 3. Production Share (Btu) by Major Source Category, 2013



In terms of total energy production, Iowa currently produces 0.9% of U.S. production—a lower amount than might be expected given that Iowa comprises 1.58% of total U.S. land area. Again, this results from the land in Iowa not overlaying significant fossil fuel deposits.

It is clear, however, that investment in renewable energy production has provided an important boost in net Iowa energy production. Without the use of Iowa biomass, wind, and to a lesser degree hydro, resources, Iowa's production versus consumption energy balance would be substantially worse.

***Conclusion 2:* Without a significant base of fossil resources, Iowa has to currently import more than twice the raw energy than it produces. Investment in renewable energy has, however, improved the balance of energy equation.**

In terms of electricity generation, Iowa produced 56,853,000 Megawatt-hours (MWh) in 2014 (See Table 4) with the largest proportion of this electricity production coming from coal-fired power plants (59.3% of Iowa's electricity production). The next highest proportion of generated electricity within Iowa comes from renewable wind power (28.7%) and nuclear power which generated 7.3% of Iowa's electricity production in 2014.

It should be noted that total electric power generation in Iowa has increased significantly since 2001. As Table 4 shows, in 2001 total utility-scale production of electricity in the state totaled 40,659,000 MWh which grew to 56,853,000 MWh in 2014 (an increase in production of 16,194,000 MWh, or 39.8%). Total electricity produced by coal decreased 2.69% over this time period – dropping from 34,665,000 MWh in 2001 to 33,733,000 MWh in 2014. The growth in total electricity generation in Iowa between

2001 and 2014 has been almost primarily driven by the growth in wind generation which rose from 488,000 MWh in 2001 to 16,307,000 MWh in 2014, a 3,241.6% increase. Some other electric power generation sources saw gains in production between 2001 and 2014. Natural gas-powered electricity generation grew by 131.5% while biomass grew by 155.8%. Petroleum liquids declined, but pet coke increased substantially, and nuclear saw moderate percent gains.

Table 4: Iowa Annual Electricity Generation, Change in Generation Mix 2001-2014 (Megawatt-hours)

Electricity Generation Source[3]	2001 Megawatt-hours of Production	2014 Megawatt-hours of Production	Percent Change 2001-2014	Percent of 2014 Iowa Electricity Generated by this Source
TOTAL	**40,659,000**	**56,875,000**	**39.9%**	**100.0%**
Coal	34,665,000	33,733,000	-2.7%	59.31%
Wind	488,000	16,307,000	3,241.6%	28.67%
Nuclear	3,853,000	4,152,000	7.8%	7.30%
Natural Gas	593,000	1,373,000	131.5%	2.41%
Hydroelectric (Conventional)	845,000	879,000	4.0%	1.55%
Biomass	104,000	266,000	155.8%	0.47%
Petroleum Liquids	99,000	59,000	-40.4%	0.10%
Petroleum Coke	4,000	85,000	2,025%	0.15%
Solar (All - Distributed and Utility)	0	21,000	--	0.04%
Other	8,000	0	--	0.00%

Source: Data from U.S. Energy Information Administration

Conclusion 3: Since 2001 Iowa has increased its electric power generation by 39.9%. The vast majority of this new generation has come in the form of renewable wind power. The net effect has been a significant decrease in the overall percentage of Iowa's electricity generated by fossil fuels which declined from 87% in 2001 to 62% in 2014.

Renewables-based electricity generation has been rising dramatically in Iowa, comprising 17,473,000 MWh of generation in 2014 (30.7% of the State's electricity production). The majority of the renewables production is wind generated (93.3% or renewables generation). The changing face of electric power generation in Iowa is well illustrated by the fact that in 2001 just 1.2% of Iowa's electricity was generated by wind (with 85.3% generated by imported coal), whereas in 2014 wind generated 28.67% of Iowa electricity (and coal dropped to 59.31%).

B. Iowa's Energy Profile - Consumption

Just as Iowa's energy production profile differs from that of the U.S. overall, so does Iowa's energy consumption. Iowa's economy is more industrially-intensive than the U.S. economy overall, and this is reflected in the fact that Iowa accounts for 2.4% of industrial energy consumption in the U.S. but comprises only 0.97% of the U.S. population. It is predominantly Iowa's strong industrial economy, which includes agriculture and biofuels production in addition to manufacturing, that accounts for

[3] Includes both utility scale plants and IPP/CHP electricity generation, plus distributed solar. U.S. Energy Information Administration.

Iowa's energy consumption profile looking different to that of the U.S. overall. Iowa's three largest manufacturing industries are machinery, food and beverages, and chemicals. Taken together these three industries account for almost two-thirds of Iowa's manufacturing gross domestic product (GDP). Iowa consistently ranks among the top 10 states in the nation in share of GDP from manufacturing. Transportation is the state's second largest energy-consuming sector.

Figure 4. Consumption (Btu) Share by End Use Sector, 2013

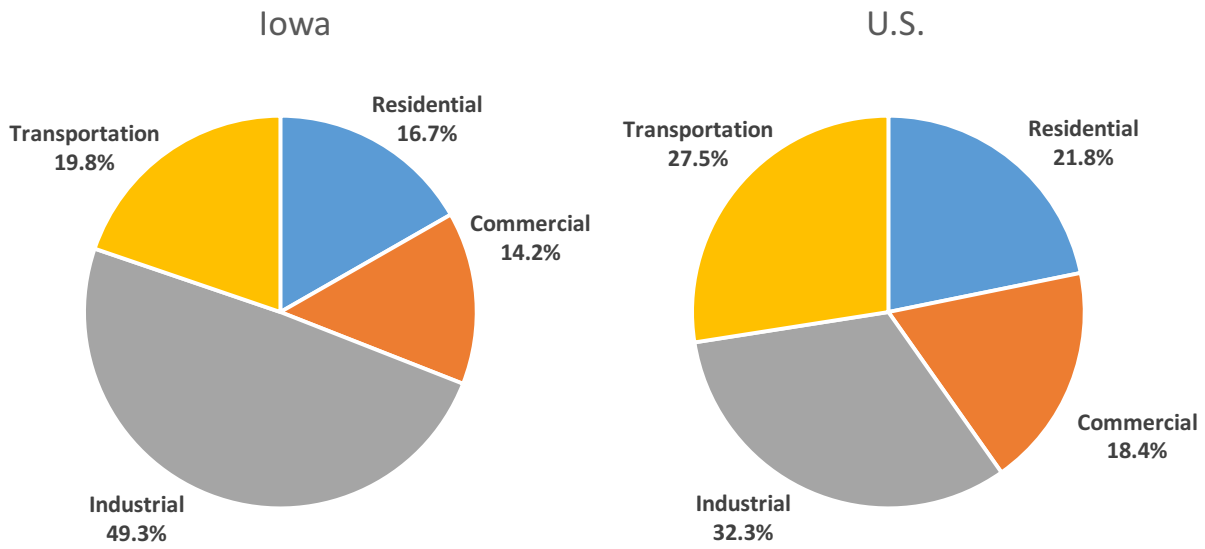


Table 5. Energy Consumption Metrics by End Use Sector, 2013

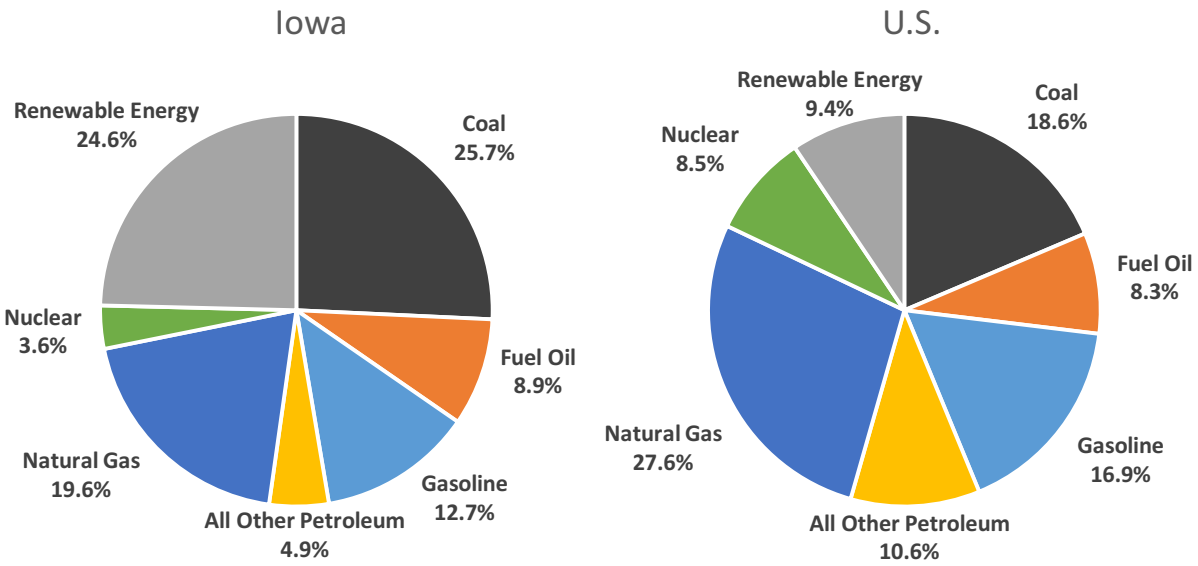
Sector	Iowa			U.S.	
	2013 Consumption (Billion Btu)	Percent Change, 2000-2013	2013 Share of U.S.	2013 Consumption (Billion Btu)	Percent Change, 2000-2013
Residential	253,709	7.1%	1.2%	21,181,996	3.9%
Commercial	215,696	24.8%	1.2%	17,894,337	4.2%
Industrial	747,332	46.3%	2.4%	31,378,925	-9.5%
Transportation	299,747	10.5%	1.1%	26,689,441	0.5%
Total Energy Consumption	**1,516,483**	**27.2%**	**1.6%**	**97,144,709**	**-1.7%**

***Conclusion 4:* Iowa, with a more industrial economy than the U.S. overall sees "industry" (which includes agriculture as well as manufacturing) consuming considerably more power as a percentage of State consumption.**

It should be noted that Iowa industry overall has been growing faster than energy consumption in Iowa's industrial sector. In other words, the industrial sector of the Iowa economy is becoming less energy intensive over time, or more energy efficient in its operations.

Examining consumption data by energy source again reveals a consumption profile quite different to that of the United States overall (Figure 5 and Table 6). Iowa uses renewable energy to a much greater degree than the nation does overall, and also uses more coal. It is less reliant than the U.S. overall in the use of natural gas, gasoline and other petroleum, and nuclear power.

