IOWA DEPARTMENT OF NATURAL RESOURCES

2012 Iowa Statewide Greenhouse Gas Emissions Inventory Report

Required by Iowa Code 455B.104
December 19, 2013

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 2012 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), hydrofluorocarbons (HFC), and sulfur hexafluoride (SF_6).

Emissions were calculated using the State Inventory Tool (SIT), the standard GHG inventory method developed for states by the United States Environmental Protection Agency (EPA). A majority of states have recently completed GHG inventories utilizing the SIT methodology. This inventory also uses GHG emissions from industrial facilities and electricity generating facilities that report emissions to EPA as required by the federal GHG Reporting Program (40 CFR 98).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 reports like this 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.

2012 Statewide GHG Emissions

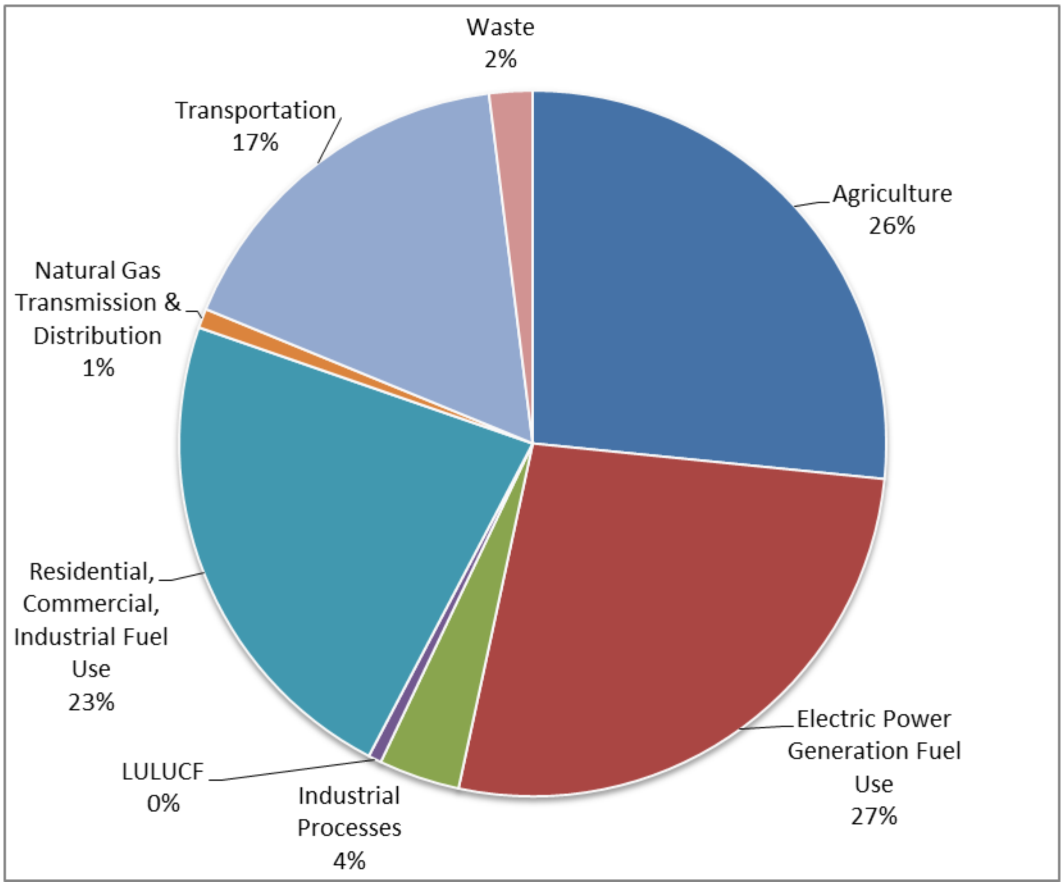
In 2012, total Iowa greenhouse gas emissions were 133.56 million metric tons carbon dioxide equivalents ($MMtCO_2e$) as shown in Table 1 on the next page. This is a decrease of 4.52 $MMtCO_2e$ or 3.27% from the previous year. The decrease resulted from less total fossil fuels being combusted in Iowa, a decrease in cattle production, and decreases in agriculture crop production. The reduction in crop production is correlated to drought conditions in 2012.

