IOWA DEPARTMENT OF NATURAL RESOURCES

2013 Iowa Statewide Greenhouse Gas Emissions Inventory Report

Required by Iowa Code 455B.104
December 29, 2014

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 2013 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 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.

2013 Statewide GHG Emissions

In 2013, total gross Iowa greenhouse gas emissions were 130.20 million metric tons carbon dioxide equivalents ($MMtCO_2e$) as shown in Table 1 on page 5. Total statewide GHG emissions decreased for the second year in a row, decreasing 0.51% from 2012 levels and decreasing 6.78% from their peak in 2007 as shown in Figure 1 below.

The primary factor in the decrease in total emissions was a decrease of 2.64 $MMtCO_2e$ (7.37%) in the emissions from the combustion of fossil fuels to generate electric power (i.e. power plants). Emissions from power plants have decreased for the third year in a row and were 21.76% below their peak in 2010 as shown in Figure 2 on the next page.

Figure 1: Iowa Gross GHG Emissions 2005 – 2013 ($MMtCO_2e$)

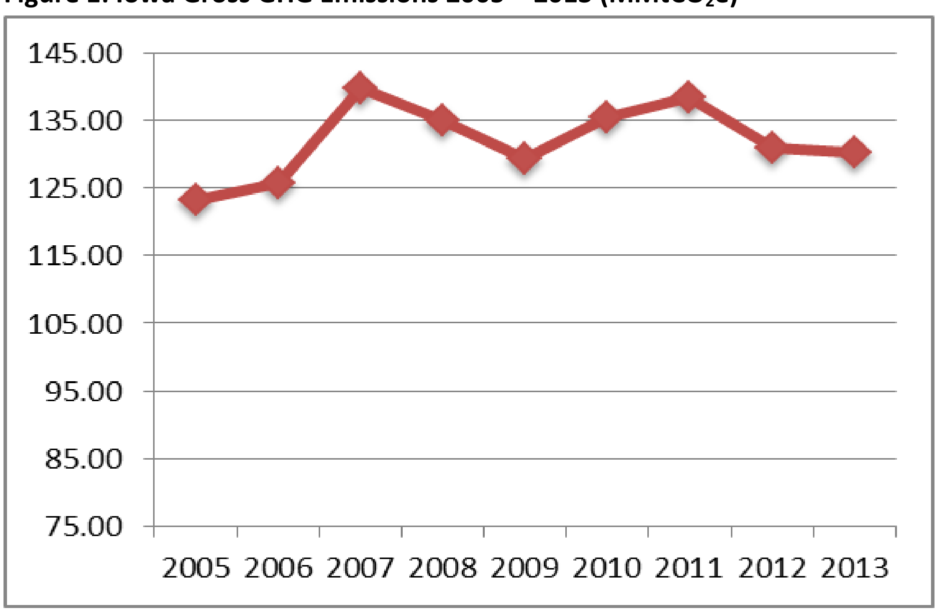
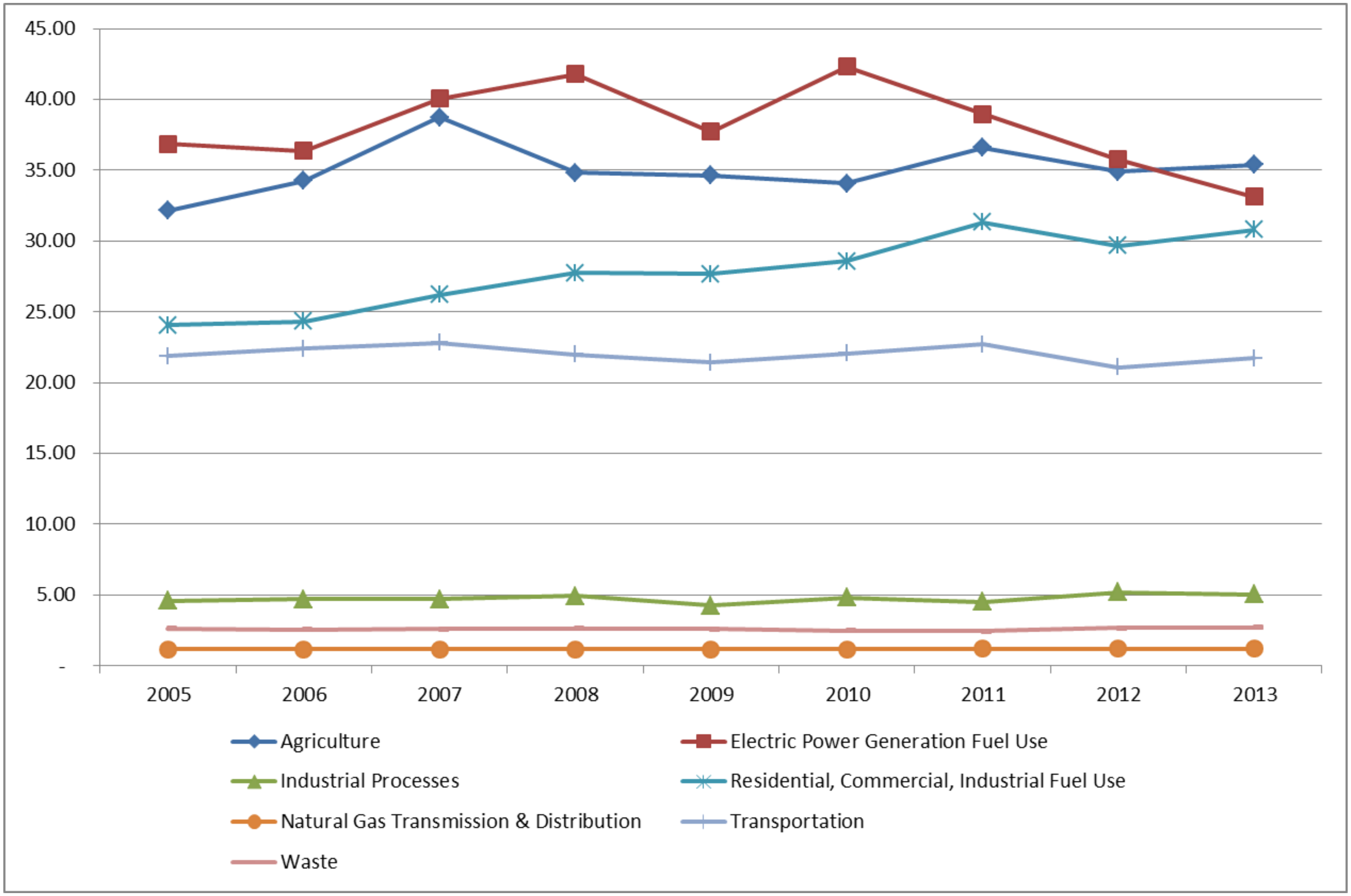