Figure 5. Consumption (Btu) Share by Major Source Category, 2013



Note: Shares do not account for Net Interstate Flow of Electricity (Exports)

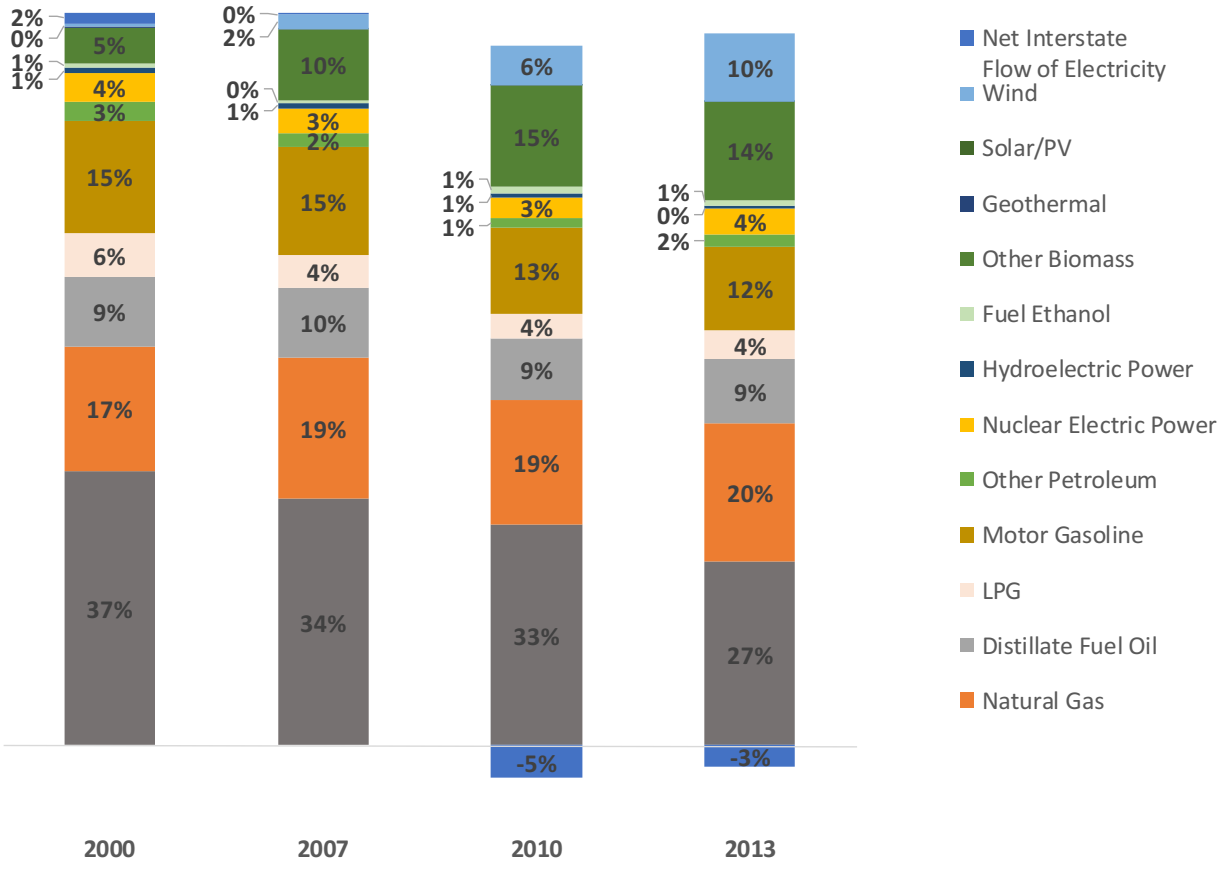
Table 6: Energy Consumption Metrics by Major Energy Category, 2013

Major Energy Category	Iowa			U.S.	
	2013 Consumption (Billion Btu)	Percent Change, 2000-2013	2013 Share of U.S.	2013 Consumption (Billion Btu)	Percent Change, 2000-2013
Coal	402.4	-9.8%	2.2%	18,038.8	-20.1%
Fuel Oil	138.9	23.9%	1.7%	8,066.4	1.8%
Gasoline	198.7	3.7%	1.2%	16,338.6	1.1%
All Other Petroleum	76.5	-18.2%	0.7%	10,323.2	-27.2%
Natural Gas	306.5	50.9%	1.1%	26,801.8	12.5%
Nuclear	55.6	19.7%	0.7%	8,244.4	4.9%
Renewable Energy	384.7	376.5%	4.2%	9,147.6	49.8%
Net Interstate Flow of Electricity (Export)	(46.8)	354.1%	N/A	N/A	N/A
Total Energy Consumption	**1,516.5**	**27.2%**	**1.6%**	**97,144.7**	**-1.7%**

To provide additional context to Iowa' s changing portfolio of energy consumption, Figure 6 profiles the consumption mix in terms of the share of Iowa's total consumption for four years—the starting year of the analysis (2000), the pre-recession peak (2007), the beginning of the economic expansion (2010) and the most current data (2013). These data also include the context of Net Interstate Flow Electricity

where ***Iowa was as an importer of electricity in 2000 and 2007, but a net exporter of electricity in 2010 and 2013.***

Figure 6. Iowa Energy Consumption Share (Btu) by Major Source, Select Years



Conclusion 5: *Iowa differs in its energy consumption versus the U.S. overall in terms of using renewables and coal considerably more than average and other major fossil fuel resources (natural gas and petroleum/gasoline) less.*

Iowa's expenditure profile in terms of the use of energy in the State is not all that different than that of the U.S. overall (Figure 7). The main difference, again, is that Iowa spends a higher percent of its total energy dollars on industrial use (25.5%) versus the nation (17%).

Figure 7. Energy Expenditures Share ($ millions) by End Use Sector, 2013

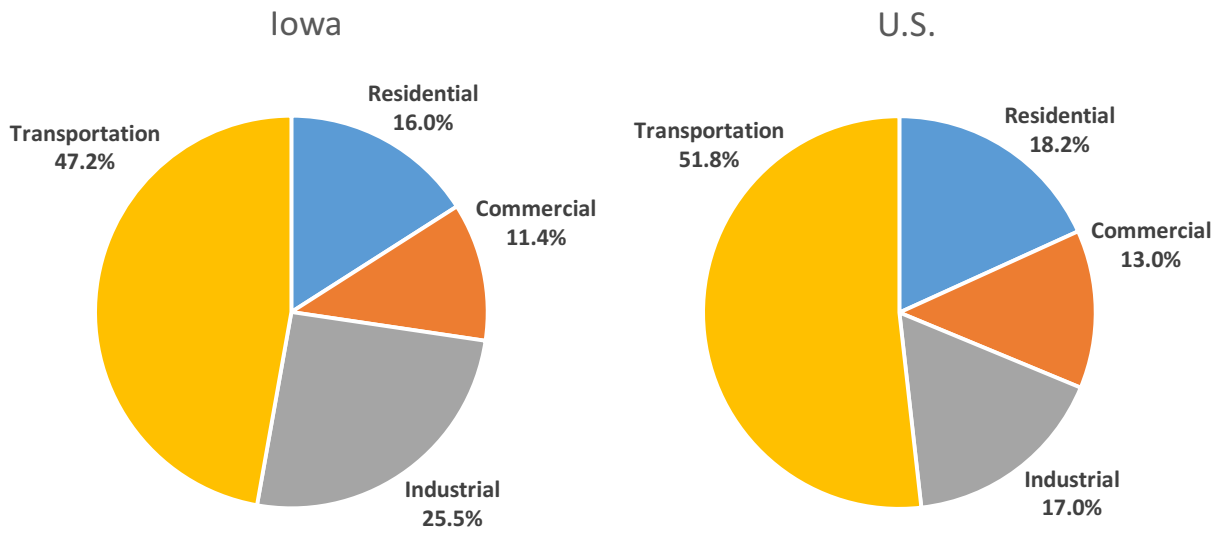


Table 7. Energy Expenditure Metrics by End Use Sector, 2013

Sector	Iowa			U.S.	
	2013 Expenditures ($ millions)	Percent Change, 2000-2013	Share of U.S.	2013 Expenditures ($ millions)	Percent Change, 2000-2013
Residential	$2,755.5	51.8%	1.1%	$250,457.4	61.3%
Commercial	$1,965.2	88.9%	1.1%	$179,359.6	58.1%
Industrial	$4,395.5	90.3%	1.9%	$233,272.3	65.3%
Transportation	$8,149.2	169.8%	1.1%	$712,216.5	156.2%
Total Energy Expenditures	**$17,265.4**	**110.9%**	**1.3%**	**$,1375,305.9**	**100.0%**

Between 2000 and 2013 Iowa saw its total expenditures on fuels increase at a somewhat faster rate than the U.S. overall – with Iowa expenditures increasing 129.9% versus the nation's 119.9%. The expenditure categories seeing the largest percent expenditure increases were fuel oil (249.5%), biomass (wood and waste, 229.3%) and motor gasoline (148.6%). Expenditures on each of these three energy sources increased at a rate higher than they did in the nation overall. Iowa's expenditures on retail electricity did not increase much more than they did nationally (increasing 62.8% versus 60.7% in the nation). Overall, expenditures in Iowa for energy increased 10.9% more than they did for the nation overall between 2000 and 2013.

Table 8. Energy Expenditure Metrics by Major Energy Category, 2013

Major Energy Category	Iowa			U.S.	
	2013 Expenditures ($ millions)	Percent Change, 2000-2013	2013 Share of U.S.	2013 Expenditures ($ millions)	Percent Change, 2000-2013
Primary Use Fuels	**$13,490.4**	**129.9%**	**1.3%**	**$1,003,224.6**	**119.9%**
Coal	$178.7	85.2%	2.6%	$6,765.4	85.1%
Natural gas	$1,988.7	38.9%	1.7%	$114,752.9	20.8%
Motor gasoline	$5,580.8	148.6%	1.2%	$467,337.6	143.2%
Fuel oil	$3,735.7	249.5%	1.7%	$220,156.5	185.9%
Liquefied petroleum gases (LPG or propane)	$1,398.4	85.2%	2.5%	$55,690.0	99.1%
All other petroleum products (except Gasoline, Fuel Oil, LPG)	$575.6	121.1%	0.4%	$131,898.7	129.6%
Biomass (Wood and waste)	$32.6	229.3%	0.5%	$6,779.9	136.4%
Retail Electricity -- All Fuels & Sources incl. Nuclear and Renewable	**$3,775.0**	**62.8%**	**1.0%**	**$372,081.3**	**60.7%**
Total Energy Expenditures	**$17,265.4**	**110.9%**	**1.3%**	**$1,375,305.9**	**100.0%**

Note: Primary use captures the expenditures on fuels put to direct use. The use of these fuels for electricity generation is captured within the Retail Electricity category.

***Conclusion 6:* Iowa's total energy expenditures for energy have increased at a rate 10.9% over expenditures in the nation between 2000 and 2013.**

C. Iowa's Electricity Profile

In terms of electricity consumption, Iowa's industrial sector consumes a considerably higher percent (42% of all electricity in the State) than does the nation overall (26.3%).

