IOWA DEPARTMENT OF NATURAL RESOURCES

2014 Iowa Statewide Greenhouse Gas Emissions Inventory Report

Required by Iowa Code 455B.104

December 31, 2015

Iowa Department of Natural Resources
502 E. 9th Street
Des Moines, IA 50319

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Background

This report is required by Iowa Code 455B.104 which states that "by December 31 of each year, the department shall submit a report to the governor and the general assembly regarding the greenhouse gas (GHG) emissions in the state during the previous calendar year and forecasting trends in such emissions…." This report focuses on calendar year 2014 GHG emissions.

This is a "top-down" inventory based on statewide activity data from agriculture, fossil fuel combustion, industrial processes, natural gas transmission and distribution, transportation, solid waste, and wastewater treatment. It also includes carbon sequestered or emitted from land use, land use change, and forestry (LULUCF). GHGs included in the inventory are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFC), hydroflurocarbons (HFC), and sulfur hexafluoride (SF_6).

Emissions were calculated using the United States Environmental Protection Agency's (EPA) State Inventory Tool (SIT) and self-reported emissions data from landfills, industrial facilities and electricity generating facilities. The calculation method and uncertainty for each sector are discussed in detail in the Technical Support document available on the DNR's Greenhouse Gas Emissions Inventory webpage. Benefits of this report include the evaluation of emissions trends and development of a baseline to track progress in reducing emissions. A state-specific inventory also provides a more in-depth analysis and more accurate inventory of emissions compared to national emissions.

2014 Statewide GHG Emissions

In 2014, total gross Iowa greenhouse gas emissions were 132.54 million metric tons carbon dioxide equivalents ($MMtCO_2e$) as shown in Table 1 on page 6. This is an increase of 3.16 $MMtCO_2e$ (2.44%) from 2013. The majority of this increase is due to increases in emissions from agriculture (+0.93 $MMtCO_2e$) and fossil fuel use (+2.33 $MMtCO_2e$). While greenhouse gas emissions increased in every category except industrial processes, waste, and transportation as shown in Figure 2 and Table 1, total 2015 statewide GHG emissions were 5.10% lower than their peak in 2007.

Figure 1: Iowa Gross GHG Emissions 2005 – 2014 ($MMtCO_2e$)

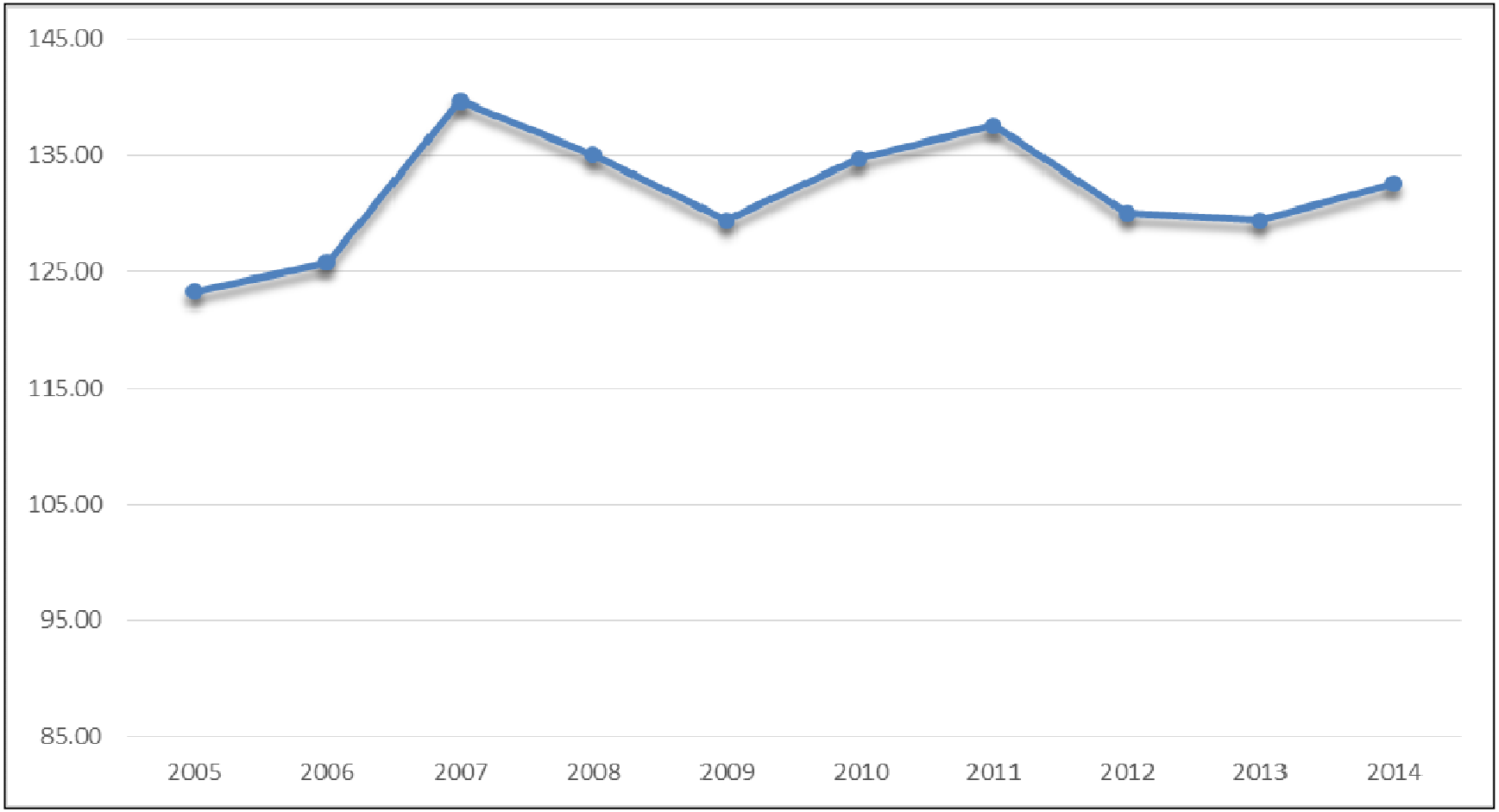
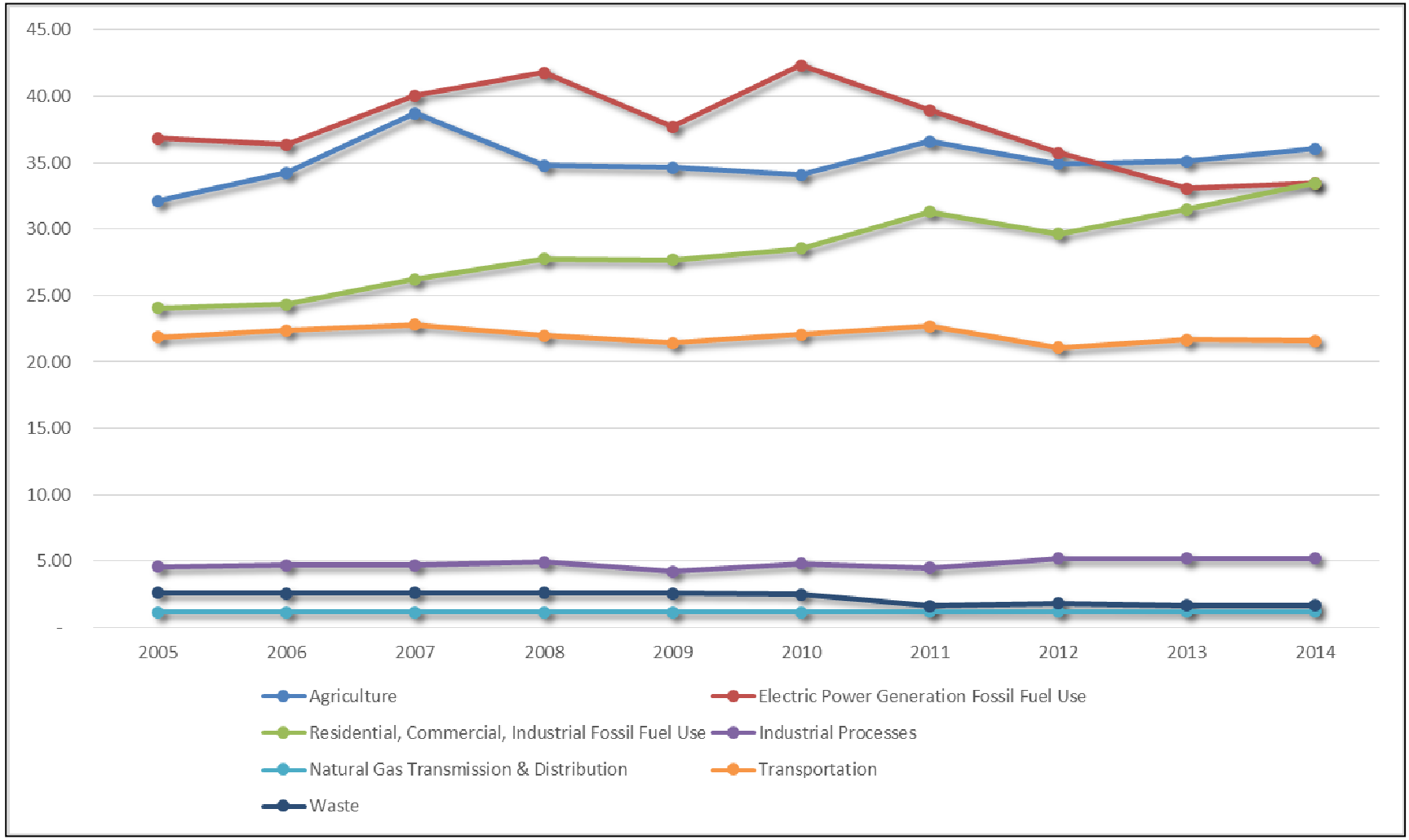