As shown in Figure 1 on the next page, the majority of GHG emissions in Iowa 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 (49.41%) of the state's GHG emissions.

Table 1: Iowa GHG Emissions[1]

Emissions ($MMtCO_2e$)	2011[2]	2012	Difference	% Change	
Agriculture	36.61	35.53	-1.07	-2.93%	↓
Electric Power Generation Fuel Use	38.98	35.76	-3.22	-8.27%	↓
Residential, Commercial, and Industrial (RCI) Fuel Use	31.31	30.23	-1.08	-3.45%	↓
Industrial Processes	4.23	4.96	+0.72	+17.13%	↑
Natural Gas and Oil Transmission and Distribution	1.18	1.18	+0.00	+0.19%	↑
Land Use, Land Use Change, and Forestry (LULUCF)	0.66	0.80	+0.14	+21.73%	↑
Transportation	22.68	22.45	-0.23	-1.03%	↓
Waste	2.43	2.65	+0.22	+9.08%	↑
Total Emissions	**138.08**	**133.56**	**-4.52**	**-3.27%**	↓

Figure 1: 2012 Iowa GHG Emissions ($MMtCO_2e$)



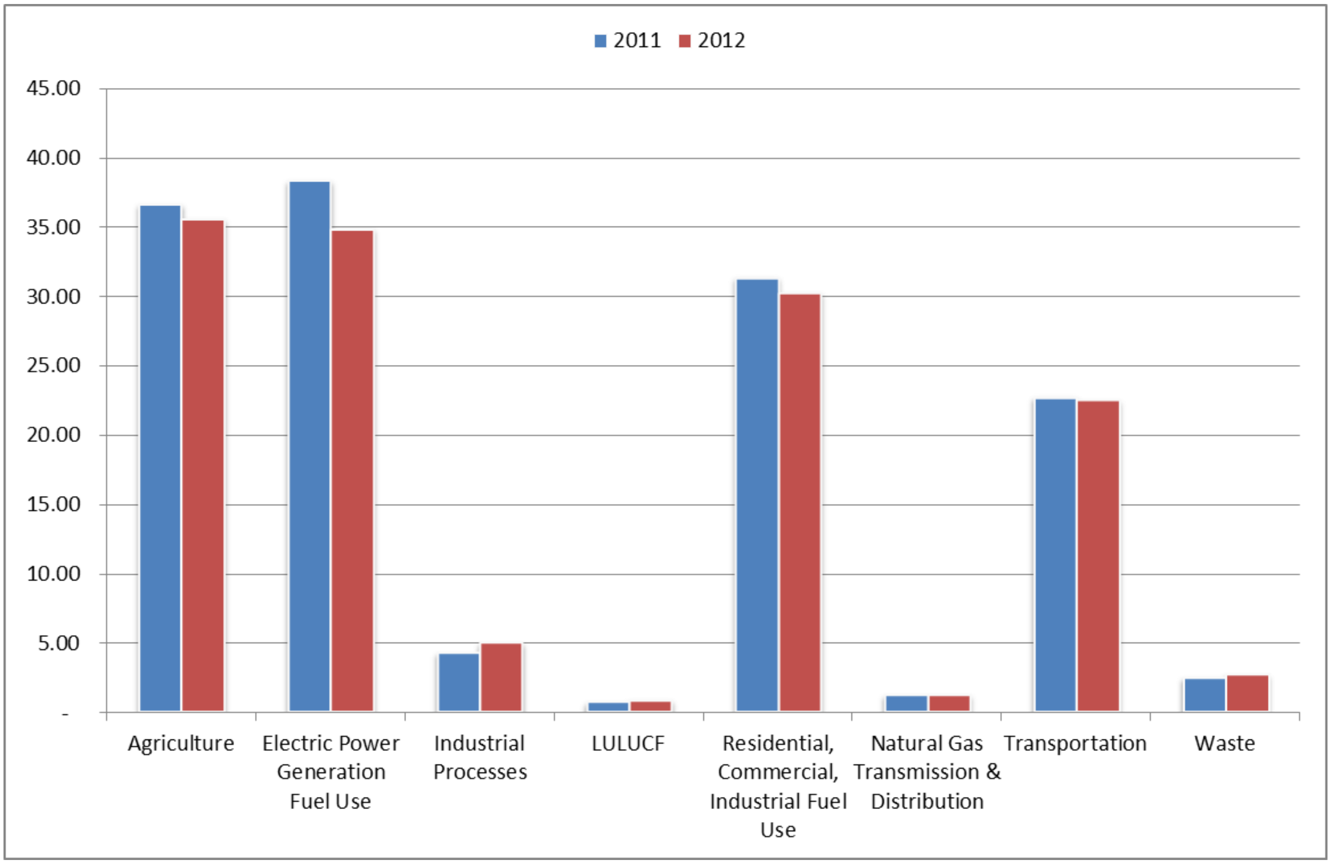
[1] Please also note that the totals in data tables may not equal the exact sum of subtotals within the table due to independent rounding.