Figure 8. Electricity Consumption (Btu) by End Use Sector, 2013

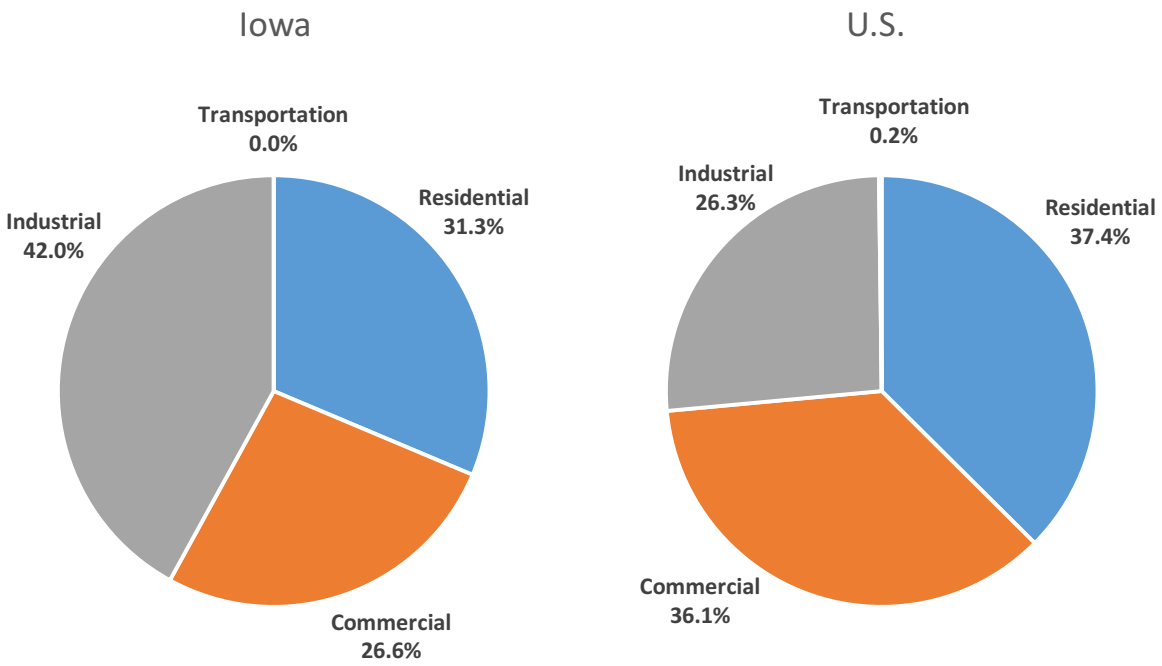


Table 9. Electricity Consumption Metrics by End Use Sector, 2013

Sector	Iowa			U.S.	
	2013 Consumption (Billion Btu)	Percent Change, 2000-2013	2013 Share of U.S.	2013 Consumption (Billion Btu)	Percent Change, 2000-2013
Residential	50,004	21.8%	1.1%	4,759,464	17.0%
Commercial	42,510	25.4%	0.9%	4,586,432	15.9%
Industrial	67,020	14.7%	2.0%	3,338,133	-8.1%
Transportation	0	0.0%	0.0%	26,017	41.7%
Total Energy Consumption	**159,534**	**19.6%**	**1.3%**	**12,710,046**	**8.9%**

A similar situation holds in overall electricity expenditures (Figure 9 and Table 10).

Figure 9. Electricity Expenditures by Sector, 2013

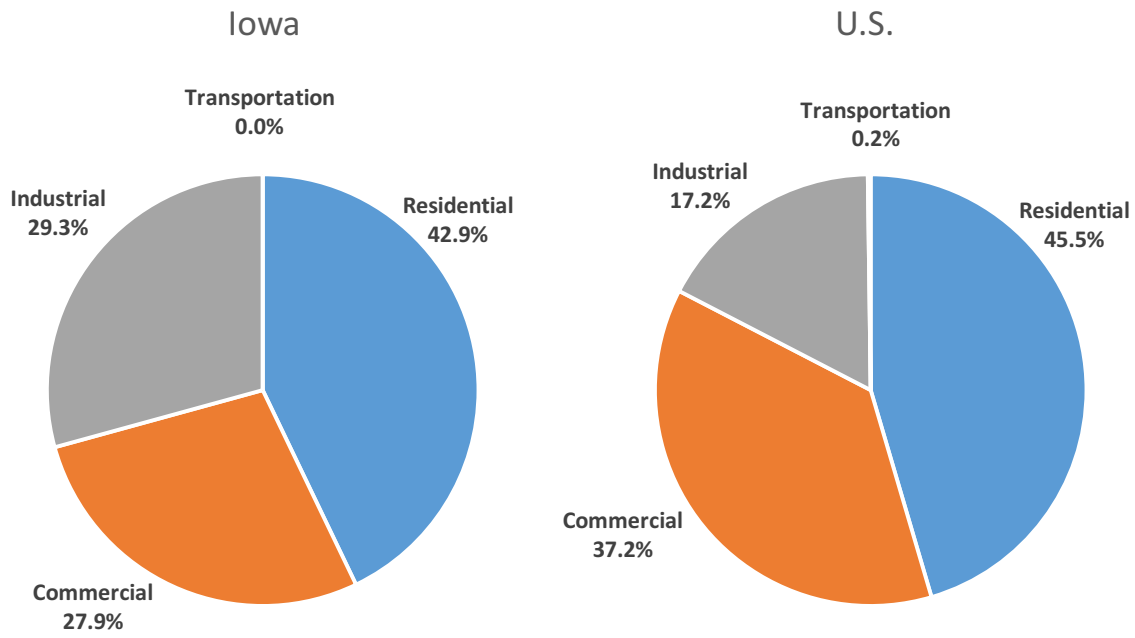


Table 10. Electricity Expenditures by Sector, 2013

Sector	Iowa			U.S.	
	2013 Expenditures ($ millions)	Percent Change, 2000-2013	2013 Share of U.S.	2013 Expenditures ($ millions)	Percent Change, 2000-2013
Residential	$1,618.7	60.7%	1.0%	$169,112.6	72.2%
Commercial	$1,051.5	62.7%	0.8%	$138,229.1	62.4%
Industrial	$1,104.8	66.0%	1.7%	$63,934.9	33.6%
Transportation	$0.0	0.0%	0.0%	$804.8	111.6%
Total Electricity Expenditures	**$3,775.0**	**62.8%**	**1.0%**	**$372,081.3**	**60.7%**

D. Iowa's Energy Profile in Comparison to Surrounding States

Comparing Iowa's energy consumption to national overall statistics provides a useful perspective, but so too does comparing Iowa's energy consumption to the six states that border Iowa: Minnesota; Wisconsin; Illinois; Missouri; South Dakota, and Nebraska. By comparing these North Central U.S. states to Iowa, perspective can be gained on how Iowa differs in energy consumption versus similar surrounding states.

It should, of course, be noted that these seven states are not all the same in terms of their fundamental natural energy resources. Several contain significant fossil fuel resources (primarily coal, but also natural gas and crude oil) – whereas Iowa does not. Similarly, differences in topography, hydrology, soils and meteorological conditions mean differing potentials for renewable energy production and in-state consumption.

Table 11 presents the overall summary statistics for Iowa and the benchmark states. Obviously, given significantly different population sizes total consumption varies significantly – so data have been normalized by TEConomy Partners in terms of consumption per capita and total energy consumption as a percent of state GDP, for more appropriate comparisons.

Table 11. Energy Consumption, Iowa and Benchmark States, 2013

State	Total Energy Consumption (Million Btu)	Rank	Total Energy Consumption (Million Btu) per Capita	Rank	Energy Consumption Intensity of GSP*	Rank
Iowa	**1,516,483**	**24**	**490**	**5**	**9.22**	**12**
Illinois	4,011,485	4	311	25	5.60	31
Minnesota	1,859,790	18	343	18	6.06	29
Missouri	1,857,005	19	307	26	6.81	23
Nebraska	871,805	33	466	7	8.14	19
South Dakota	390,367	45	462	8	8.73	15
Wisconsin	1,804,018	21	314	24	6.42	26

*Note: Energy Consumption Intensity of GSP is calculated as total energy consumption as percent of GDP.

The benchmark data show that Iowa has the highest consumption of energy per capita among the benchmark states (where the range runs from a low of 311 million Btu per capita in Illinois, to Iowa's high of 490). Iowa similarly has the highest energy consumption intensity as measured by energy consumption as a percent of GDP. These high normalized ranks largely reflect the significant industrial-oriented energy consumption within Iowa.

Table 12 examines statistics for the benchmark states in terms of energy expenditures. Again, Iowa has the highest expenditures per capita on energy ($5,583.30 per capita for 2013). In terms of energy expenditure intensity, South Dakota has the highest (10.54) closely followed by Iowa at (10.50).

Table 12. Energy Expenditures, Iowa and Benchmark States, 2013

State	Total Energy Expenditures ($ million)	Rank	Total Energy Expenditures per Capita (S)	Rank	Energy Expenditure Intensity of GSP*	Rank
Iowa	**$17,265.4**	**28**	**$5,583.3**	**7**	**10.50**	**19**
Illinois	$49,296.6	7	$3,824.2	39	6.89	42
Minnesota	$24,689.5	20	$4,553.5	22	8.05	36
Missouri	$26,721.7	17	$4,420.5	25	9.79	24
Nebraska	$10,293.8	35	$5,507.7	9	9.61	26
South Dakota	$4,708.9	47	$5,569.3	8	10.54	18
Wisconsin	$24,715.9	19	$4,303.7	30	8.80	30

*Note: Energy Expenditure Intensity of GSP is calculated as total energy expenditures as percent of GDP.

***Conclusion 7:** For Iowa, undertaking a state energy strategy is particularly important since energy consumption and expenditure per capita is higher than it is in surrounding states, as is (generally) the intensity of energy use as measured as a percentage of state GDP.*

Appendix A provides further detail on comparative consumption of specific energy resources across Iowa and the benchmark states. Benchmark profiles are provided for:

- Coal
- Natural Gas
- Petroleum
- Motor Gasoline
- Fuel Oil
- Propane
- Nuclear
- Renewable Fuels (with break-outs for wind, biomass and ethanol).

III. Energy as a Key Employer in Iowa

A. Iowa's Employment Growth, Size and Specialization in Energy Sub-Sectors

As discussed in Chapter I, TEConomy Partners uses a fairly broad definition of energy and energy-related sectors of the economy (see Table 1). The definition not only includes industry sectors engaged in extracting energy resources, generating power, or distributing and retailing power, but also includes the many related industry sectors that provide tools, technologies and services to the energy industry or to consumers of energy. In effect, the definition used captures and breaks-out the key components of the energy sector value-chain.

Examining Iowa's energy profile in terms of this value-chain and the jobs it generates in the state is important, and generating a baseline profile of employment and employment trends across the energy value-chain is a key starting point for strategic planning.

Table 1 shows the full complement of 32 NAICS used to define the overall energy sector in Iowa. TEConomy Partners assigned each of these individual NAICS to one of eight subsectors for analysis purposes:

- Biodiesel Production
- Ethanol Production
- Extraction and Resource Development
- Other Renewable Energy and Storage
- Petroleum Products and Wholesale
- Power Transmission and Distribution
- Power Generation
- Refineries.

Table 13 summarizes most recently available establishment and employment data (2014) for these eight subsectors and also shows for comparison total private sector and total manufacturing employment. In total, the Iowa energy sector consists of 849 establishments, with a combined employment of 16,292 (1.3% of the state's total private sector labor force).

The overall energy sector currently is relatively under-concentrated in Iowa and therefore not seen as a state "specialization" since the location quotient (LQ)[4] for this level of energy employment reaches only 0.78 (a state specialization, as designated by TEConomy, requires an LQ of 1.2 or higher). At an LQ of 0.78, the energy sector in Iowa employs approximately 22% *fewer* workers than would be expected, given the energy sector's overall share of employment in the national economy.

[4] Location quotients (LQs) are a standard measure of the concentration of a particular industry in a region relative to the nation. The LQ is the share of total state or regional employment in the particular industry divided by the share of total industry employment in the nation. An LQ greater than 1.0 for a particular industry indicates that the region has a greater relative concentration, whereas an LQ less than 1.0 signifies a relative underrepresentation. An LQ greater than 1.20 denotes employment concentration significantly above the national average. In this analysis, regional specializations are defined by LQs of 1.20 or greater.

Table 13: Iowa Establishments, Employment and Location Quotients for the Total Energy Sector and Individual Subsectors, 2014

Energy Subsector	Iowa Establishments, 2014	Iowa Employment, 2014	Iowa Location Quotient, 2014	Iowa Employment % Change, 2001–14	U.S. Employment % Change, 2001–14
Total Energy Sector	849	16,292	0.78	22.2%	18.6%
Power Transmission/ Distribution[5]	428	7,011	0.88	-2.8%	25.6%
Other Renewable Energy & Storage	12	2,606	4.42	143.6%	-7.7%
Power Generation	99	2,520	1.41	-5.1%	-42.3%
Ethanol Production	40	1,845	15.71	3838.6%	225.1%
Petroleum Products & Wholesale	242	1,699	0.88	-22.3%	-20.5%
Biodiesel Production	14	550	1.37	310.4%	-5.2%
Refineries	3	39	0.05	254.5%	-7.6%
Extraction/Resource Development	11	22	0.00	161.7%	91.7%
Total Private Sector[6]	93,351	1,280,079	1.00	6.5%	5.5%
Total Manufacturing	4,048	216,834	1.61	-10.0%	-25.8%

Source: TEConomy Partners analysis of Bureau of Labor Statistics, QCEW data and enhanced file from IMPLAN.