Figure 2: Iowa Gross* GHG Emissions 2005 – 2014 by Sector ($MMtCO_2e$)



*Does not include carbon sinks from land use, land use change, and forestry.

Table 1: GHG Emissions 2005 – 2014 by Sector ($MMtCO_2e$) [1]

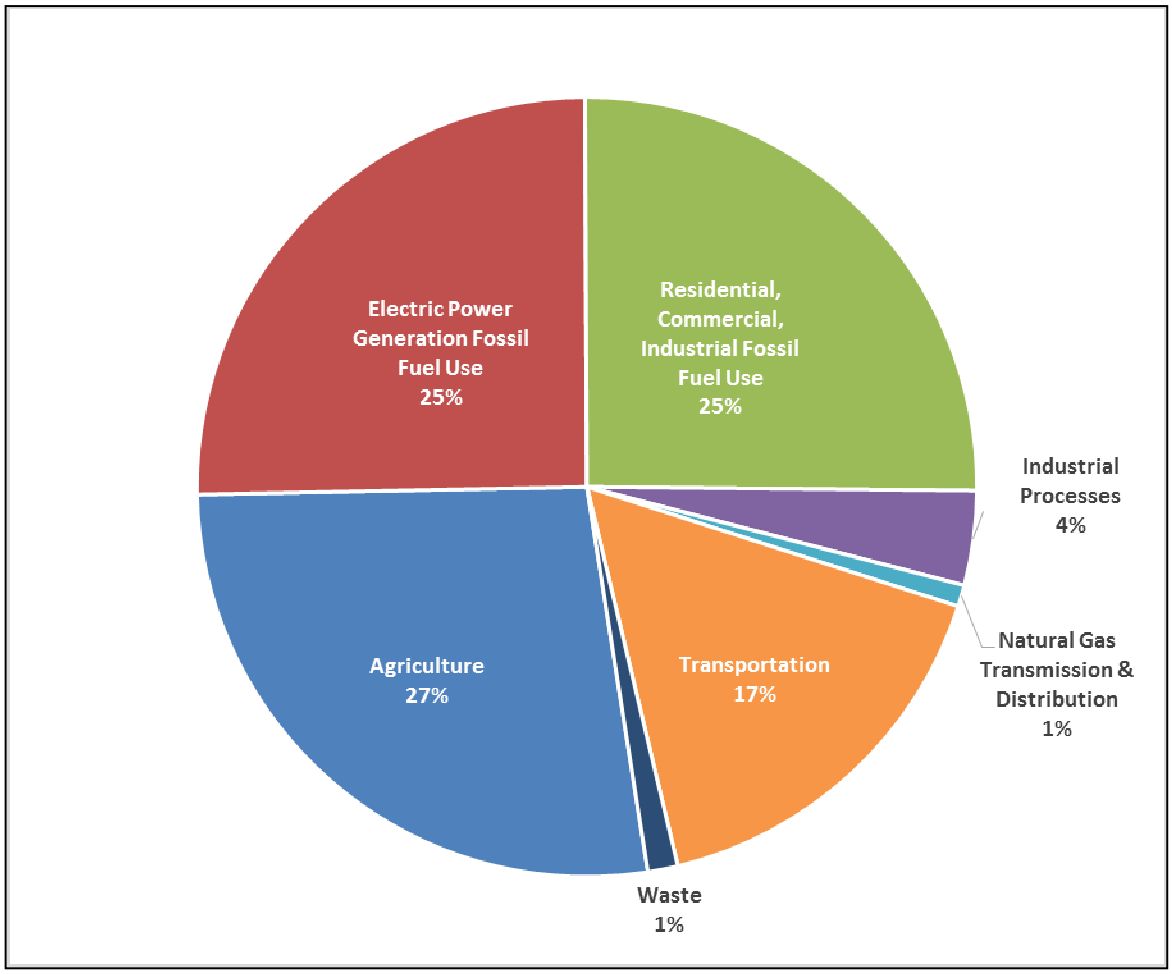
Emissions ($MMtCO_2e$)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Change from 2013		
Agriculture	32.14	34.25	38.73	34.81	34.63	34.07	36.61	34.90	**35.11**	36.04	+0.93	+2.64%	↑
Electric Power Generation Fuel Use	36.84	36.35	40.04	41.78	37.71	42.33	38.98	35.76	**33.06**	33.44	+0.38	+1.16%	↑
Residential, Commercial, and Industrial Fuel Use	24.07	24.32	26.21	27.75	27.66	28.56	31.31	29.65	**31.50**	33.44	+1.95	+6.18%	↑
Industrial Processes	4.58	4.71	4.70	4.93	4.23	4.80	4.49	5.18	**5.20**	5.19	-0.02	-0.30%	↓
Land Use, Land Use Change, and Forestry (LULUCF)	-20.54	-5.79	3.41	-3.91	-5.00	-2.00	0.66	0.48	**-0.72**	-0.79	-0.07	+9.64	↑
Natural Gas Transmission and Distribution	1.15	1.15	1.16	1.17	1.17	1.17	1.18	1.18	1.18	1.18	0.00	+0.22%	↑
Transportation	21.88	22.38	22.81	21.97	21.42	22.07	22.68	21.07	**21.67**	21.61	-0.06	-0.28%	↓
Waste	2.62	2.56	2.60	2.62	2.58	**1.71**	**1.64**	**1.82**	**1.67**	1.65	-0.02	-1.47%	↓
Total Gross Emissions[2]	123.27	125.73	139.67	135.04	129.42	**134.71**	**137.54**	**130.04**	**129.38**	132.54	+3.16	+2.44%	↑
Sinks from LULUCF	-20.54	-5.79	0	-3.91	-5.00	-2.00	0	0	**-0.72**	-0.79	-0.07	+9.64%	↑
Total Net Emissions	102.73	119.93	139.67	131.13	124.42	**132.71**	**137.54**	**130.04**	**128.66**	131.75	+2.07	+1.61%	↑

[1] Totals may not equal the exact sum of subtotals in this table due to independent rounding. Values that are bolded have been adjusted since the previous 2013 inventory published by the DNR in December 2014. The adjustments are described in detail in the Technical Support Document. Negative numbers indicate carbon sequestration.
[2] Gross emissions do not include any carbon sinks from land use, land use change, and forestry.

GHG Emissions by Sector

The majority of GHG emissions in Iowa in 2014 were from the agriculture sector and from fossil fuel use by the electric power generation and residential/commercial/ industrial (RCI) sectors. Together the emissions from electric power and RCI fuel use account for just over half (50.46%) of the state's GHG emissions as shown in Figure 3 below.

Figure 3: 2014 Iowa GHG Emissions by Sector



Emissions from each sector are summarized below. For more information on a specific sector, such as sources of emissions, calculations, and uncertainty, please refer to the Technical Support Document.

Agriculture

This sector includes GHG emissions from livestock and crop production such as enteric fermentation, manure management, agricultural soils, and burning of agricultural crop waste. Enteric fermentation includes emissions from the digestive systems of ruminant animals. Emissions from agricultural soils include emissions from animals and runoff, plant fertilizers, plant residues, and cultivation of histosols.

GHG emissions from fossil-fuel fired agricultural equipment (such as tractors) are included in the transportation sector.

2014 agriculture emissions increased 2.64% from the previous year as shown in Table 2 below. This was primarily due to a 6.70% increase in emissions from agricultural soil management that resulted from increased crop production and fertilizer application.

Table 2: GHG Emissions from Agriculture ($MMtCO_2e$)

Category	2013	2014	% Change
Enteric Fermentation	7.02	6.76	-3.75%
Manure Management	8.48	8.36	-1.43%
Agricultural Soil Management	19.61	20.92	+6.70%
Burning of Agricultural Crop Waste	0.00	0.00	-
Total	**35.11**	**36.04**	**+2.64%**

Fossil Fuel Combustion

This sector includes GHG emission from fossil fuels combusted in four categories: electric power generation, residential, industrial, and commercial. The residential, industrial, and commercial categories are often combined into one category called RCI. Together, these four categories account for nearly half (50.46% in 2014) of Iowa's GHG emissions. Emissions from each sector increased in 2014, and total emissions from the four sectors increased 3.61% from the previous year as shown in Table 3.