[2] The 2011 value is as revised by the Department. The 2011 GHG emissions presented in this inventory are higher (+2.76 $MMtCO_2e$) than the emissions in the previous 2011 inventory published by the Department in December 2012. The difference can be attributed to improved activity data in the agriculture, fossil fuel combustion, industrial processes, and LULUCF sectors. This is further discussed in the Technical Support Document available at http://www.iowadnr.gov/InsideDNR/RegulatoryAir/GreenhouseGasEmissions/GHGInventories.aspx.

GHG Emissions By Sector

Changes in GHG emissions from 2011 – 2012 varied by sector as shown in Figure 2 below. GHG emissions increased in the industrial processes, LULUCF, natural gas transmission and distribution, and waste sectors. Emissions in the agriculture, electric power generation fuel use, RCI fuel use, and transportation sectors decreased.

Figure 2: 2012 Iowa Gross GHG Emissions ($MMtCO_2e$) 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

2012 agriculture emissions decreased 2.93% from the previous year as shown in Table 2 on the next page, primarily due to decreases in the cattle population (enteric fermentation) and crop production (agricultural soil management). Drought conditions across the state in 2012 are the primary cause for the reduced crop production.

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.

Table 2: GHG Emissions from Agriculture (MMtCO$_2$e)

Category	2011	2012	% Change
Enteric Fermentation	7.04	6.95	-1.39%
Manure Management	8.34	8.54	+2.47%
Agricultural Soil Management	21.22	20.04	-5.56%
Burning of Agricultural Crop Waste	0.008	0.007	-15.80%
Total	**36.61**	**35.53**	**-2.93%**

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 (49.41% in 2012) of Iowa's GHG emissions. In total, GHG emissions from these four categories decreased 6.12% from 2011-2012 as shown in Table 3.

Actual fuel use data for 2012 for the RCI sector was not available from the U.S. Energy Information Administration (EIA), so emissions were calculated based on forecasts from the EIA. For the electric power category, the Department 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). While these facilities, in total, produced 0.97% more electricity in 2012, emissions from this category decreased by 8.27% from 2011 – 2012 as they generated less electricity from fossil fuels. Of the electricity generated from fossil fuels, generation from coal decreased 6.97% while generation from natural gas increased 99.01% and generation from wind increased 30.21% as shown in Figure 3 on the next page. In 2012, 63% of electricity produced was generated from coal as shown in Figure 4. Iowa is a net exporter of electricity; not all electricity produced in Iowa is consumed in Iowa.