Figure 2: Iowa Gross* GHG Emissions 2005 – 2013 by Sector ($MMtCO_2e$)



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

Table 1: GHG Emissions 2005 – 2013 by Sector (MMtCO$_2$e) [1]

Emissions (MMtCO$_2$e)	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Change from 2012**		
Agriculture	32.14	34.25	38.73	34.81	34.63	34.07	36.61	**34.90**	35.38	+0.47	+1.34%	↑
Electric Power Generation Fuel Use	36.84	36.35	40.04	41.78	37.71	42.33	38.98	35.76	33.12	-2.64	-7.37%	↓
Residential, Commercial, and Industrial Fuel Use	24.07	24.32	26.21	27.75	27.66	28.56	31.31	**29.65**	30.78	+1.14	+3.83%	↑
Industrial Processes	**4.58**	**4.71**	**4.70**	**4.93**	**4.23**	**4.80**	**4.49**	**5.18**	5.05	-0.13	-2.56%	↓
Land Use, Land Use Change, and Forestry (LULUCF)	-20.54	-5.79	3.41	-3.91	-5.00	-2.00	0.66	**0.48**	0.28	-0.20	-40.71%[2]	↓
Natural Gas Transmission and Distribution	1.15	1.15	1.16	1.17	1.17	1.17	1.18	1.18	1.18	0.00	-0.14%	↓
Transportation	21.88	22.38	22.81	21.97	21.42	22.07	22.68	**21.07**	21.71	+0.64	+3.03%	↑
Waste	2.62	2.56	2.60	2.62	2.58	2.49	2.43	2.65	2.69	+0.04	+1.67%	↑
Total Gross Emissions[3],[4]	**123.27**	**125.73**	**139.67**	**135.04**	**129.42**	**135.49**	**138.34**	**130.87**	130.20	-0.67	-0.51%	↓
Sinks from LULUCF	-20.54	-5.79	0	-3.91	-5.00	-2.00	0	0	0			
Total Net Emissions	**102.73**	**119.93**	**139.67**	**131.13**	**124.42**	**133.49**	**138.34**	**130.87**	130.20			

[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 2012 inventory published by the DNR in December 2013. The adjustments are described in detail in the Technical Support Document. Negative numbers indicate carbon sequestration.

[2] The decrease of 0.20 MMtCO$_2$e (40.71%) is primarily due to a 0.18 MMtCO$_2$e decrease in emissions from liming of agricultural soils.