While the overall energy sector in Iowa is not a state specialization (as measured by location quotient) this should not obscure the fact that employment is highly concentrated among several key energy subsectors, with four—ethanol production **(**LQ=15.71), other renewable energy & storage (LQ=4.42), power generation (LQ=1.41), and biodiesel production (LQ=1.37) all rising to the level of state "specializations."

Several of the subsectors have been significant new job generators for Iowa over the assessed time period of 2001 through 2014. Overall the energy sector in Iowa employs 16,292 personnel and increased employment by 22.2% between 2001-2014, larger than the growth seen nationally. Notably, biodiesel production grew by 310.4% and other renewable energy and storage grew employment by 143.6% over this time period (also reaching 2,606 jobs in 2014) while ethanol production truly emerged as a state industry sector growing by 3,838% to reach 1,845 jobs. In all three cases, these sectors far outpaced growth rates in those subsectors within the nation overall.

Conclusion 8: Though the energy sector overall is a currently not a specialized industry for Iowa, distinct niches (subsectors) exist within Iowa that are specialized and do show significant growth. In addition, the energy sector has been a significant job generator, far outpacing overall private sector growth in the state.

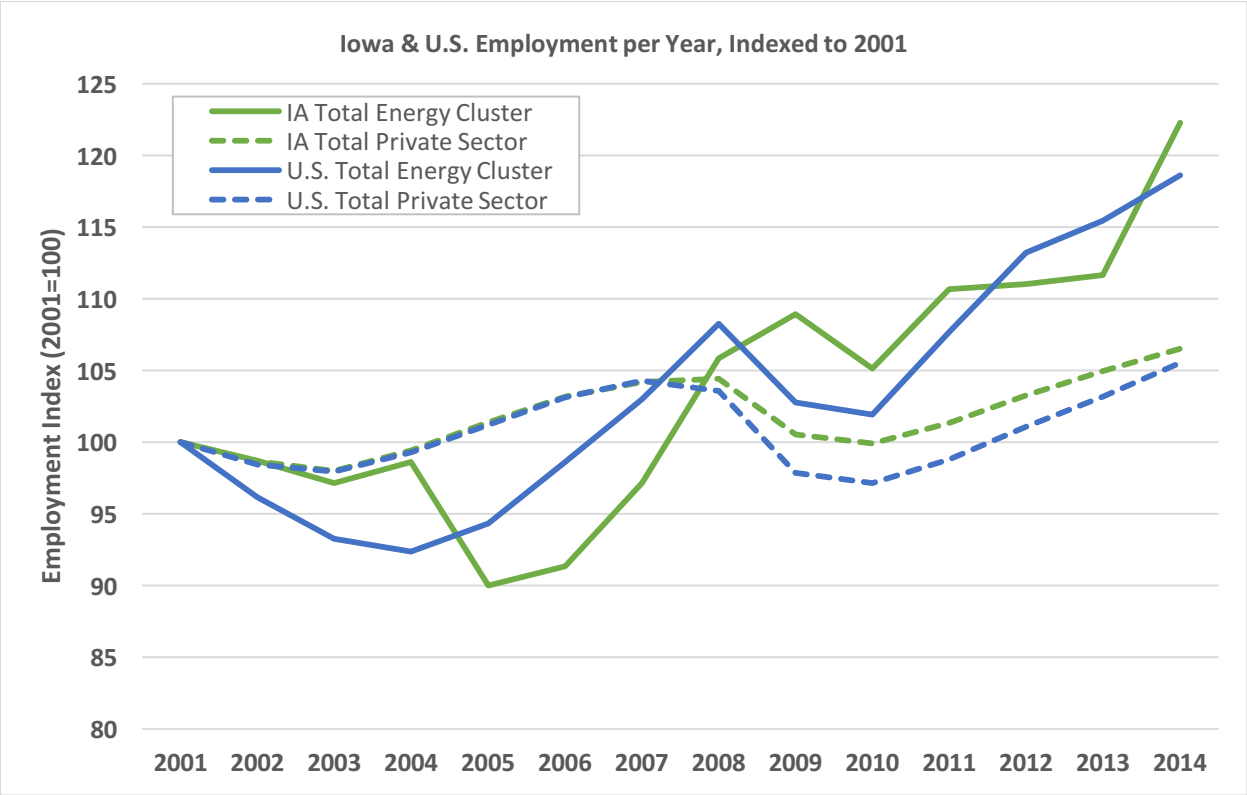
Overall, employment growth in Iowa's energy sector, benchmarked against national employment growth, has performed as well as the nation overall, and far out-performed average private sector industry growth in the state. Structural changes in the energy industry led to declines in the early 2000's in Iowa and the U.S. overall. After this structural decline, the energy sectors' employment began a

[5] Sub-sectors shown comprise the individual NAICS listed on Table 1.
[6] This category, for comparison purposes shows all private sector jobs in the state (i.e. not just those in the energy sector).

steady period of growth, for both Iowa and the U.S., with the exception of slight employment declines during the recessionary period between 2007–2010 (Figure 10). It should be noted that Iowa's energy sector actually only experienced one employment decline (2010). Between 2010 and 2014, a period of economic expansion, energy sector employment in Iowa grew 14.9% compared to 16.5% growth nationally (this in part due to steeper recessionary declines in the U.S. energy sector).

***Conclusion 9:* The Iowa Energy sector has seen significant net growth in employment since 2001, performing at the same level as the U.S. Energy sector and outperforming Iowa's overall private sector.**

Figure 10: Total Energy Sector Employment Trends for Iowa and the U.S. for 2001 through 2014



Source: TEConomy Partners analysis of Bureau of Labor Statistics, QCEW data and enhanced file from IMPLAN.

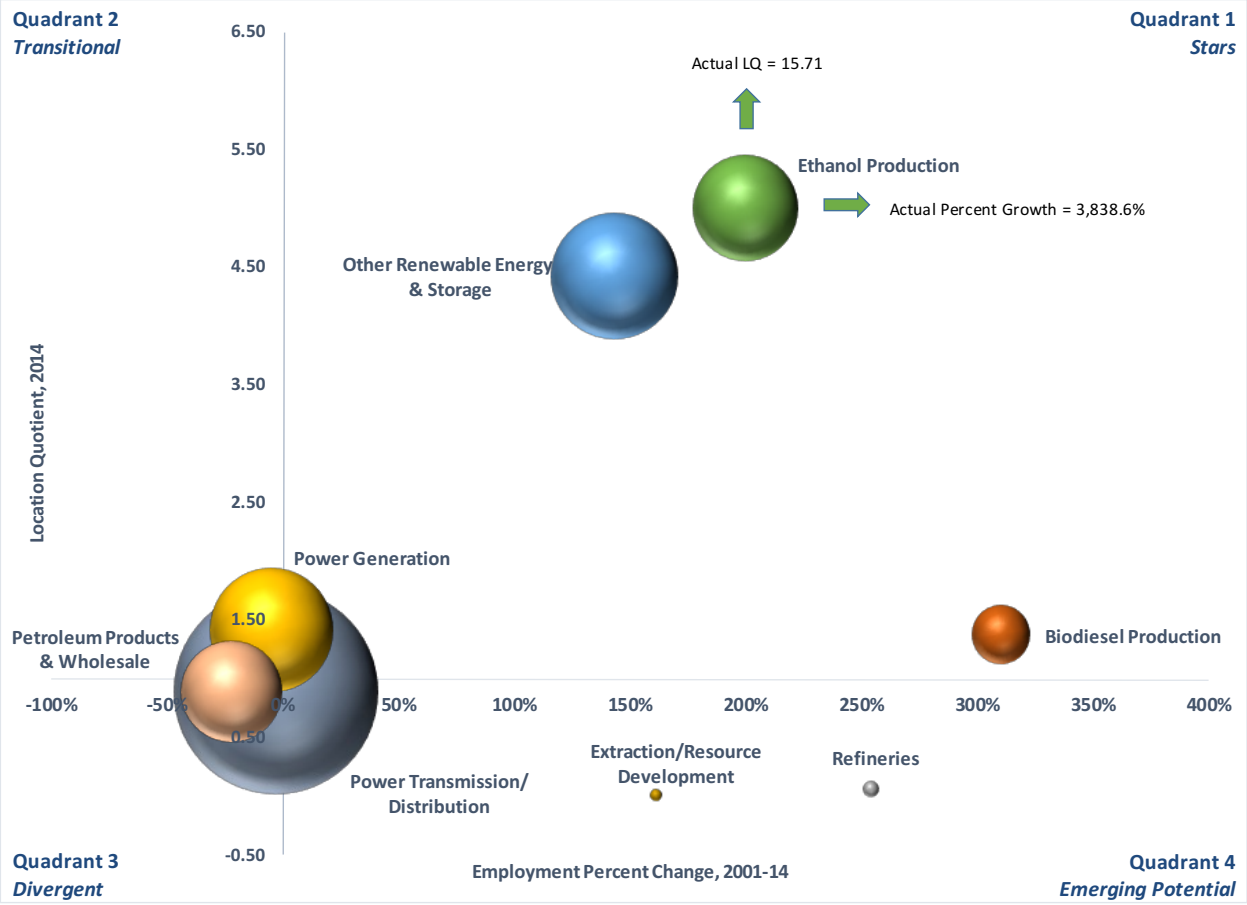
By analyzing the individual energy subsectors' location quotients and comparative employment growth rates versus the nation, it is possible to see which energy subsectors are performing most strongly for Iowa. The bubble chart (Figure 11) is divided into four quadrants with quadrants to the right of the vertical axis in the center of the chart representing areas of employment growth over the time period evaluated (2001–2014) and the quadrants to the left containing sectors that saw employment decline. Quadrants above the horizontal line represent state specialization industries, defined by their location quotient being greater than 1.0. Clearly, the ideal place from a state perspective for a subsector to be is the upper right quadrant (specialized and growing), while the bottom right quadrant represents promising areas in which the state is experiencing growth, but not yet achieved specialization status. The size of each bubble is proportional to the level of employment in that energy subsector.

As Figure 11 shows, the Iowa energy sector currently contains two robust "***star"*** energy subsectors that are both specialized and growing, these being "other renewable energy and storage" (2,606 employees

in 2014) and "ethanol production" (1,845 employees in 2014). The "power generation" subsector is also a state specialization for Iowa, but experienced employment declines over the 2001–2014 period (2,520 employees in 2014). Overall, the significant size of the "power transmission/distribution" sector is apparent, but this subsector has held at slightly below the national average specialization with a slight employment decline during the period.

Two subsectors "extraction/resource development" and "refineries" while considered to be ***emerging potential*** quadrant have significant growth rates due to extremely small 2001 employment. It should also be noted that while the state "refineries" subsector includes 39 employees; it is highly likely that these three refinery establishments are actually involved in petrochemical-related refining not energy-related production.

Figure 11: Iowa Energy Employment Size, Growth, and Degree of Specialization (LQ) by Subsector, for 2001-2014



Source: TEConomy Partners LLC analysis of Bureau of Labor Statistics, QCEW data and enhanced file from IMPLAN.

Conclusion 10: Within the energy sector two subsectors related to renewable energy – "ethanol production" and "other renewable energy & storage" are the high performing subsectors for Iowa. However, more than 40% of the total energy sector's employment is in power transmission/distribution.