Table 3: GHG Emissions from Fossil Fuel Combustion (MMtCO$_2$e)

Category	2011	2012	% Change
Electric Power Generation	38.98	35.76	-8.27%
Residential, Commercial, Industrial Fuel Use	31.31	30.23	-3.45%
Residential	*4.89*	*4.46*	*-8.76%*
Commercial	*4.60*	*4.36*	*-5.21%*
Industrial	*21.82*	*21.41*	*-1.89%*
Total	**70.29**	**65.99**	**-6.12%**

Figure 3: Iowa Electricity Generation by Fuel (Megawatt hours produced)

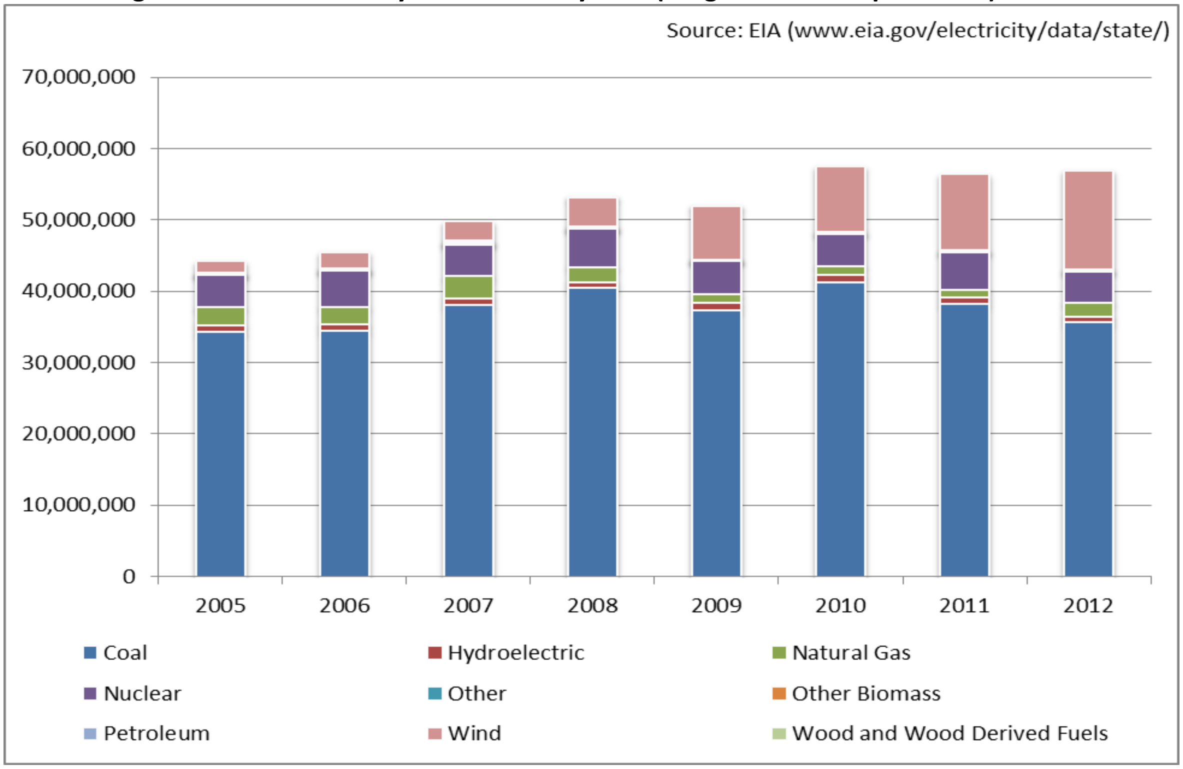
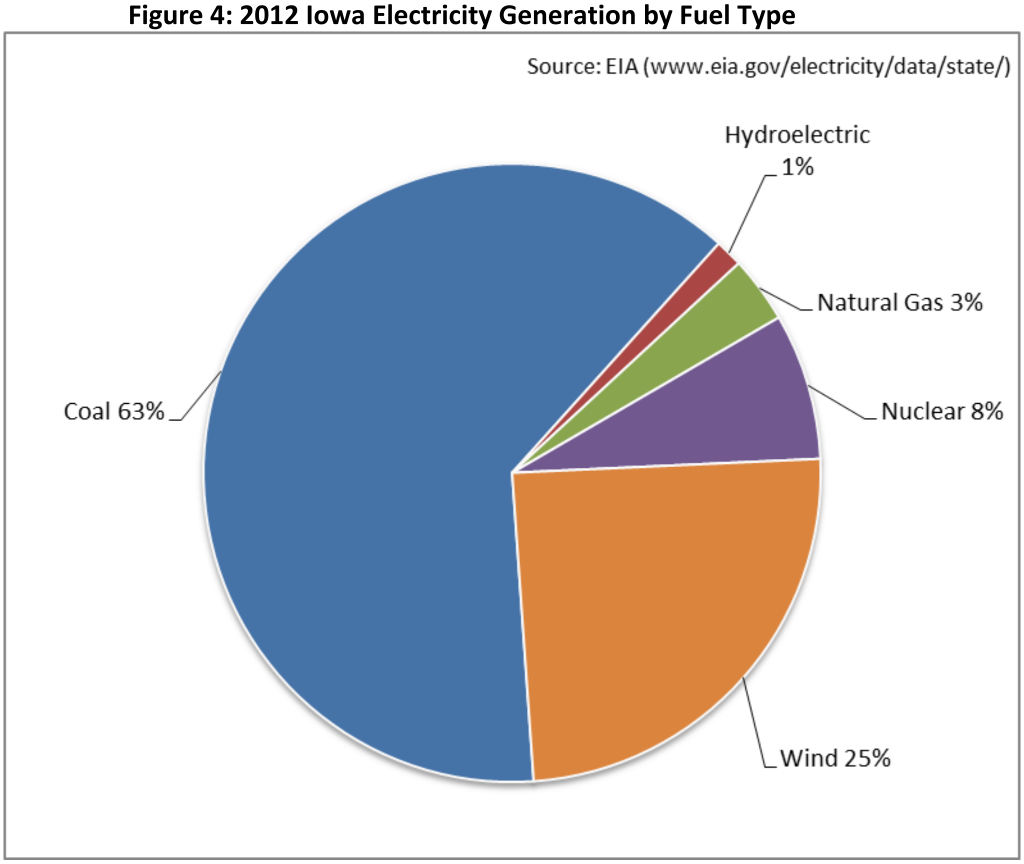