Table 3: GHG Emissions from Fossil Fuel Combustion ($MMtCO_2e$)

Category	2013	2014	% Change
Residential, Commercial, Industrial Fuel Use	31.50	33.44	+6.18%
Residential	*5.17*	*5.36*	*+3.72%*
Commercial	*4.08*	*5.10*	*+25.06%*
Industrial	*22.25*	*22.98*	*+3.28%*
Electric Power Generation (i.e. Power Plants)	33.06	33.44	+1.16%
Total	**64.56**	**66.88**	**+3.61%**

Residential, Commercial, Industrial (RCI Fuel Use)

Actual fuel use data for 2014 for the RCI sector was not available from the U.S. Energy Information Administration (EIA), so emissions were calculated based on projected energy consumption values from the EIA's *Annual Energy Outlook 2015 with Projections to 2040.* Emissions predicted for 2013 from the RCI sector in last year's inventory (30.78 $MMtCO_2e$) were replaced with actual 2013

consumption values now available from EIA. The resulting recalculated 2013 emissions were 31.50 $MMtCO_2e$. Emissions from this sector increased because the consumption of fossil fuels by users in each category increased, as did electricity consumption.

Electric Power Generation Fuel Use (i.e. Power Plants)

For the electric power generation category, the DNR used emissions reported by electricity generating stations to EPA as required by the federal GHG reporting program (40 CFR 98). CO_2 emissions for these facilities are measured by continuous emission monitors (CEMS). Emissions from this sector increased as electric power generators used more coal (+1.31%), less diesel fuel (-11.68%) and less natural gas (-8.36%) in 2014 to generate electricity. However, this does not match the overall trend in electric power generation, as for several years the percentage of electricity generated from coal has been decreasing, and the percentage generated from wind has been increasing as shown in Figures 4 and 5 on the below.

Figure 4: 2005 Net Iowa Electricity Generation by Energy Source (EIA 2015)

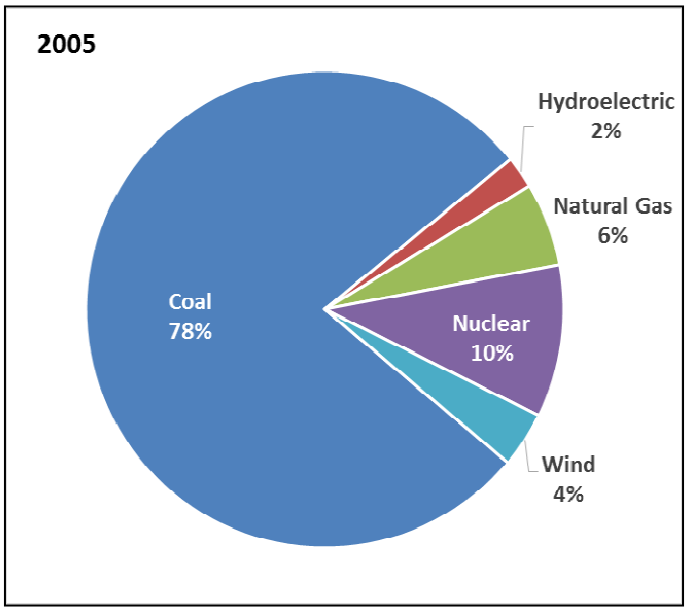
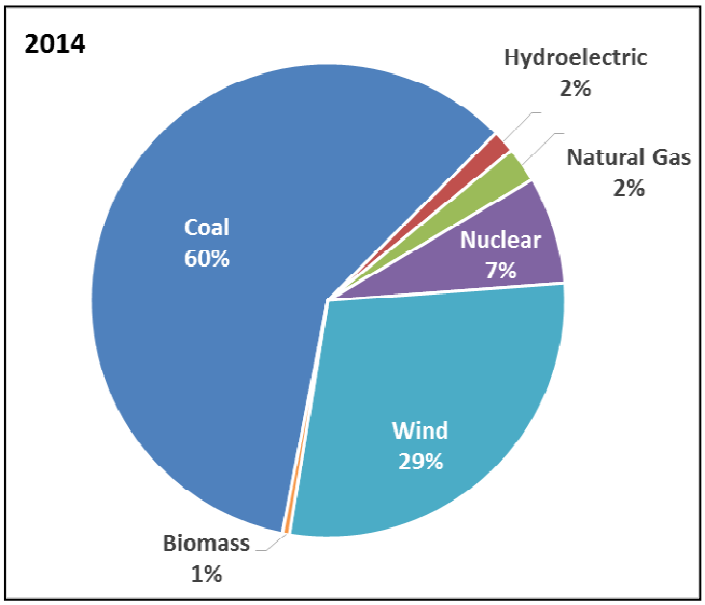


Figure 5: 2014 Net Iowa Electricity Generation by Energy Source (EIA 2015)



Industrial Processes

This sector includes non-combustion GHG emissions from a variety of processes including cement production, lime manufacture, limestone and dolomite use, soda ash use, iron and steel production, ammonia production, nitric acid production, substitutes for ozone depleting substances (ODS) and electric power transmission and distribution. GHG emission trends in each process category vary, but overall total industrial process emissions decreased 0.30% from 2013 - 2014 as shown in Table 4.

GHG emissions reported by industrial facilities to EPA as required by the federal GHG reporting program were used for these categories: ammonia and urea production, cement manufacture, iron and steel production, lime manufacture, and nitric acid production. Emissions from the other categories were calculated using EPA's SIT.

Table 4: GHG Emissions from Industrial Processes ($MMtCO_2e$)

Category	2013	2014	% Change
Ammonia & Urea Production	0.88	0.86	-1.61%
Cement Manufacture	1.41	1.38	-1.79%
Electric Power Transmission and Distribution Systems	0.06	0.06	NA[3]
Iron and Steel Production	0.19	0.18	-0.85%
Lime Manufacture	0.16	0.17	+2.65%
Limestone and Dolomite Use	0.33	0.33	NA[3]
Nitric Acid Production	0.83	0.86	+3.02%
Ozone Depleting Substance Substitutes	1.33	1.33	-0.32%
Soda Ash Consumption	0.02	0.02	NA[3]
Total	**5.20**	**5.19**	**-0.30%**

Natural Gas Transmission and Distribution (T & D)

This sector includes emissions from natural gas transmission and distribution systems in the state. 2014 GHG emissions increased 0.08% from 2013 as shown in Table 5, due to increases in miles of distribution pipeline and number of steel services (e.g. gas meters).