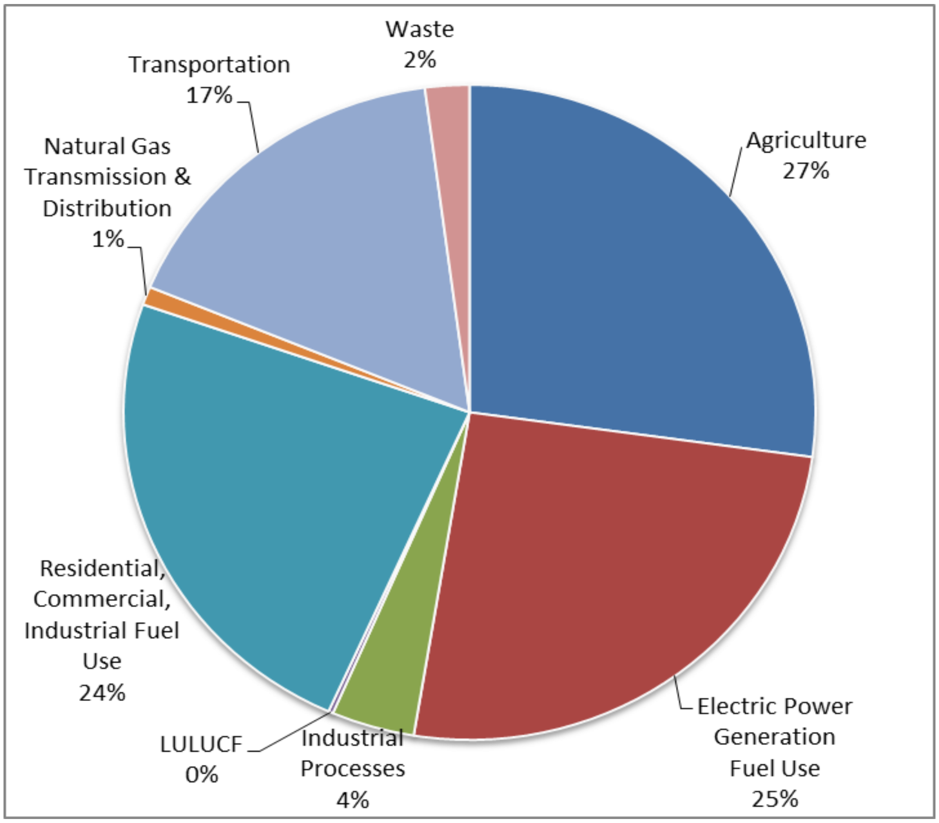
[3] Gross emissions do not include carbon sinks from land use, land use change, and forestry.

[4] Totals may not equal the sum of subtotals shown in this table and other tables in the report due to independent rounding.

GHG Emissions By Sector

The majority of GHG emissions in Iowa in 2013 were from the agriculture sector and from fossil fuel use by the electric power and residential/commercial/ industrial (RCI) sectors. Together the emissions from electric power and RCI fuel use account for nearly half (49.08%) of the state's GHG emissions as shown in Figure 3.

Figure 3: 2013 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.

2013 agriculture emissions increased 1.36% from the previous year as shown in Table 2 on the next page, primarily due to increases in the beef cattle and swine populations (enteric fermentation and manure management) and crop production (agricultural soil management).

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

Category	2012	2013	% Change
Enteric Fermentation	6.95	6.98	+0.36%
Manure Management	8.40	8.59	+2.30%
Agricultural Soil Management	19.56	19.82	+1.31%
Burning of Agricultural Crop Waste	0.00	0.00	-
Total	**34.90**	**35.38**	**+1.36%**

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 (49.08% in 2013) of Iowa's GHG emissions. Although emissions increased in all three RCI subcategories – residential, commercial, and industrial – total GHG emissions RCI and electric power generation decreased 2.29% from 2012-2013 as shown in Table 3.

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

Category	2012	2013	% Change
Residential, Commercial, Industrial Fuel Use	29.65	30.78	+3.83%
Residential	*4.00*	*4.60*	*+15.07%*
Commercial	*4.16*	*4.56*	*+9.64%*
Industrial	*21.49*	*21.62*	*+0.62%*
Electric Power Generation (i.e. Power Plants)	35.76	33.12	-7.37%
Total	**65.40**	**63.90**	**-2.29%**

Residential, Commercial, Industrial (RCI Fuel Use)

Actual fuel use data for 2013 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 2014 with Projections to 2040.* Emissions predicted for 2012 from the RCI sector in last year's inventory (30.23 $MMtCO_2e$) were replaced with actual 2012 consumption values now available from EIA. The resulting recalculated 2012 emissions were 29.65 $MMtCO_2e$.

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).

2013 emissions decreased 7.37% from the previous year, and are now 10.10% below 2005 levels. This is because less electricity was produced and less fossil fuel was used to generate the electricity produced: the total net generation of electricity in Iowa decreased 2.9% from August 2012 – August 2013.[5] In addition, 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 next page.

[5] Iowa is a net-exporter of electricity; not all electricity generated in the state is consumed in Iowa.