Figure 4: 2012 Iowa Electricity Generation by Fuel Type



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 increased 17.13% from 2011 - 2012 as shown in Table 4. This increase is primarily from an increase in emissions from cement manufacture.

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	2011	2012	% Change
Ammonia & Urea Production	0.75	0.85	+12.60%
Cement Manufacture	0.79	1.27	+60.41%
Electric Power Transmission and Distribution Systems	0.08	0.08	NA[3]
Iron and Steel Production	0.20	0.23	+16.36%
Lime Manufacture	0.18	0.18	-0.17%
Limestone and Dolomite Use	0.16	0.16	NA[3]
Nitric Acid Production	0.94	0.99	+5.97%
Ozone Depleting Substance Substitutes	1.13	1.19	+5.82%
Soda Ash Consumption	0.02	0.02	-3.26%
Total	**4.23**	**4.96**	**+17.13%**

Natural Gas Transmission and Distribution (T & D)

This sector includes emissions from natural gas transmission and distribution systems in the state. 2012 GHG emissions increased 0.19% from 2011 as shown in Table 5, due to increases in miles of distribution pipeline and number of services (e.g. gas meters).

Table 5: GHG Emissions from Natural Gas Transmission and Distribution (MMtCO$_2$e)

Category	2011	2012	% Change
Transmission	0.66	0.66	+0.04%
Distribution	0.52	0.52	+0.43%
Total	**1.18**	**1.18**	**+0.19%**

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

[3] Due to a lack of current data, the Department assumed 2012 emissions = 2011 emissions.

vehicles. Actual 2012 fuel use data for non-road 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 decrease 1.03% from 2011 as shown in Table 6.