Table 5: GHG Emissions from Natural Gas Transmission and Distribution ($MMtCO_2e$)[4]

Category	2013	2014	% Change
Transmission	0.6606	0.6605	+0.02%
Distribution	0.5154	0.5181	+0.15%
Total	**1.1760**	**1.1786**	**+0.08%**

Transportation

The transportation sector includes GHG emissions from both highway and non-highway vehicles. Aviation, boats, locomotives, tractors, other utility vehicles, and alternative fuel vehicles are considered to be non-highway vehicles. Actual 2014 fuel use data for highway vehicles was not available from the U.S. Energy Information Administration (EIA), so CO_2 emissions from transportation

[3] Due to a lack of current data, the DNR assumed 2014 emissions = 2013 emissions.

[4] DNR uses two decimal places throughout this report for consistency. However, in this sector four decimal places are needed to show the difference in emissions from year to year.

were calculated based on fuel forecasts from the EIA. Total GHG emissions from transportation were estimated to decrease 0.28% from 2013 as shown in Table 6.

Table 6: GHG Emissions from Transportation ($MMtCO_2e$)

Category	2013	2014	% Change
Transportation	21.67	21.61	-0.28%

Waste

The waste sector includes GHG emissions from both solid waste landfills and the treatment of municipal and industrial wastewater. Overall, GHG emissions from waste decreased 1.47% from 2013 as shown in Table 7. DNR refined its calculation method for this report and used facility-specific emissions data directly reported by landfills and industrial wastewater facilities to U.S. EPA. This recalculation is discussed in detail in the Technical Support Document.

Emissions from smaller landfills that are not required to report to EPA were estimated using the LandGEM model. The SIT was used to estimate emissions from municipal wastewater treatment and combustion of municipal solid waste.

Table 7: GHG Emissions from Waste ($MMtCO_2e$)[5]

Category	2013	2014	% Change
Solid Waste	1.2641	1.2557	-0.67%
Wastewater	0.4087	0.3926	-3.95%
Total	**1.6729**	**1.6483**	**-1.47%**

Land Use, Land Use Change, and Forestry (LULUCF)

The LULUCF sector includes emissions from liming of agricultural soils and fertilization of all developed land (settlement soils). It also includes carbon sequestered by forests and urban trees, as well as carbon stored in yard waste and food scraps that are sent to the landfill. Carbon sequestration from forests and trees in 2013 was recalculated using more current Iowa-specific data, and the 2013 value was used as a surrogate for 2014. This recalculation is discussed in detail in the Technical Support Document.

Overall, total 2014 emissions from LULUCF were -0.79 $MMtCO_2e$ as shown in Table 8. Negative emissions mean that 0.79 $MMtCO_2e$ is being stored or "sequestered" instead of being emitted to the atmosphere. This is a 9.64% increase in the amount of CO_2e being sequestered. This can be attributed

[5] DNR uses two decimal places throughout this report for consistency. However, in this sector four decimal places are needed to show the difference in emissions from year to year.

to decreases in emissions from the liming of agricultural soils and fertilization of settlement soils as well as an increase in the amount of CO_2e sequestered in yard trimmings and food scraps disposed of in landfills. Carbon sequestration from forest carbon flux and urban trees was assumed be unchanged from 2013, as were emissions from urea fertilization. Emissions from forest fires were not calculated due to a lack of data.

Table 8: GHG Emissions by LULUCF ($MMtCO_2e$)

Category	2013	2014	% Change
Forest Carbon Flux	-1.02	-1.02	NA[6]
Liming of Agricultural Soils	0.47	0.41	-13.95%
Urea Fertilization	0.13	0.13	NA[6]
Urban Trees	-0.74	-0.74	NA[6]
Yard Trimmings and Food Scraps Stored in Landfills	-0.11	-0.12	+1.97%
Fertilization of Settlement Soils	0.55	0.55	-0.33%
Total	**-0.72**	**-0.79**	**+9.64%**

Carbon emissions or sequestration from agricultural soil carbon flux are not included in the inventory. This is because the SIT does not have a calculation function for this category and because of the uncertainty in this category. Recent scientific studies and literature reviews do not agree on the relationship between soil tillage and soil carbon. Therefore, the DNR did not include this category. More details on the uncertainty in soil carbon flux are included in the Technical Support Document.

GHG Emissions by Pollutant

GHGs included in the inventory are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFC), hydrofluorocarbons (HFC), and sulfur hexafluoride (SF_6). Figures 6-9 show the distribution of GHG pollutants in 2014 by both pollutant and by category.

Carbon dioxide (CO_2) is the greenhouse gas emitted in the highest amounts in Iowa, accounting for 68% of all greenhouse gas emissions as shown in Figure 6. Nearly all CO_2 emissions are from fossil fuel combustion (97%) as shown in Figure 8, with a small percentage coming from industrial processes such as manufacturing of cement, lime, ammonia, urea, iron, and steel; as well as the use of limestone, dolomite, and soda ash in manufacturing. Methane (CH_4) and nitrous oxides (N_2O) are emitted in smaller amounts – 17.00 $MMtCO_2e$ of CH_4 and 23.89 $MMtCO_2e$ of N_2O. The majority of these two pollutants are from agriculture as shown in Figures 7 and 9.

[6] Due to a lack of current data, the DNR assumed 2014 values = 2013 values.