In breaking the data down to a finer level of granularity, it is evident that five of the 32 energy NAICS industries are large (> 1,000 jobs) and specialized (LQ>1.2), with three of these five also exhibiting substantial employment growth (Table 14). These five industry components account for two-thirds of

the total Iowa energy sectors' employment in 2014.[7] The significant growth of the state ethyl alcohol (ethanol) production is clearly evident, as well as significant growth in the manufacture of turbine and turbine generator sets used in a variety of energy-related applications from wind turbines, to hydroelectric turbines, to turbines sets used in other power generation applications.

Table 14: Performance of Large & Specialized Detailed Iowa Energy Sectors, 2001 - 2014

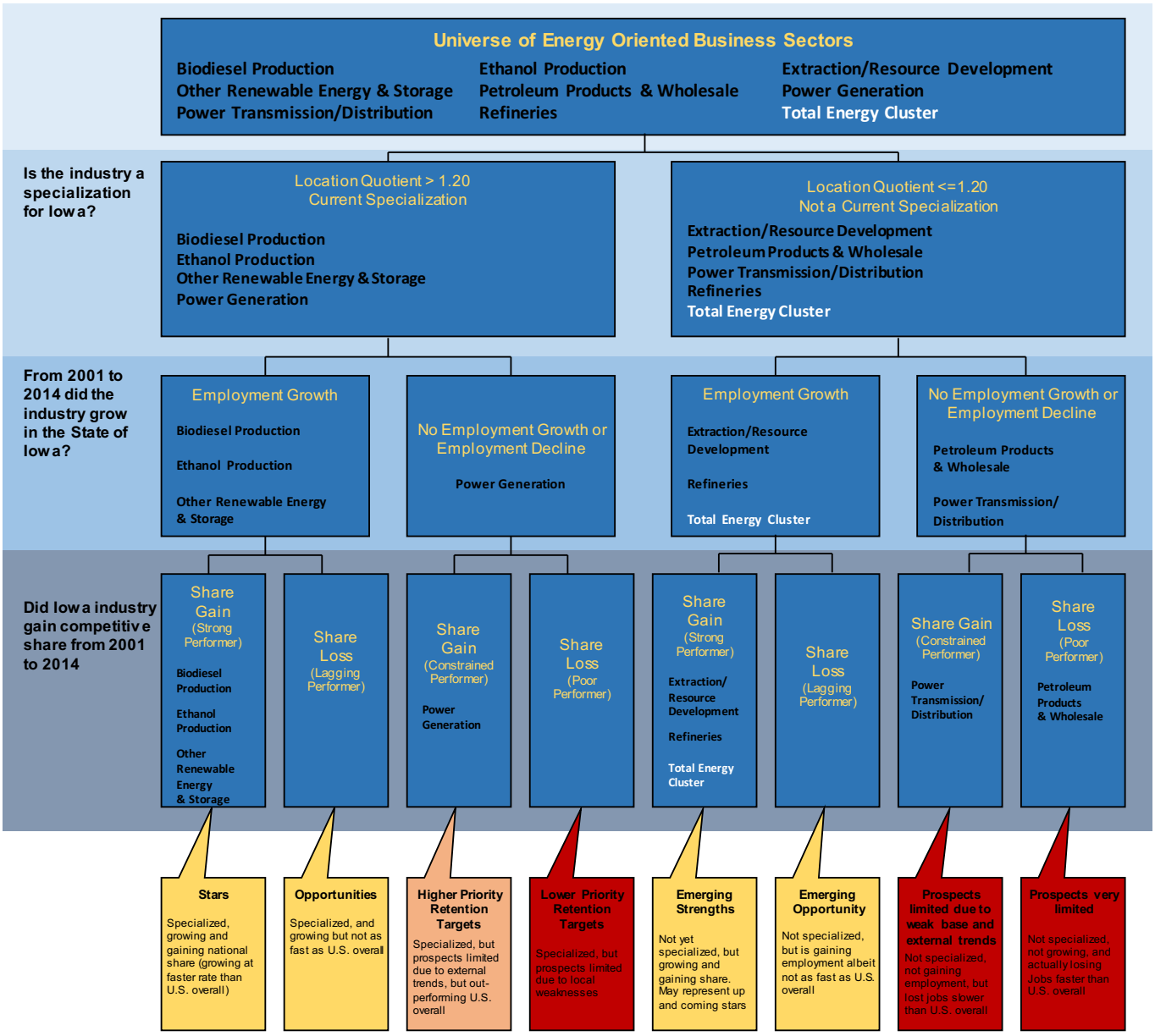
Energy Subsector	NAICS Description	Establishments		Employment		Location Quotient (LQ) 2014
		Number, 2014	Growth, 2001-2014	Jobs, 2014	Growth, 2001-2014	
Ethanol Production	Ethyl Alcohol Manufacturing (325193)	40	1100.0%	1,845	3838.6%	15.71
Other Renewable Energy & Storage	Turbine and Turbine Generator Set Units Manufacturing (333611)	8	220.0%	1,896	728.5%	6.37
Power Generation	Fossil Fuel Electric Power Generation (221112)	77	-33.0%	1,759	-24.7%	1.60
Power Transmission/ Distribution	Electric Power Distribution (221122)	145	17.6%	2,846	-19.2%	1.26
	Power/Communication Line and Related Structures Construction (237130)	158	41.1%	2,202	112.8%	1.20

Source: TEConomy Partners analysis of Bureau of Labor Statistics, QCEW data and enhanced file from IMPLAN.

Of the 31 NAICS energy and energy-related industries captured in the broad energy definition, Iowa currently has employment in 23. Each of these industries, each of the eight energy subsectors, and the overall Iowa energy sector are analyzed according to the **Industry Targeting Analysis** graphic (Figure 12) which divides these industries into relative performance categories based on their performance on location quotients, growth or decline in employment, and growth or decline in employment share versus the nation. The results of this targeting analysis are shown in Table 15.

[7] It should be noted, that within the limitations placed on this analysis by the nature of the North American Industrial Classification System (NAICS) there is a strong likelihood of energy-related employment also spread throughout a variety of additional NAICS codes, which are not primarily energy-related in nature. For example, a company making foam insulation, would be included within a broader plastics-related NAICS code that includes substantial non-energy-related employment.

Figure 12. Industry Targeting Analysis for Iowa Energy Sector and Subsectors



Source: TEConomy Partners analysis of Bureau of Labor Statistics, QCEW data and enhanced file from IMPLAN.

B. Employment Compensation in the Iowa Energy Sector

A goal of economic developers is not just to help promote the creation of jobs, but also to particularly encourage the generation of "high quality" jobs—jobs paying above average, family-sustaining wage levels. Bureau of Labor Statistics data confirm that Iowa energy jobs indeed are high-quality—paying a 2014 average annual wage of $73,412 in 2014 which is considerably higher than the state's average private sector wage of $41,964. Jobs in Iowa's power generation and power transmission/distribution energy subsectors are particularly high paying, with an average of $102,264 and $80,135 respectively. In fact, all eight of Iowa's energy subsectors pay at or above the state's average annual wage.

Table 15: Targeting Analysis of Iowa's Energy Sector, Subsectors, and NAICS-level Industry

NAICS Description	Iowa Industry Specialization	Iowa Industry Growth	Iowa Gained Competitive Share	Target Status
Biodiesel Production	**Current Specialization**	**Employment Growth**	**Share Gain**	**Stars**
Other Organic Chemical Manufacturing	Current Specialization	Employment Growth	Share Gain	Stars
Ethanol Production	**Current Specialization**	**Employment Growth**	**Share Gain**	**Stars**
Ethyl Alcohol Manufacturing	Current Specialization	Employment Growth	Share Gain	Stars
Extraction/Resource Development	**Not a Current Specialization**	**Employment Growth**	**Share Gain**	**Emerging Strengths**
Drilling Oil and Gas Wells	Not a Current Specialization	Employment Growth	Share Gain	Emerging Strengths
Support Activities for Oil and Gas Operations	Not a Current Specialization	Employment Decline	Share Loss	Emerging Opportunity
Support Activities for Coal Mining	Not a Current Specialization	Employment Growth	Share Gain	Emerging Strengths
Other Renewable Energy & Storage	**Current Specialization**	**Employment Growth**	**Share Gain**	**Stars**
Turbine and Turbine Generator Set Units Mfg.	Current Specialization	Employment Growth	Share Gain	Stars
Storage Battery Manufacturing	Current Specialization	Employment Decline	Share Gain	Higher Priority Retention Targets
Primary Battery Manufacturing	Not a Current Specialization	Employment Growth	Share Gain	Emerging Strengths
Petroleum Products & Wholesale	**Not a Current Specialization**	**Employment Decline**	**Share Loss**	**Prospects Very Limited**
Petroleum Bulk Stations and Terminals	Not a Current Specialization	Employment Growth	Share Gain	Emerging Strengths
Petroleum and Petroleum Products Wholesalers	Current Specialization	Employment Decline	Share Loss	Lower Priority Retention Targets
Heating Oil Dealers	Not a Current Specialization	Employment Decline	Share Loss	Prospects Very Limited
Liquefied Petroleum Gas (Bottled Gas) Dealers	Not a Current Specialization	Employment Decline	Share Loss	Prospects Very Limited
Power Generation	**Current Specialization**	**Employment Decline**	**Share Gain**	**Higher Priority Retention Targets**
Hydroelectric Power Generation	Not a Current Specialization	Employment Decline	Share Loss	Prospects Very Limited
Fossil Fuel Electric Power Generation	Current Specialization	Employment Decline	Share Gain	Higher Priority Retention Targets
Nuclear Electric Power Generation	Not a Current Specialization	Employment Growth	Share Gain	Emerging Strengths
Other Electric Power Generation	Current Specialization	Employment Growth	Share Gain	Stars
Power Transmission/Distribution	**Not a Current Specialization**	**Employment Decline**	**Share Loss**	**Prospects Limited**
Electric Bulk Power Transmission and Control	Not a Current Specialization	Employment Growth	Share Gain	Emerging Strengths
Electric Power Distribution	Current Specialization	Employment Decline	Share Gain	Higher Priority Retention Targets
Natural Gas Distribution	Not a Current Specialization	Employment Decline	Share Loss	Prospects Very Limited
Oil/Gas Pipeline and Related Structures Const.	Not a Current Specialization	Employment Growth	Share Gain	Emerging Strengths
Power/Communication Line and Related Structures Const.	Current Specialization	Employment Growth	Share Gain	Stars
Pipeline Transport. of Natural Gas	Not a Current Specialization	Employment Growth	Share Gain	Emerging Strengths
Pipeline Transport. of Refined Petroleum Products	Not a Current Specialization	Employment Decline	Share Loss	Prospects Very Limited
Refineries	**Not a Current Specialization**	**Employment Growth**	**Share Gain**	**Emerging Strengths**
Petroleum Refineries	Not a Current Specialization	Employment Growth	Share Gain	Emerging Strengths
Total Energy Sector	**Not a Current Specialization**	**Employment Growth**	**Share Gain**	**Emerging Strengths**

Source: TEConomy Partners analysis of Bureau of Labor Statistics, QCEW data and enhanced file from IMPLAN.

From an economic development marketing perspective pay levels in Iowa are still considerably below those for the national economy overall. That is, employers do not pay as much in Iowa for labor as in other U.S. locations on average—Iowa energy wages, on average, are only 76% of the national level. Differences in wages can reflect the composition of the industry sector and the skill sets in demand, the costs of living and doing business, the value-added within an industry compared with other regions, and many other reasons.