Table 6: GHG Emissions from Transportation (MMtCO$_2$e)

Category	2011	2012	% Change
Transportation	22.68	22.45	-1.03%

Waste

The waste sector includes GHG emissions from both municipal solid waste landfills and the treatment of municipal and industrial waste water. Overall, GHG emissions from waste increased 9.08% from 2011 as shown in Table 7.

Solid waste emissions were calculated based on data submitted directly to the Department by landfills and other facilities in Iowa. Emissions from municipal solid waste increased 11.08% because less landfill gas was flared or combusted in landfill gas-to-energy projects in 2012.

Table 7: GHG Emissions from Waste (MMtCO$_2$e)

Category	2011	2012	% Change
Municipal Solid Waste	1.97	2.18	+11.08%
Wastewater	0.47	0.47	+0.59%
Total	**2.43**	**2.65**	**+9.08%**

Emissions from wastewater increased 0.59% due to increases in Iowa's population and the amount of wastewater produced by industrial facilities.

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 sequestered in yard waste and food scraps that are sent to the landfill. Carbon sequestration from forests and trees from 2005 – 2011 were recalculated using more current Iowa-specific data. These improvements are discussed in detail in the Technical Support Document.

Overall, total 2012 emissions from LULUCF were 0.80 MMtCO$_2$e, an increase of 21.73% from 2011 - 2012 as shown in Table 8 on the next page. This increase in emissions can be attributed to increases in liming of agricultural soils and fertilization of settlement soils, as well as a decrease in sequestration from yard trimmings and food scraps in landfills. Carbon sequestration from forest carbon flux and urban trees were assumed be unchanged from 2011, 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	2011	2012	% Change
Forest Carbon Flux	-0.14[4]	-0.14	NA[5]
Liming of Agricultural Soils	0.51	0.65	+25.54
Urea Fertilization	0.12	0.12	NA[5]
Urban Trees	0.28	0.28	NA[5]
Yard Trimmings and Food Scraps Stored in Landfills	0.13	0.12	-4.70%
Fertilization of Settlement Soils	0.56	0.57	+1.05%
Total	**0.66**	**0.80**	**+21.73%**

Carbon emissions or sequestration from 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 Department did include this category. More details on the uncertainty in soil carbon flux are included in the Technical Support Document.

GHG Emissions by Pollutant

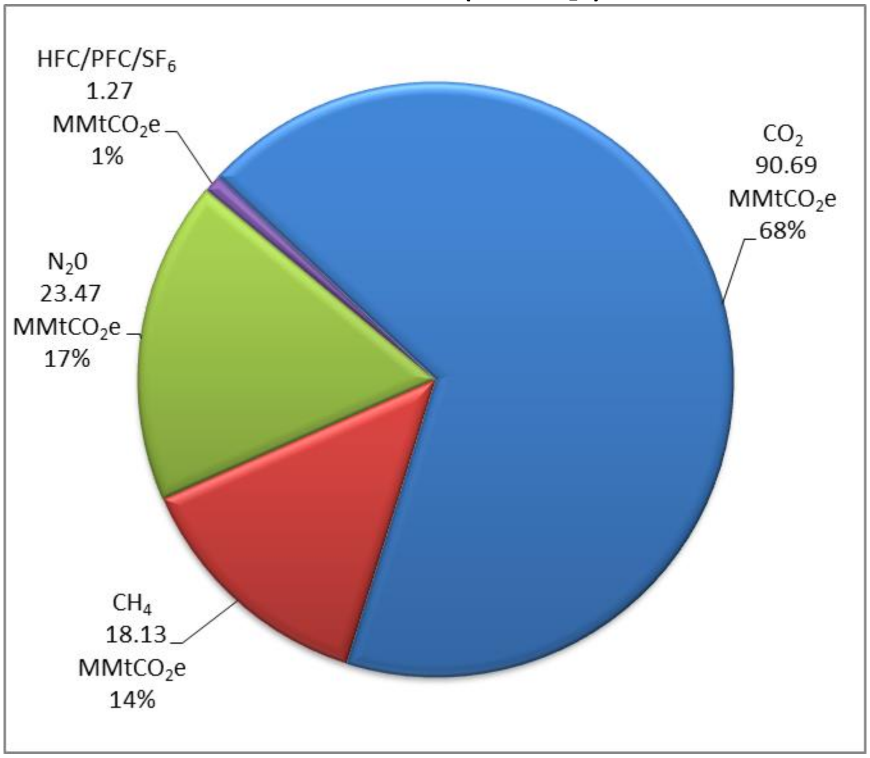
GHGs included in the inventory are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFC), hydrofluorocarbons (HFC), and sulfur hexafluoride (SF_6). Figure 5 on the next page shows the distribution of GHG pollutants in 2012. The majority of CO_2 emissions (96.75%) are from fossil fuel combustion. The majority of all N_2O emissions (85.39%) are from agricultural soils, and the majority of CH_4 emissions (78.42%) are from enteric fermentation and manure management in the agriculture sector.