Figure 6: 2014 GHG Emissions by Pollutant

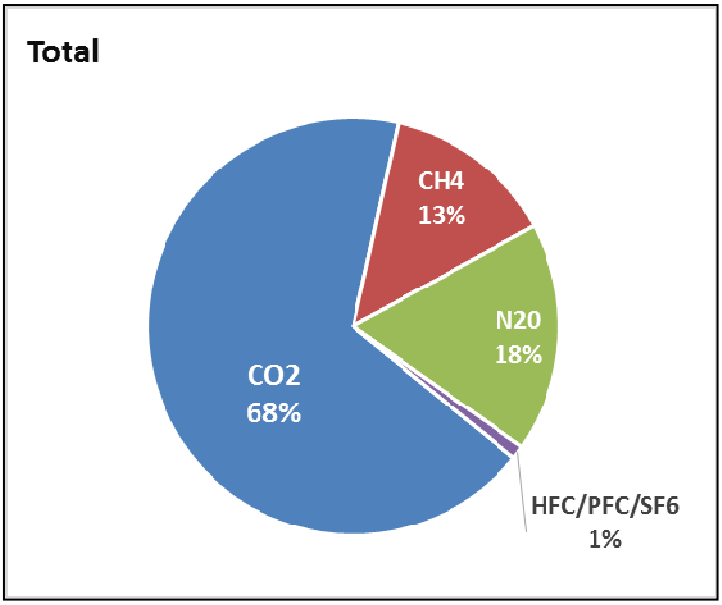


Figure 7: 2014 Methane Emissions by Category

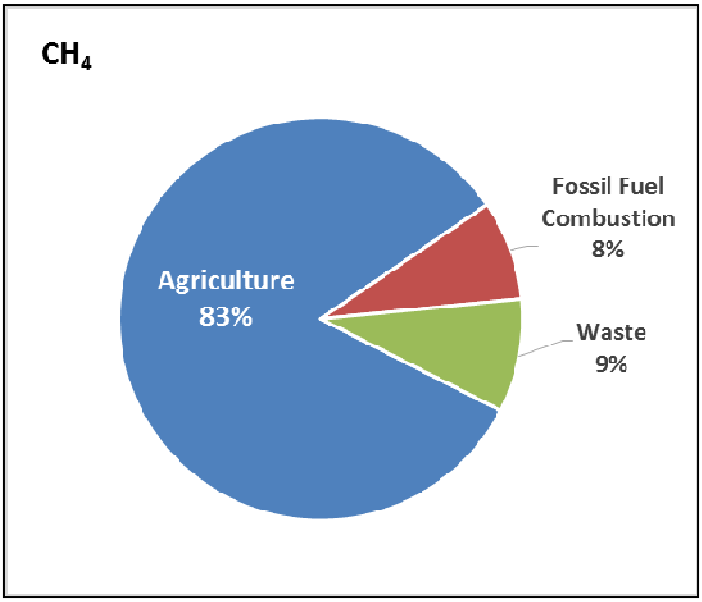


Figure 8: 2014 Carbon Dioxide Emissions by Category

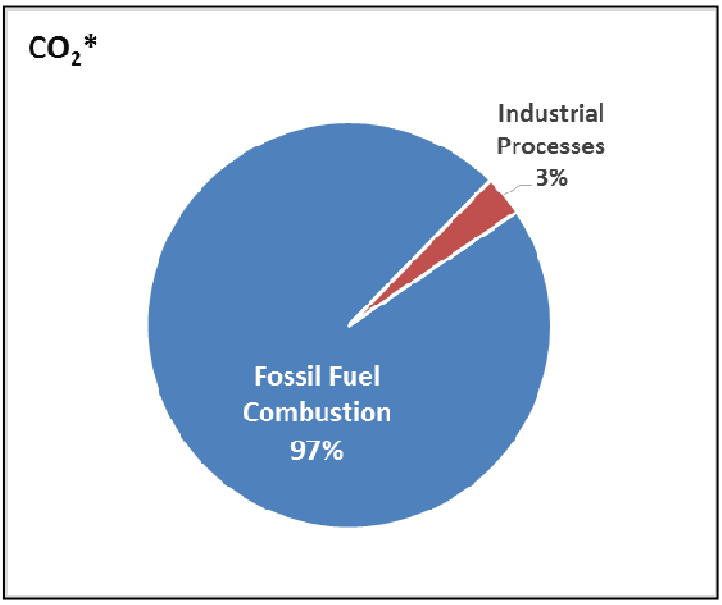
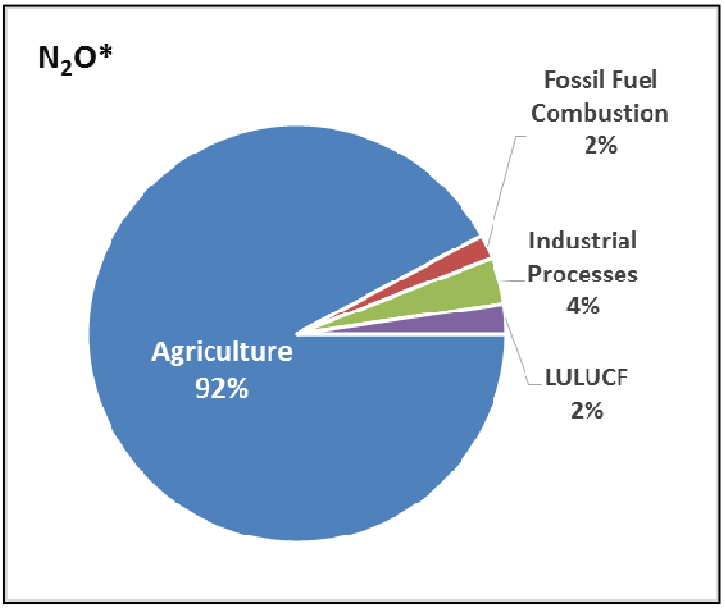


Figure 9: 2014 Nitrous Oxide Emissions by Category



Comparison with U.S. Emissions

Figures 10 and 11 below compare Iowa and national GHG emissions by sector. For comparison purposes and to be consistent with the sectors in the national GHG inventory, the fossil fuel combustion, natural gas distribution and transmission, and transportation sectors have been combined into one sector called "Energy". Emissions from 2013 are used for this comparison as the 2014 national GHG inventory has not yet been published. Overall, Iowa emits 2.0% of U.S. GHG emissions. National emissions from the LULUCF sector rounded to 0%.