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

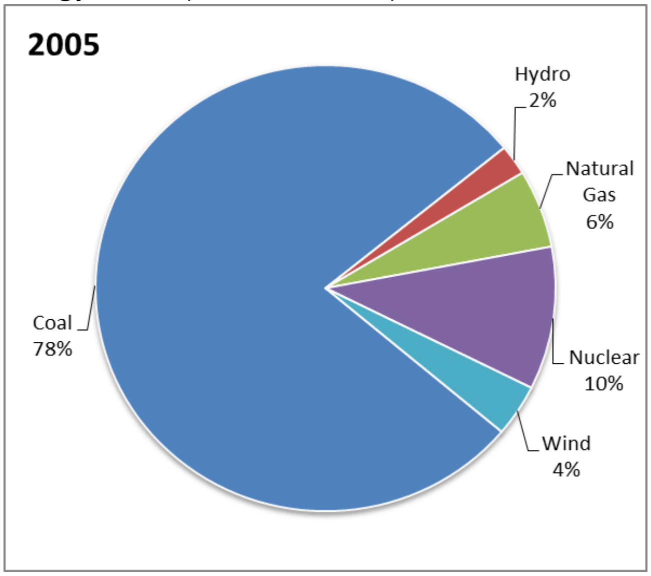
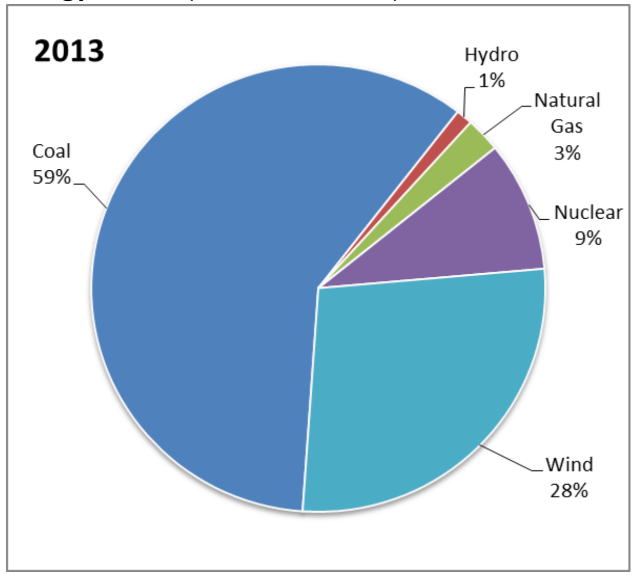


Figure 5: 2013 Net Iowa Electricity Generation by Energy Source (Data Source: EIA)



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 2.56% from 2012 - 2013 as shown in Table 4. This decrease is primarily from decreases in emissions from the production of nitric acid and the production of iron and steel.

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 productions. Emissions from the other categories were calculated using EPA's SIT.

Table 4: GHG Emissions from Industrial Processes (MMtCO$_2$e)

Category	2012	2013	% Change
Ammonia & Urea Production	0.85	0.86	+1.56%
Cement Manufacture	1.27	1.34	+6.03%
Electric Power Transmission and Distribution Systems	0.06	0.06	NA[6]
Iron and Steel Production	0.23	0.19	-19.03%
Lime Manufacture	0.18	0.16	-8.29%
Limestone and Dolomite Use	0.15	0.15	NA[3]
Nitric Acid Production	0.99	0.83	-16.22%
Ozone Depleting Substance Substitutes	1.44	1.44	-0.18%
Soda Ash Consumption	0.02	0.02	-1.36%
Total	**5.18**	**5.05**	**-2.56%**

[6] Due to a lack of current data, the DNR assumed 2013 emissions = 2012 emissions.

2005 – 2012 emissions from limestone and dolomite use and ozone depleting substance substitutes were recalculated using better data and emission factors from EPA. Emissions from electric power transmission and distribution from 2008 – 2012 were also recalculated. These improvements are discussed in detail in the Technical Support Document.

Natural Gas Transmission and Distribution (T & D)

This sector includes emissions from natural gas transmission and distribution systems in the state. 2013 GHG emissions decreased 0.14% from 2012 as shown in Table 5, due to decreases in miles of distribution pipeline and number of steel services (e.g. gas meters).

Table 5: GHG Emissions from Natural Gas Transmission and Distribution ($MMtCO_2e$)[7]

Category	2012	2013	% Change
Transmission	0.6604	0.6606	+0.04%
Distribution	0.5173	0.5154	-0.37%
Total	**1.1777**	**1.1760**	**-0.14%**

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 2013 fuel use data for highway vehicles was not available from the U.S. Energy Information Administration (EIA), so CO_2 emissions from transportation were calculated based on fuel forecasts from the EIA. Total GHG emissions from transportation were estimated to increase 3.03% from 2012 as shown in Table 6.

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

Category	2012	2013	% Change
Transportation	21.07	21.71	+3.03%

Waste

The waste sector includes GHG emissions from both municipal solid waste landfills and the treatment of municipal and industrial wastewater. Overall, GHG emissions from waste increased 1.67% from 2012 as shown in Table 7.
Solid waste emissions were calculated based on data submitted directly to the DNR by landfills and other facilities in Iowa. Emissions from municipal solid waste increased 2.03% for two reasons. First, the cumulative amount of waste in landfills increases every year, but the calculation method assumes that the waste composition if each landfill is the same. Second, more methane was emitted because less landfill gas was flared off than in the previous year. Emissions from wastewater decreased 0.03% due to a decrease in the amount of wastewater produced by industrial meat processing facilities.