Table 16: Average Wages for Select Iowa and U.S. Industries, 2014

Industry Sector, Subsector, or Sector	Iowa Average Wages, 2014	U.S. Average Wages, 2014	Iowa Wage Share of U.S. Wage
Power Generation	*$102,264*	*$111,298*	*92%*
Power Transmission/Distribution	*$80,135*	*$87,232*	*92%*
Management of Companies & Enterprises	$77,959	$112,868	69%
Biodiesel Production	*$77,954*	*$93,063*	*84%*
Total Energy Sector	*$73,254*	*$96,468*	*76%*
Finance & Insurance	$68,456	$97,373	70%
Professional, Scientific, & Technical Services	$60,472	$86,391	70%
Refineries	*$60,158*	*$132,020*	*46%*
Wholesale Trade	$58,766	$71,043	83%
Manufacturing	$54,418	$62,977	86%
Construction	$51,934	$55,040	94%
Extraction/Resource Development	*$51,191*	*$109,875*	*47%*
Information	$50,764	$90,804	56%
Other Renewable Energy & Storage	*$49,907*	*$73,100*	*68%*
Petroleum Products & Wholesale	*$45,693*	*$63,903*	*72%*
Real Estate & Rental & Leasing	$42,762	$51,808	83%
Transportation & Warehousing	$42,047	$48,720	86%
Ethanol Production	*$41,964*	*$74,758*	*56%*
Total Private Sector	$41,964	$51,298	82%
Health Care & Social Assistance	$39,605	$45,859	86%
Agriculture, Forestry, Fishing & Hunting	$37,113	$30,625	121%
Retail Trade	$24,673	$28,743	86%
Arts, Entertainment, & Recreation	$17,540	$34,856	50%

Source: TEConomy Partners analysis of Bureau of Labor Statistics, QCEW data and enhanced file from IMPLAN.

Conclusion 11: The energy sector in Iowa pays higher wages in comparison to the private sector overall in the state. It provides the sort of high quality, family-sustaining jobs that economic developers seek to grow.

C. Labor Productivity in the Iowa Energy Sector

Comparing the productivity of a state sector to its national level provides insights into whether the state industry is more or less competitive. Higher levels of productivity compared to the nation mean that for each job more economic output is generated suggesting that a local industry is better able to make use

of advances in technology to produce goods and services and is able to produce more complex, higher value products.

In terms of labor productivity in the energy sector, measured by value-added per worker[8], Iowa lags behind the nation. Latest data, for 2014 (Table 17), shows that the energy sector in Iowa produces $193,326 in value-added activity per employee, versus $263,028 for the nation.[9] Thus Iowa's energy productivity level runs at about 74% of the national level. However, taking into account the fact that Iowa energy wages are, on average, only 76% of the national level it is evident that the Iowa workforce is effectively still good value for money.

Table 17: Value-Added per Worker in the Energy Sector 2014—Iowa Compared to the U.S.

Industry Sector	Iowa Productivity, 2014	U.S. Productivity, 2014	Iowa Productivity Share of U.S. Productivity
Energy Sector	$193,326	$263,028	74%
Total Private Sector	$88,548	$93,915	94%

Source: TEConomy Partners analysis of IMPLAN Input/Output Model for Iowa and the U.S.

It is also clear from these high dollar values that the energy sector, in general, is highly capital intensive—i.e., it is an industry in which the infrastructure required to produce its product (ethanol production equipment, power stations, distribution infrastructure, etc.) require high levels of investment in comparison to the total number of jobs generated. This is evidenced by the fact that the energy sector produces $193,326 in value-added per worker in Iowa, versus just $88,548 per worker in the private sector on average. In highly capital intensive industries, relative wage rates for workers can be a relatively minor location factor and, in this regard, the comparatively lower levels of wages paid in the energy sector in Iowa may not be a particularly strong comparative advantage.

Productivity varies widely across the various energy subsectors, with power generation having the largest value-added per employee in both Iowa and the U.S., $508,765 and $546,474, respectively—again indicating the extreme capital intensity of this subsector. Important for Iowa is that ethanol production productivity, as measured by value-added per employee, reached $309,805 in 2014, compared to the U.S. level of $253,645.

Conclusion 12: While overall Iowa energy wages and productivity levels are lower than the national average for the sector, the relationship between wages and productivity is slightly better than the national average and key subsectors offer significant competitive advantage and opportunities.

[8] Value-added represents the difference between an industry's total output and the cost of its intermediate inputs; a measure of the sector's contribution to GSP. A significant component of value-added is worker wages. The measure of value-added per employee is often used as a measure of overall industry productivity.

[9] Some industries do not map directly 1:1 from NAICS to the IMPLAN model-specific industry sectors and therefore some are left out of this analysis as including the full IMPLAN sector would be overly inclusive (e.g., Energy-related sectors in Wholesale and Retail are not included in this calculation).

IV. Preliminary Scenarios for Energy Change in Iowa

A. Initial Scenario Development

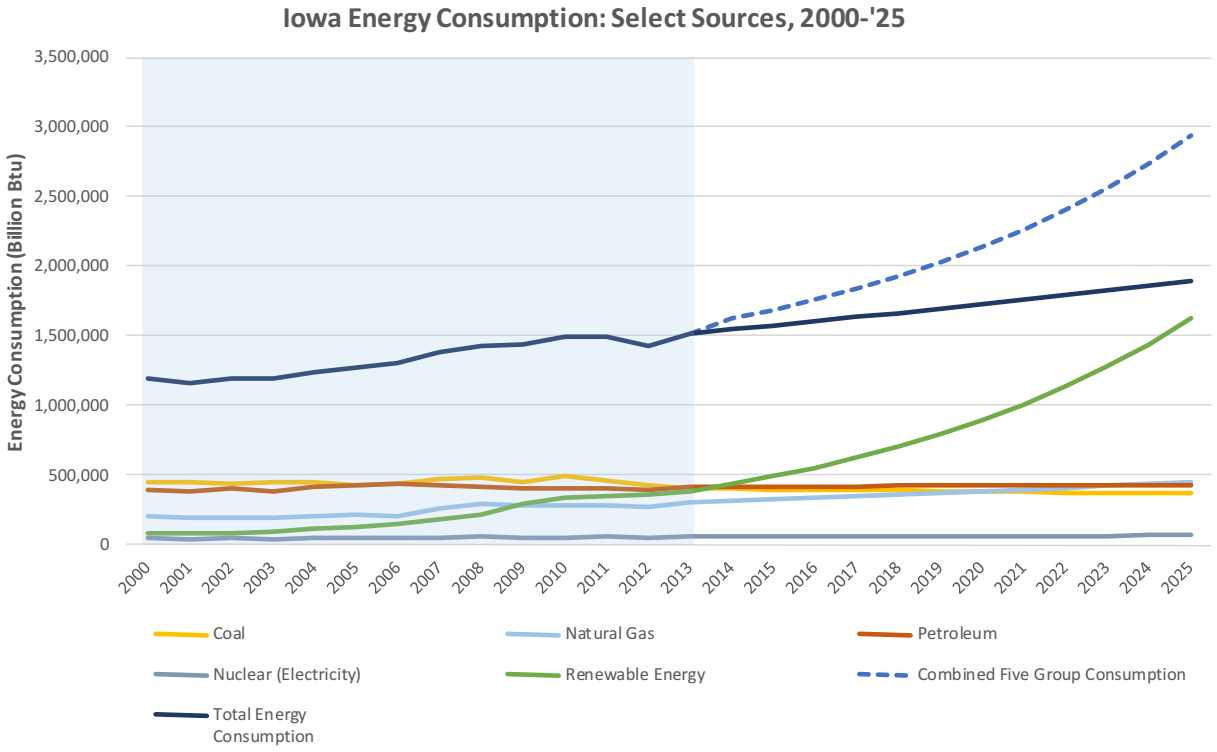
The ultimate goal of these Iowa energy scenarios is to establish a future path for energy development activities in the State. This initial set of scenarios are developed to provide a basic "baseline" perspective of recent energy performance, measured by consumption (demand) and production (supply) and how even a simple continuation of this performance will alter Iowa's future energy landscape, and how choices, strategies, and actions developed as part of the Iowa Energy Plan can alter Iowa's energy future.

This initial set of scenarios will be updated, modified, and replaced using additional and "to be collected" information from the state's energy stakeholders through both interviews and working group perspectives, leading to a final set of scenarios that plot potential energy futures for Iowa. These initial scenarios provide forecasts for the major energy fuel-related groups of coal, natural gas, petroleum (oil), nuclear, and renewable (including hydro-electric, geothermal, biomass, solar, etc.) as well as total energy consumption and a composite of the combined five fuel-related groups.

Scenario I: Continuation of Decade-plus Trends

The first scenario shows previous Iowa energy consumption from 2000 through 2013 (shaded area) and then extends this consumption performance, based upon the calculated compound annual growth rate (CAGR) of this performance to 2025 (Figure 13).

Figure 13. Iowa Energy Consumption Forecast to 2025 at 2000-2013 CAGR.



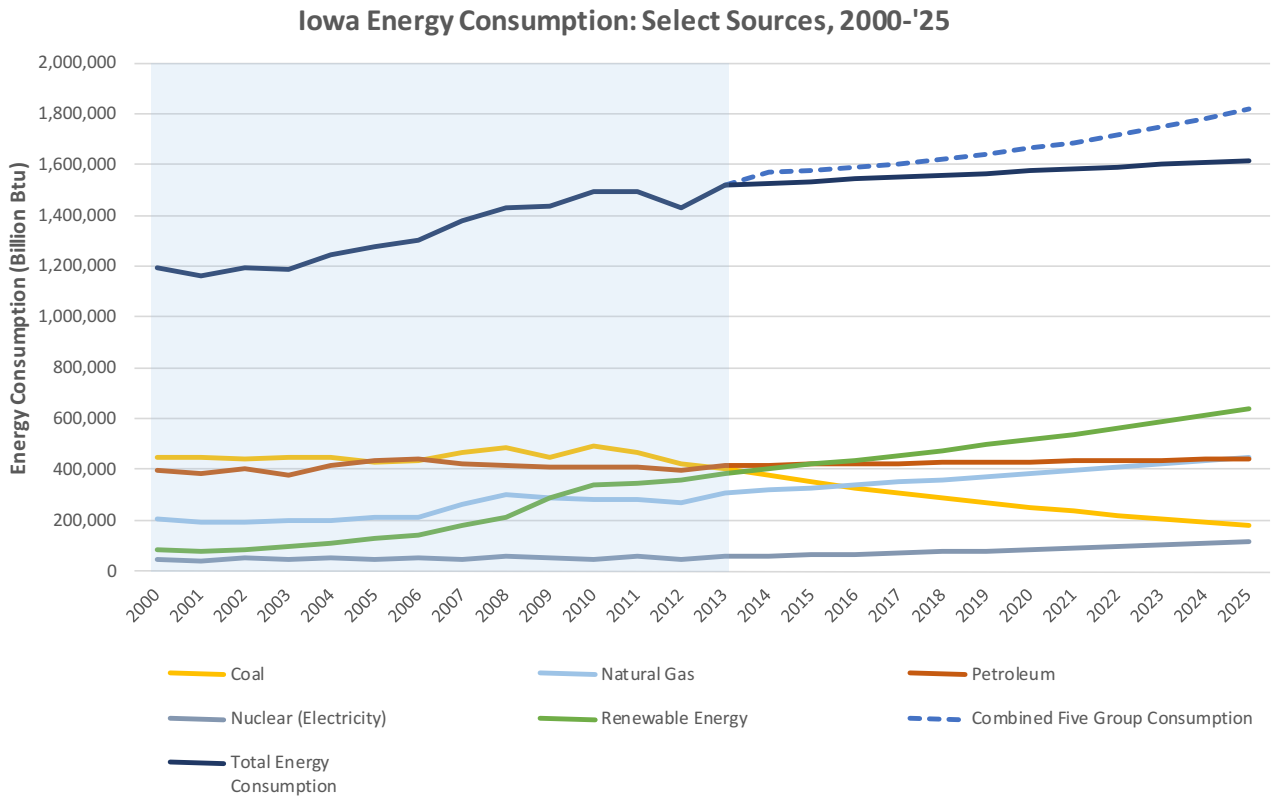
Source: TEConomy Partners analysis of U.S. Energy Information Administration data for Iowa.
Note: CAGR = Compound Annual Growth Rate.