Figure 10: 2013 Iowa GHG Emissions by Sector

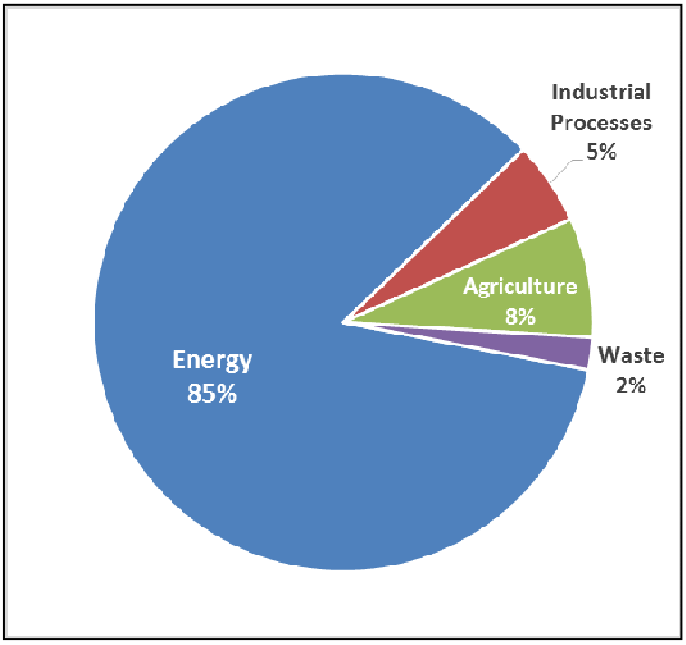
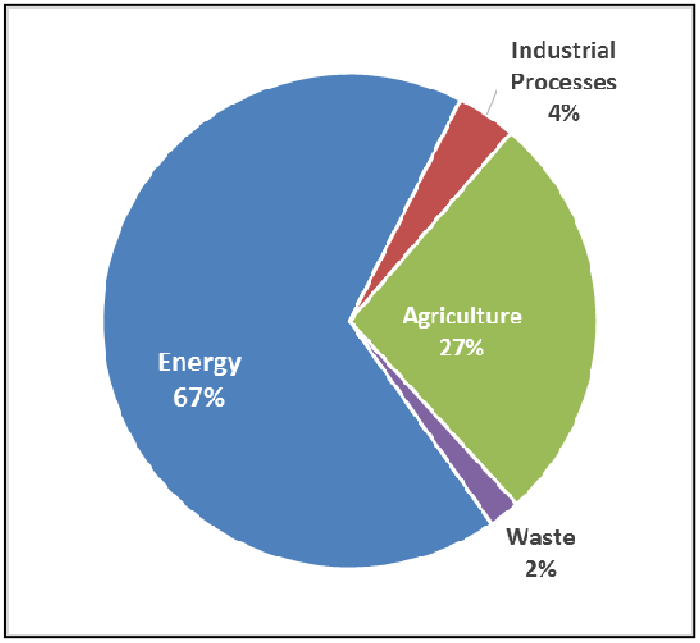


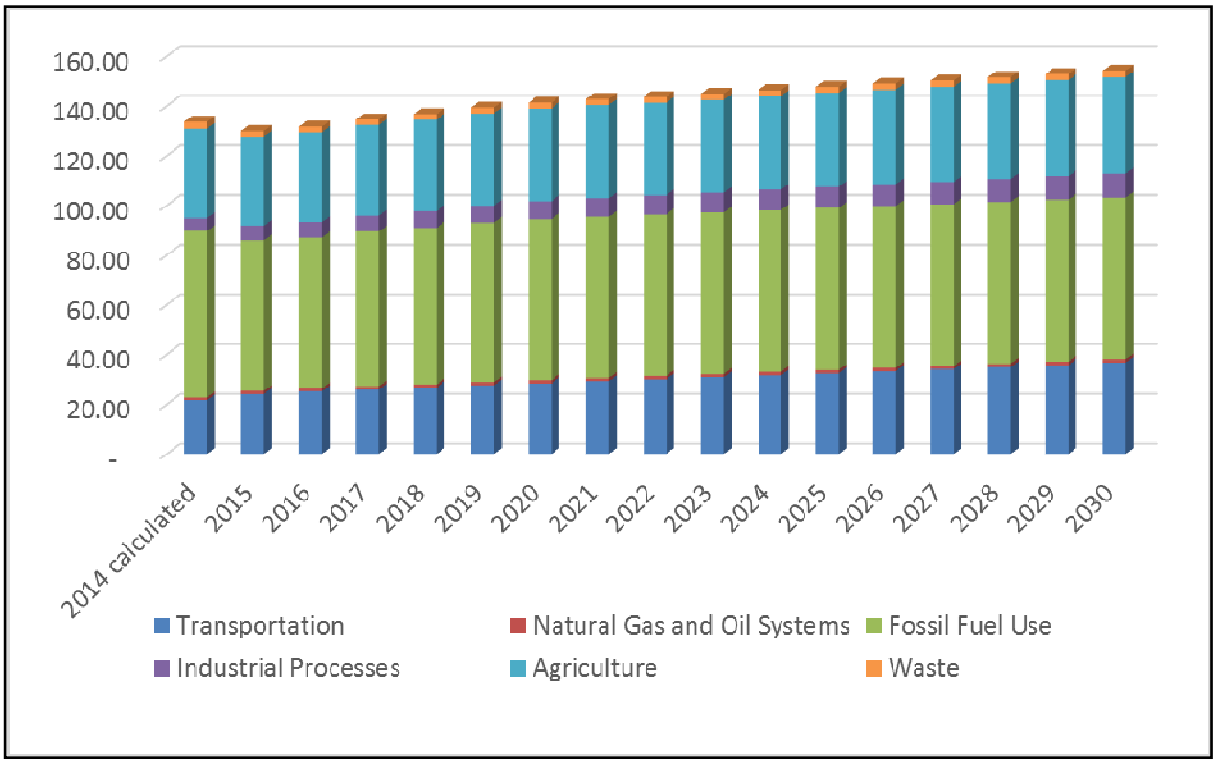
Figure 11: 2013 U.S. GHG Emissions by Sector



Future Emissions

Iowa Code 455B.104 requires that the DNR forecast trends in GHG emissions. The DNR projected emissions from to 2030 using the SIT Projection Tool. As with many forecasts, there are numerous factors that affect the significant level of uncertainty with future emissions. These factors may include among other things - the economy, weather, current and future environmental regulations, energy efficiency and conservation practices, driving practices, use of renewable fuels, etc. The projected emissions for 2015 – 2030 for each category are shown in Figure 12 on the next page. The SIT Projection Tool forecasts emissions from industrial processes, agriculture, and waste based on historical emissions from 1990 – 2012, using a combination of data sources and national projections for activity data.