Table 7: GHG Emissions from Waste ($MMtCO_2e$)[8]

Category	2012	2013	% Change
Municipal Solid Waste	2.1837	2.2281	+2.03%
Wastewater	0.4650	0.4649	-0.03%
Total	**2.6487**	**2.6930**	**+1.67%**

[7, 8] 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.

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 2012 was recalculated using more current Iowa-specific data. This recalculation is discussed in detail in the Technical Support Document.

Overall, total 2013 emissions from LULUCF were 0.28 MMtCO_2e, a decrease of 40.71% from 2012 - 2013 as shown in Table 8 below. This decrease in emissions can be attributed to decreases in liming of agricultural soils and fertilization of settlement soils. Carbon sequestration from forest carbon flux and urban trees was assumed be unchanged from 2012, 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	2012	2013	% Change
Forest Carbon Flux	-0.47[9]	-0.47	NA[10]
Liming of Agricultural Soils	0.65	0.47	-27.12
Urea Fertilization	0.13	0.13	NA[5]
Urban Trees	-0.28	-0.28	NA[5]
Yard Trimmings and Food Scraps Stored in Landfills	-0.12	-0.12	-4.21%
Fertilization of Settlement Soils	0.57	0.55	-3.85%
Total	**0.48**	**0.28**	**-40.31%**

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 2013 by both pollutant and by category.

Carbon dioxide (CO_2) is the greenhouse gas emitted in the highest amounts in Iowa, accounting for 67% 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 – 18.37 MMtCO_2e of CH_4 and 22.87 MMtCO_2e of N_2O. The majority of these two pollutants are from agriculture as shown in Figures 7 and 9.

[9] Negative numbers indicate carbon sequestration.

[10] Due to a lack of current data, the DNR assumed 2013 emissions = 2012 emissions.