This scenario depicts a continuation of the extreme growth in renewable energy consumption within the state over the 2000-2013 period, and what consumption values for this energy source would look like in the unlikely case that all five energy groups continued on their historical path. In this scenario renewable energy consumption's substantial growth (CAGR=12.8%) along with relatively flat growth or slight declines in the remaining fuel groups show the combined growth would far surpass overall projected total energy consumption growth.

Scenario II: Continuation of More Recent Trends

The second scenario (Figure 14) shows a similar forecast approach, but only uses the truncated recent period, 2010-2013, to establish the historical CAGR rate for the forecast. This more recent growth rate eliminates some of the extremely high growth periods in the early 2000's as the renewable energy sector began developing in Iowa.

Figure 14. Iowa Energy Consumption Forecast to 2025 at 2010-1013 CAGR.



Source: TEConomy Partners analysis of U.S. Energy Information Administration data for Iowa.

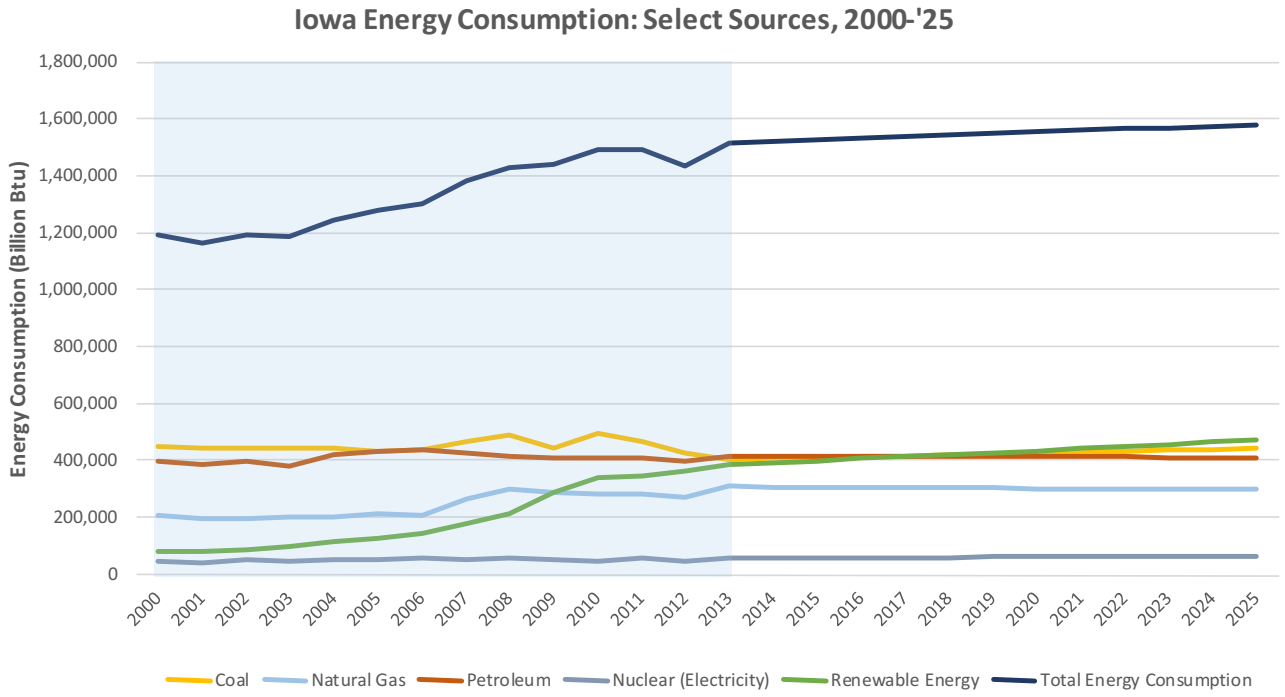
Even with the CAGR focused on the most recent period, the renewable energy sector continues a significant CAGR of 4.3% per year. This lessened growth rate in renewable energy is combined with a now more pronounced decline in coal consumption (CAGR from 2000-2013 = -0.8%; CAGR from 2010-2013 = -6.6%), to bring the combined five group consumption forecast much closer to total energy consumption forecast, yet it still exceeds it by 200,000 Billion Btu.

Scenario III: National EIA Forecasts

The third initial scenario (Figure 15) replaces Iowa consumption forecast CAGRs, built upon Iowa historical consumption data, with a forecast built upon an existing U.S. EIA forecast for the West North Central region that is a component of their Annual Energy Outlook (AEO).[10] In their AEO, the U.S. EIA forecasts energy consumption in a mostly similar context to the year 2040.[11] For the purposes of this scenario, a CAGR was calculated from the AEO West North Central forecast for the years 2013-2025 to coincide with the previous scenarios.

In this scenario, total energy consumption is forecast to grow at a CAGR of less than 1.0% similar to Scenario II. With Scenario III's forecast built upon the structured forecast of the AEO the developed CAGR lead to a combination of the five energy groups equaling the total energy consumption forecast.[12]

Figure 15. Iowa Energy Consumption Forecast to 2025 at U.S. EIA AEO Forecast 2013-2025 CAGR.



Source: TEConomy Partners analysis of U.S. Energy Information Administration data for Iowa and Annual Energy Outlook data for the West North Central Region (which includes Iowa).

Scenario IV: Production Forecast

The fourth scenario (Figure 16) depicts Iowa historical production from 2000-2013 in the three areas in which Iowa currently produces energy—nuclear energy production, other renewable energy (electricity)

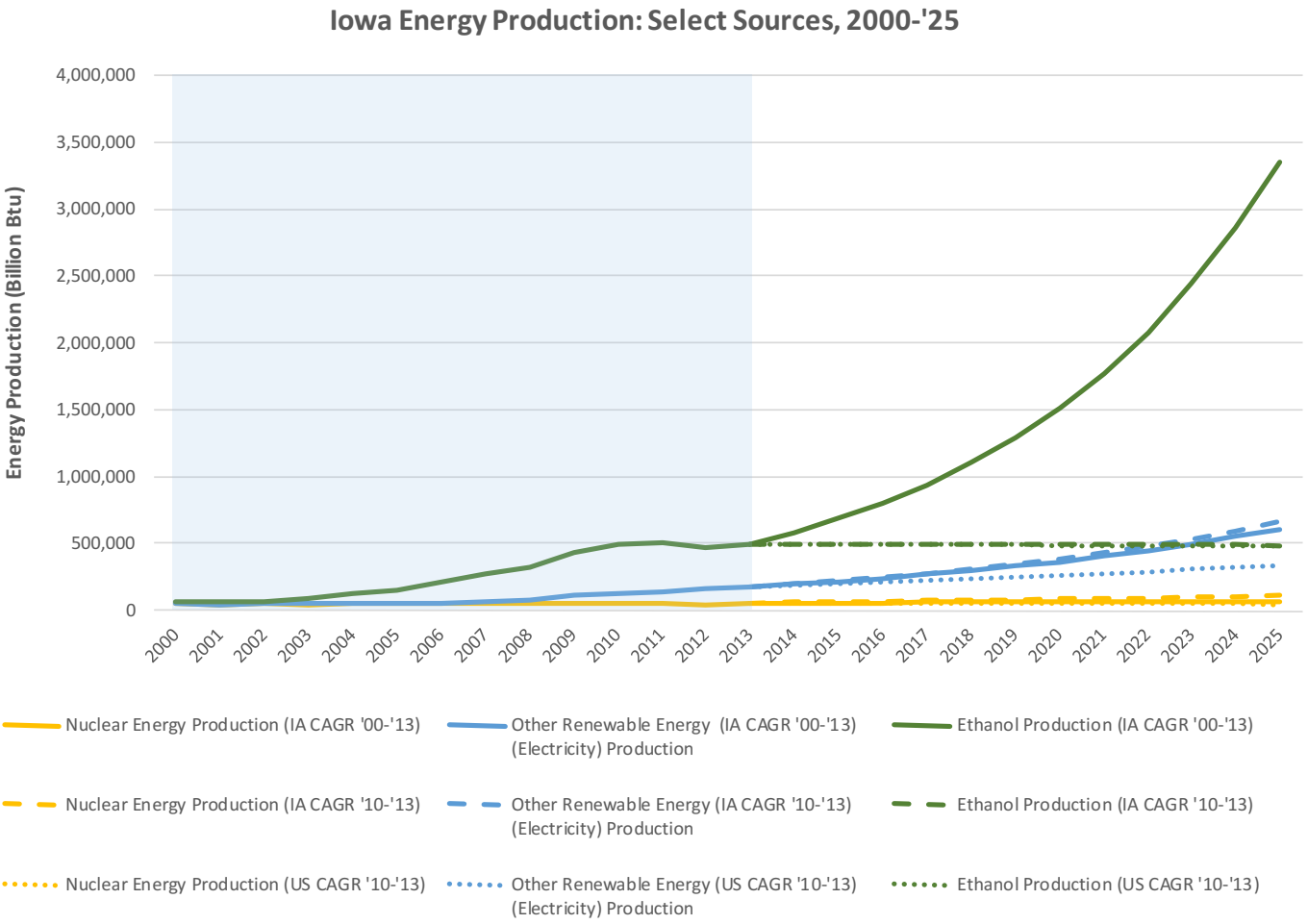
[10] The West North Central Region is defined as Iowa, Missouri, Missouri, Kansas, Nebraska, South Dakota, North Dakota, and Minnesota.

[11] Some slight definitional differences exist between the AEO categories and U.S. EIA SEDS data used for the base Iowa consumption data from 2000-2013. At the broad energy groups used in these basic scenarios the differences are negligible.

[12] For purposes of these baseline, illustrative scenarios, the forecast years do not take into account net energy loss and import/export considerations.

production, and ethanol production. Three forecasts are developed for each source—a CAGR based upon Iowa's historical 2000-2013 production (IA CAGR '00-'13), a CAGR based upon Iowa's historical 2010-2013 production (IA CAGR '10-'13), and a CAGR based upon overall U.S. 2010-2013 production (U.S. CAGR '10-'13).

Figure 16. Iowa Energy Production Forecast to 2025, Various Projected Growth Rates.



Source: TEConomy Partners analysis of U.S. Energy Information Administration data for Iowa and the U.S.

What is most surprising when examining Scenario IV is that with the exception of the ethanol production forecast based upon the 2000-2013 CAGR, the future production forecasts are very similar, with the U.S.-based forecast for other renewable energy slightly lower.

B. Scenario Development Next Steps

As described, these scenarios capture the Iowa energy-consumption data contained within this white paper and develops simple, baseline scenarios to begin the discussion of Iowa's energy future. Additional scenarios will be developed and shared with stakeholders and working groups as additional

data is gathered, the project progresses and information pertaining to potential viable scenarios is received.

At a minimum the next wave of scenarios will begin to explore key variables, opportunities, and policy initiatives and will include, among others:

- Understanding existing planned capacity and generation changes within Iowa on both production and consumption.
- Role of the Clean Power Plan and its potential impacts on both generation capacity and energy availability.
- Renewable Portfolio Standard-influenced portfolio changes.
- Continued manufacturing expansion on consumption mix.
- Reconciling differences and distinctions between consumption and demand forecasts.