Figure 12: Projected Gross GHG Emissions 2014 – 2030 ($MMtCO_2e$)



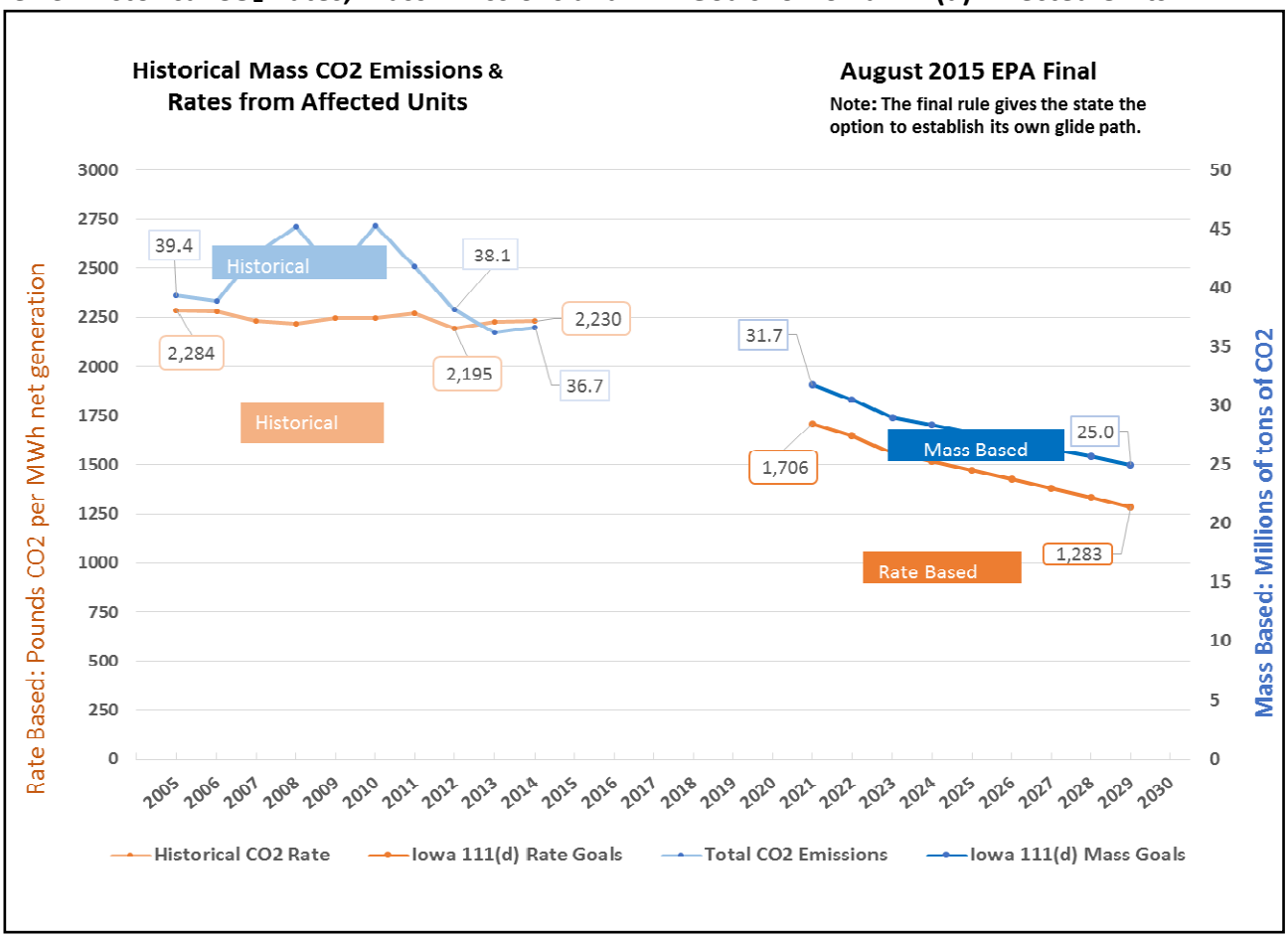
Although the SIT Projection Tool provides a good first look at projected future emissions, it is not a particularly sophisticated tool and has several areas of uncertainty:

1. In sectors where the Projection Tool predicts future emissions based on historical emissions, it only uses emissions from 1990 – 2012 and does not consider 2013 and 2014 emissions.
2. Agricultural emissions are highly dependent on the weather and crop and livestock prices, which are not addressed by the Projection Tool.
3. The Projection Tool forecasts emissions from fossil fuel use based on the reference case from the U.S. Energy Information Administration's (EIA) Annual Energy Outlook 2015 (AEO2015), which adds additional uncertainty:
    - The AEO2015 projections are done at a regional level and are not specific to Iowa, which is net exporter of electricity.
    - The Projection Tool does not address publically announced changes to Iowa's fossil fuel generation mix. Iowa utilities have announced that from 2014 – 2025, approximately 1,500 MW of coal-fired electric generation units will retire or convert to natural gas. During that same time period, approximately 621 MW of older natural gas-fired electric generation units will retire, and approximately 650 MW of newer, more efficient natural gas-fired electric generating units will come online. This will significantly reduce emissions from the electric power sector as natural gas emits approximately 50% less CO_2 per heating unit

than coal emits. In addition, at least an additional 1,934 MW of wind generation is planned to be installed in the next few years.

- AEO2015 assumes that the laws and regulations in effect as of the end of October 2014 remain unchanged throughout the projections. This over-estimates future CO_2 emissions from fossil fuel use by the electric power generation sector because it does not include the reductions required by EPA's final 111(d) Emission Guidelines for Existing Power Plants (also known as the Clean Power Plan) as shown in Figure 13.

Figure 13: Historical CO_2 Rates, Mass Emissions and EPA Goals for Iowa 111(d) Affected Units



Future Improvements

The DNR continually strives to make the annual statewide GHG inventory as accurate and timely as possible. DNR intends to update historical emissions in future reports with the IPCC AR4 global warming potentials. Other areas for enhancement include improved forecasting and further research of soil carbon flux emissions or sinks. Furthermore, the DNR plans to investigate whether emissions from the application of synthetic fertilizer are double-counted in the agriculture and LULUCF sectors.