Figure 6: 2013 Gross GHG Emissions by Pollutant

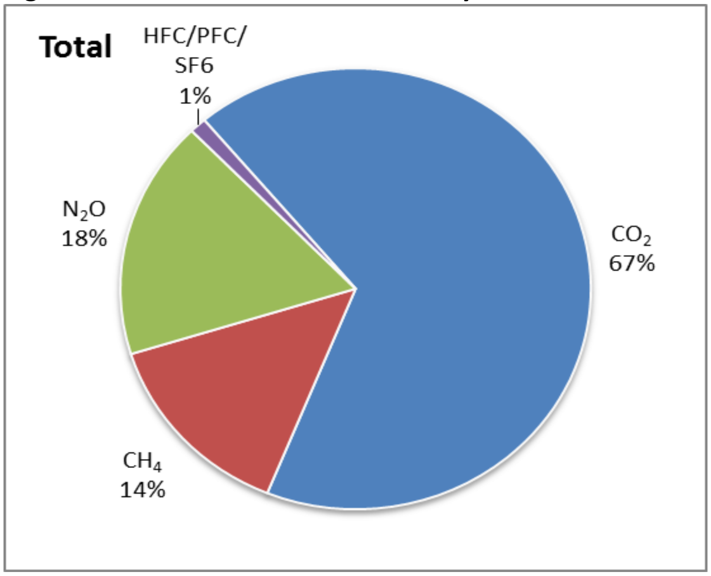


Figure 7: 2013 Methane Emissions by Category

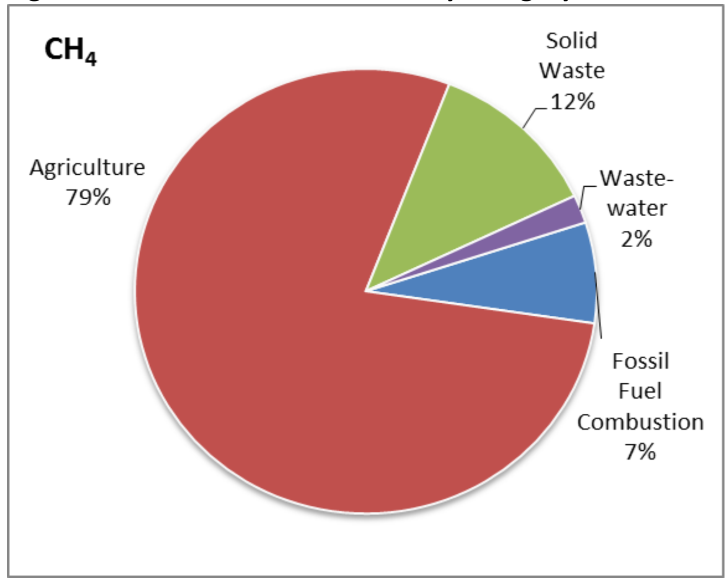


Figure 8: 2013 Gross CO_2 Emissions by Category

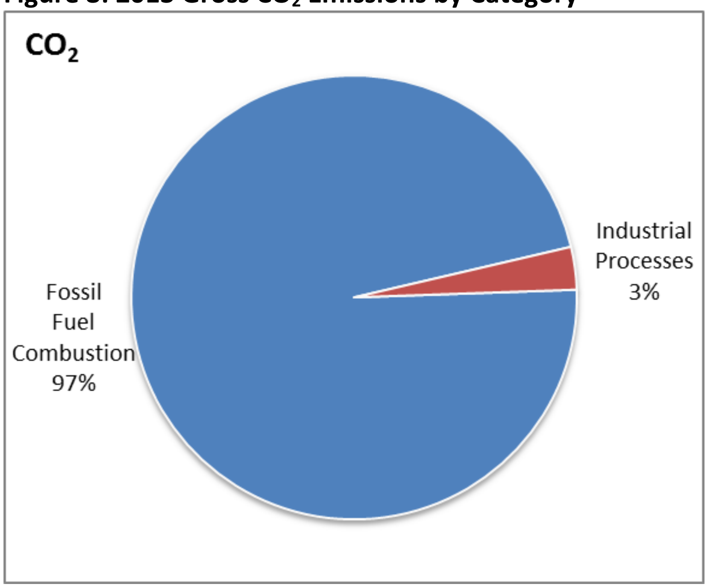
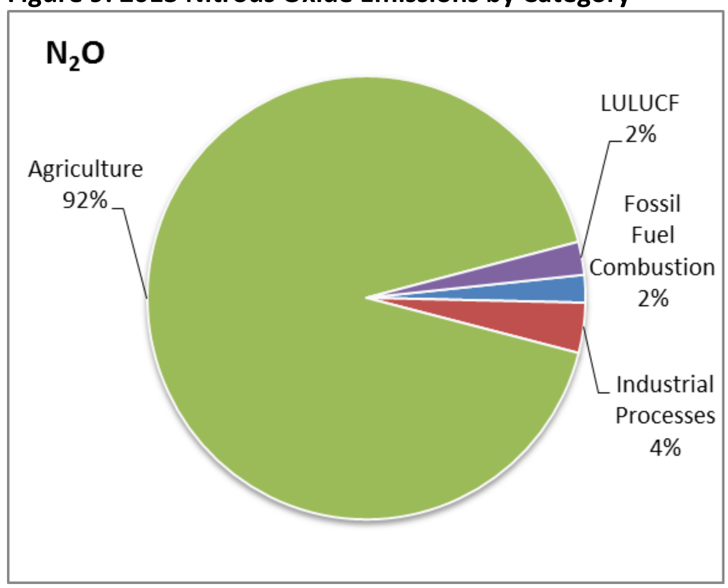


Figure 9: 2013 Nitrous Oxide Emissions by Category



<u>Comparison with U.S. Emissions</u>

Figures 10 and 11 on the next page 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 2012 are used for this comparison as the 2013 national GHG inventory has not yet been published. Overall, Iowa emits 2.01% of U.S. GHG emissions.

Figure 10: 2011 Iowa GHG Emissions by Sector

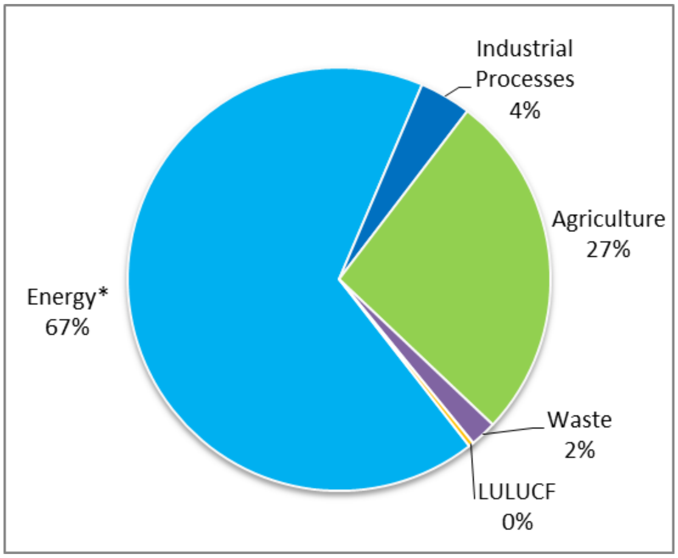
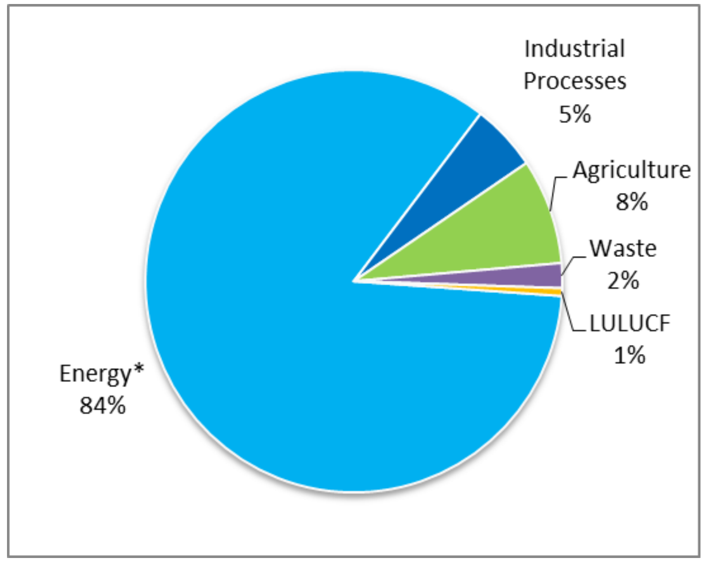