Thoughts on how these factors will weigh on and impact the scenarios for Iowa's energy future will be brought to light through the on-going efforts of this project.

APPENDIX A: Performance Comparison by Energy Category – Iowa and Surrounding Benchmark States

Data for the following tables and figures in Chapter II are from the U.S. Energy Information Administrations, State Energy Data Systems (SEDS) database, 2000-2013 (most currently available).

Coal Demand Profile

Table A1. Coal Consumption, Expenditures, and Price by Benchmark State

	Consumption (Billion Btu)		Consumption Percent Change, 2000-2013		Expenditures ($ Millions)		Price ($ per Million Btu)	
State	Metric	State Rank	Metric	State Rank	Metric	State Rank	Metric	State Rank
Iowa	**402,402**	**17**	**-9.8%**	**14**	**$736.5**	**22**	**$1.83**	**46**
Illinois	1,026,925	5	1.0%	7	$2,128.4	6	$2.07	38
Minnesota	267,695	27	-28.4%	27	$566.5	30	$2.12	33
Missouri	806,549	7	17.1%	3	$1,553.0	12	$1.93	43
Nebraska	292,956	25	41.6%	1	$423.1	31	$1.44	49
South Dakota	34,246	40	-32.3%	29	$71.2	42	$2.08	35
Wisconsin	454,554	15	-8.9%	13	$1,108.9	14	$2.44	28
U.S. Totals	18,038,771		-20.1%		$45,516.6		$2.52	

Natural Gas Demand Profile

Table A2. Natural Gas Consumption, Expenditures, and Price by Benchmark State

	Consumption (Billion Btu)		Consumption Percent Change, 2000-2013		Expenditures ($ Millions)		Price ($ per Million Btu)	
State	Metric	State Rank	Metric	State Rank	Metric	State Rank	Metric	State Rank
Iowa	**306,460**	**25**	**50.9%**	**12**	**$2,045.7**	**23**	**$6.32**	**33**
Illinois	1,063,690	7	2.3%	35	$7,260.8	5	$7.20	18
Minnesota	478,810	16	30.3%	24	$2,426.4	20	$6.26	35
Missouri	281,486	30	-2.3%	41	$1,811.0	28	$8.80	8
Nebraska	179,610	38	41.1%	20	$994.6	36	$5.78	43
South Dakota	84,527	44	121.8%	2	$462.0	46	$6.04	40
Wisconsin	450,169	18	13.2%	30	$2,997.3	17	$6.72	26
U.S. Totals	26,801,763		12.5%		$151,704.5		$6.44	

Petroleum Demand Profile

Table A3. Petroleum Consumption, Expenditures, and Price by Benchmark State

	Consumption (Billion Btu)		Consumption Percent Change, 2000-2013		Expenditures ($ Millions)		Price ($ per Million Btu)	
State	Metric	State Rank	Metric	State Rank	Metric	State Rank	Metric	State Rank
Iowa	427,080	29	5.5%	10	$11,314.3	28	$26.49	37
Illinois	1,234,444	6	-4.1%	20	$30,305.9	6	$27.05	26
Minnesota	608,922	18	-10.2%	32	$15,509.3	19	$27.30	23
Missouri	632,148	17	-6.8%	25	$16,735.4	17	$26.47	39
Nebraska	238,966	37	6.3%	8	$6,601.2	35	$27.62	17
South Dakota	117,362	47	-0.6%	15	$3,167.8	47	$26.99	28
Wisconsin	525,625	23	-13.0%	38	$14,433.9	21	$27.68	15
U.S. Totals	35,820,042		-6.7%		$878,115.6		$26.11	

Motor Gasoline Demand Profile

Table A4. Gasoline Consumption, Expenditures, and Price by Benchmark State

	Consumption (Billion Btu)		Consumption Percent Change, 2000-2013		Expenditures ($ Millions)		Price ($ per Million Btu)	
State	Metric	State Rank	Metric	State Rank	Metric	State Rank	Metric	State Rank
Iowa	198,722	28	3.7%	19	$5,580.8	28	$28.08	33
Illinois	559,961	8	-10.5%	48	$16,001.8	7	$28.58	29
Minnesota	304,634	22	-4.4%	39	$8,798.4	20	$28.88	25
Missouri	368,645	14	-4.3%	38	$10,047.2	15	$27.25	47
Nebraska	103,043	37	-3.4%	37	$2,973.3	37	$28.85	26
South Dakota	53,510	45	-0.4%	29	$1,555.0	45	$29.06	22
Wisconsin	295,970	23	-2.5%	33	$8,731.2	21	$29.50	14
U.S. Totals	16,338,562		1.1%		$467,337.6		$28.60	

Fuel Oil Demand Profile

Table A5. Fuel Oil Consumption, Expenditures, and Price by Benchmark State

	Consumption (Billion Btu)		Consumption Percent Change, 2000-2013		Expenditures ($ Millions)		Price ($ per Million Btu)	
State	Metric	State Rank	Metric	State Rank	Metric	State Rank	Metric	State Rank
Iowa	138,913	24	23.9%	10	$3,759.6	25	$27.06	40
Illinois	267,542	7	7.1%	20	$7,400.9	7	$27.67	19
Minnesota	157,153	20	8.7%	18	$4,368.3	20	$27.80	15
Missouri	172,049	14	2.6%	24	$4,660.4	14	$27.09	39
Nebraska	110,112	32	26.7%	7	$3,001.0	32	$27.25	35
South Dakota	45,907	45	30.7%	5	$1,238.4	45	$26.98	41
Wisconsin	139,116	23	-18.4%	42	$3,893.2	23	$27.99	8
U.S. Totals	8,066,422		1.8%		$221,442.4		$27.46	

Propane Demand Profile

Table A6. LPG (Propane) Consumption, Expenditures, and Price by Benchmark State

	Consumption (Billion Btu)		Consumption Percent Change, 2000-2013		Expenditures ($ Millions)		Price ($ per Million Btu)	
State	Metric	State Rank	Metric	State Rank	Metric	State Rank	Metric	State Rank
Iowa	**63,297**	**5**	**-11.2%**	**29**	**$1,398.4**	**7**	**$22.09**	**47**
Illinois	84,791	3	15.8%	16	$1,899.3	3	$22.47	44
Minnesota	36,575	9	-0.4%	24	$853.4	11	$23.40	37
Missouri	30,742	13	-23.9%	38	$706.4	15	$22.98	41
Nebraska	12,338	27	-12.9%	31	$288.9	29	$23.42	36
South Dakota	7,523	40	-23.1%	36	$175.4	41	$23.32	38
Wisconsin	36,388	10	-12.7%	30	$814.6	12	$22.39	45
U.S. Totals	3,166,737		7.5%		$55,690.0		$17.61	

Nuclear Energy Demand Profile

Table A7. Nuclear Energy Consumption, Expenditures, and Price by Benchmark State

	Consumption (Billion Btu)		Consumption Percent Change, 2000-2013		Expenditures ($ Millions)		Price ($ per Million Btu)	
State	Metric	State Rank	Metric	State Rank	Metric	State Rank	Metric	State Rank
Iowa	55,597	29	19.7%	5	$46.5	29	$0.84	7
Illinois	1014,926	1	8.8%	8	$820.8	1	$0.81	14
Minnesota	111,885	24	-17.2%	26	$108.5	21	$0.97	2
Missouri	87,428	26	-16.1%	25	$78.7	24	$0.90	5
Nebraska	71,736	28	-20.3%	28	$60.0	27	$0.84	7
South Dakota	0	32		N/A	$0.0	32	$0.00	32
Wisconsin	121,994	21	1.6%	21	$93.5	22	$0.77	19
U.S. Totals	8,244,433		4.9%		$6,522.6		$0.79	

Note: 19 states and the District of Columbia have no direct production/consumption of nuclear power. These regions are all ranked at 32. Consumption metrics based on Nuclear energy consumed for electricity generation, total

Biomass Demand Profile

Table A8. Biomass Consumption, Expenditures, and Price by Benchmark State

	Consumption (Billion Btu)		Consumption Change, 2000-2013		Expenditures* ($ Millions)		Price* ($ per Million Btu)	
State	Metric	State Rank	Metric	State Rank	Metric	State Rank	Metric	State Rank
Iowa	227,581	4	244.1%	8	$35.7	37	$6.08	17
Illinois	136,667	11	43.0%	32	$92.5	29	$6.04	18
Minnesota	148,410	9	70.1%	21	$170.7	18	$3.51	35
Missouri	71,291	25	319.7%	6	$135.6	23	$11.36	10
Nebraska	107,101	21	281.9%	7	$15.2	43	$7.53	12
South Dakota	61,432	28	1209.0%	1	$8.7	49	$11.67	9
Wisconsin	133,836	12	40.7%	33	$227.9	16	$4.18	31
U.S. Totals	4,464,695		48.4%		$7,834.0		$3.79	

Note: *These biomass figures represent the “values” of all biomass including the consumption of biomass that is ultimately converted to other energy products including ethanol.

For the following, renewable energy-specific tables expenditure and price information is unavailable from the SEDS as these sources do not have "fuel-related" expenditures and all feed into the overall electricity pool (grid) from a price consideration, at this level of data availability. Further efforts to examine "green power pricing" and other RPS-related impacts is on-going.

Renewable Energy Demand Profile

Table A9. Total Renewable Energy Consumption by Benchmark State

	Consumption (Billion Btu)		Consumption Percent Change, 2000-2013	
State	Metric	State Rank	Metric	State Rank
Iowa	384,690	6	376.5%	3
Illinois	234,642	10	140.2%	15
Minnesota	233,732	11	123.3%	16
Missouri	94,515	33	305.7%	5
Nebraska	136,286	25	212.0%	12
South Dakota	127,714	27	101.3%	18
Wisconsin	168,986	17	46.0%	31
U.S. Totals	9,147,633		49.8%	

Wind Energy Demand Profile

Table A10. Wind (Renewable Energy) Consumption by Benchmark State

	Consumption (Billion Btu)		Consumption Change, 2000-2013	
State	Metric	State Rank	Metric	State Rank
Iowa	148,538	2	143,501	2
Illinois	91,834	5	91,834	4
Minnesota	78,797	7	71,406	7
Missouri	11,133	24	11,133	24
Nebraska	17,191	20	17,191	20
South Dakota	25,643	17	25,643	17
Wisconsin	14,864	22	14,836	22
U.S. Totals	1,601,359		1,544,302	

- Iowa was one of only 11 states registering any wind energy consumption in 2000. In 2013, 39 states registered wind energy consumption.
- Iowa accounts for 9.3% of U.S. wind consumption in 2013 and accounts for 9.3% of the increase in U.S. consumption from 2000 to 2013.

Ethanol Demand Profile

A11. Ethanol (Renewable Energy) Consumption by Benchmark State

	Consumption (Billion Btu)		Consumption Change, 2000-2013	
State	**Metric**	**State Rank**	**Metric**	**State Rank**
Iowa	**12,926**	**28**	**5,236**	**37**
Illinois	39,470	7	15,514	23
Minnesota	25,491	15	6,105	34
Missouri	21,436	19	19,021	18
Nebraska	5,586	40	2,837	46
South Dakota	3,731	43	1,806	49
Wisconsin	20,706	21	17,998	20
U.S. Totals	1,091,826		955,293	

- Iowa was one of 34 states with ethanol consumption in 2000. By 2013, all 50 states and the District of Columbia had some level of ethanol consumption.
- Iowa accounts for only 1.2% of U.S. ethanol consumption in 2013 and 0.5% of the change in total ethanol consumption from 2000 to 2013.
- Overall U.S. ethanol consumption increased by 700% from 2000 to 2013.