Figure 11: 2011 U.S. GHG Emissions by Sector



Future Emissions

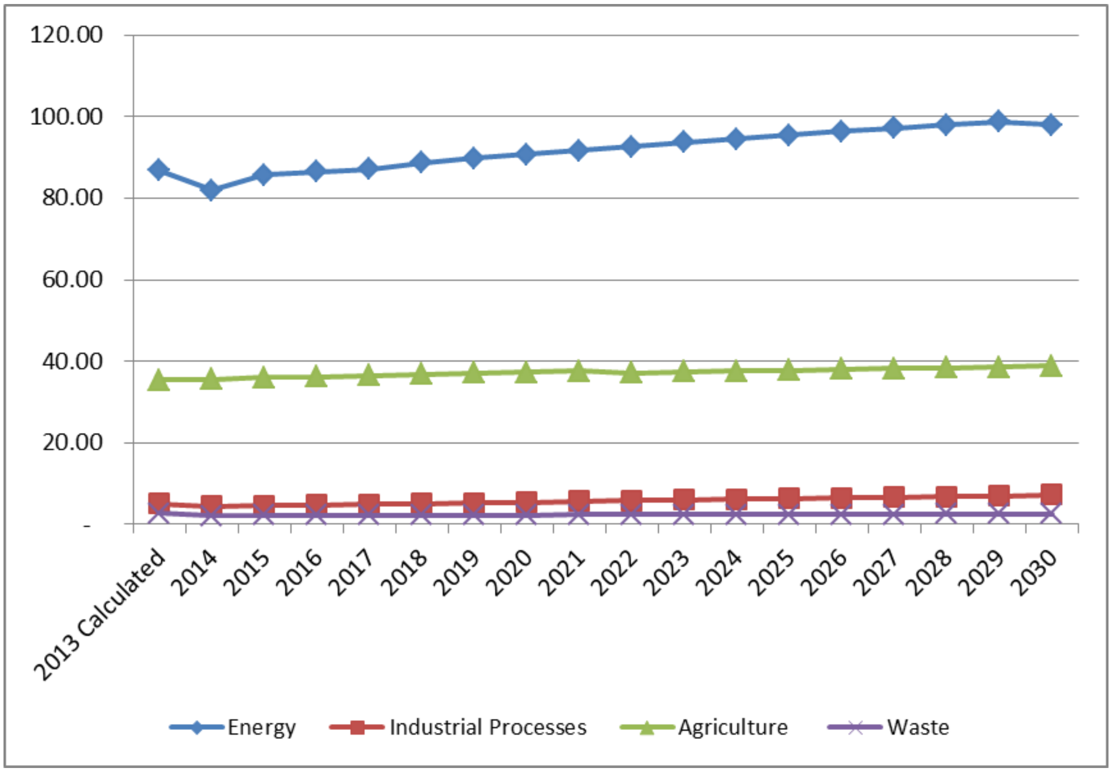
Iowa Code 455B.104 requires that the DNR forecast trends in GHG emissions. The DNR projected emissions from to 2030 using the SIT Projection Tool. As with many forecasts, there are numerous factors that affect the significant level of uncertainty with future emissions. These factors may include among 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 2014 – 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.

The energy forecast is based on projected energy consumption values from the EIA's *Annual Energy Outlook 2014 with Projections to 2040.* The AEO2014 includes thirty different projection cases, which each address different uncertainties. The DNR used the AEO2014 "Reference Case", which assumes that the laws and regulations in effect as of the end of October 2013 remain unchanged throughout the projections. It does not include future reductions resulting from EPA's proposed Clean Power Plan. The projections in the Reference Case are done at the regional level, and Iowa is in the West North Central U.S. Census Region. The AEO2014 includes six key findings:

- "Growing domestic production of natural gas and oil continues to reshape the U.S. energy economy, largely as a result of rising production from tight formations, but the effect could vary substantially depending on expectations about resources and technology.
- Industrial production expands over the next 10 to 15 years as the competitive advantage of low natural gas prices provides a boost to the industrial sector with increasing natural gas use.
- There is greater upside uncertainty than downside uncertainty in oil and natural gas production; higher production could spur even more industrial growth and lower the use of imported petroleum.
- Improvement in light-duty vehicle (LDV) efficiency more than offsets modest growth in vehicle miles traveled (VMT) that reflects changing driving patterns, leading to a sharp decline in LDV energy use.

- Evolving natural gas markets spur increased use of natural gas for electricity generation and transportation, as well as expanded export opportunities.
- Improved efficiency of energy use in the residential and transportation sectors and a shift away from more carbon-intensive fuels such as coal for electricity generation help to stabilize U.S. energy-related carbon dioxide (CO2) emissions. "[11]

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



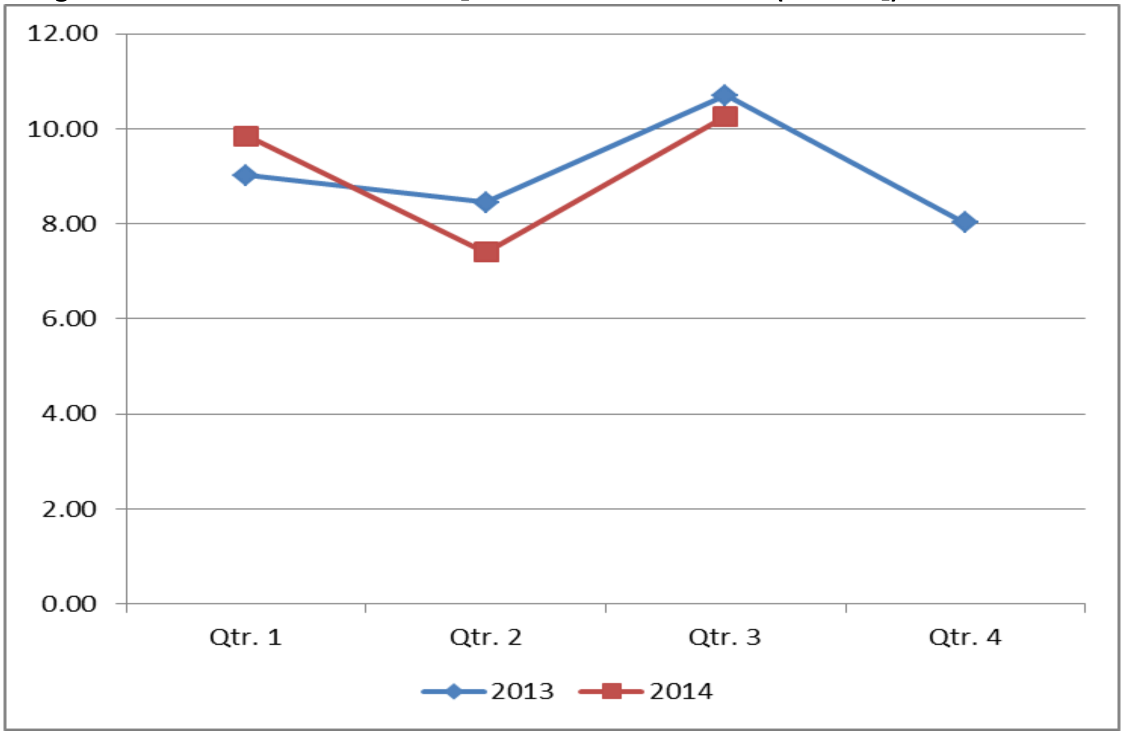
Short-term Projections for the Electric Power Sector

CO_2 emissions from the electric power sector are likely to decrease slightly in 2014 based on CO_2 data submitted by electric generating stations to EPA's Clean Air Markets Division (CAMD) for the first three quarters of 2014.[12] However, if temperatures are unusually cold during October – December this year, demand for electricity could increase, resulting in an increase in emissions. So far this year, total CO_2 emissions are 2.36% lower than during the first three quarters of 2013 as shown in Figure 13 on the next page. Total coal usage in the first three quarters of 2014 was 2.03% lower than the previous year, and total natural gas usage in the first three quarters was 21.10% lower than in same time period in 2013.

[11] U.S. Energy Information Administration - *Annual Energy Outlook 2014 with Projections to 2040*. Available online at <http://www.eia.gov/forecasts/aeo/>.

[12] Emissions data for the fourth quarter of 2014 will not be available until January 30, 2015.

Figure 13: Electric Power Sector CO_2 Emissions 2013 vs. 2014 ($MMtCO_2$)



Uncertainty

Because the Projection Tool's energy projections are done at the regional level, the emissions predicted for future years have a significant level of uncertainty. Iowa is currently a net exporter of electricity, which may cause Iowa energy emissions to be higher than projected for the West Central region overall. In addition, the projections do not include any reductions resulting from future regulations such as EPA's planned carbon reduction standards for power plants. A high level of uncertainty also exists in the agriculture sector, as emissions from agricultural soils are highly dependent on the weather.

Future Improvements

The DNR continually strives to make the annual statewide GHG inventory as accurate and timely as possible. Accuracy may be improved by incorporating as much Continuous Emission Monitor (CEM) data and facility-level GHG data from the federal GHG reporting program as possible. Iowa is one of the only states to blend SIT-calculated data, CEM data, and facility-level data into one comprehensive GHG inventory.

Other areas for enhancement include improved forecasting and further development of soil carbon flux emissions or sinks. The calculations for carbon sequestered in urban forests may also be improved as the DNR recently obtained land cover/remote sensing data for urban forests that has approximately a one meter resolution and could be used in future inventories. Furthermore, the DNR plans to investigate whether emissions from the application of synthetic fertilizer are double-counted in the agriculture and LULUCF sectors.