EPA's Greenhouse Gas Equivalencies Calculator [6] estimates that the reduction of Iowa GHG emissions (4.52 $MMtCO_2e$) in Iowa from 2012 is equivalent to:

- Annual GHG emissions from 941,362 passenger vehicles
- CO_2 emissions from 10.5 million barrels of oil
- CO_2 emissions from the electricity use of 621,703 homes for one year
- CO_2 emissions from the energy use of 225,701 homes for one year
- The carbon sequestered annually by 115.9 million tree seedlings grown for ten years

[4] Negative numbers indicate carbon sequestration.
[5] Due to a lack of current data, the Department assumed 2012 emissions = 2011 emissions.
[6] U.S. EPA Greenhouse Gas Equivalencies Calculator. Available at http://www.epa.gov/cleanenergy/energy-resources/calculator.html.

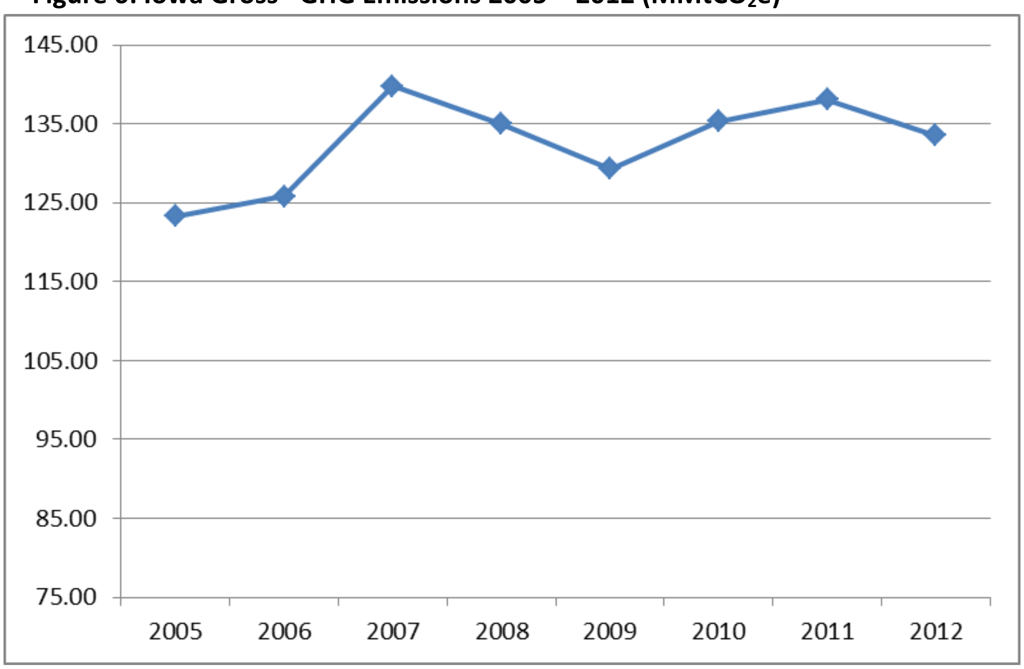
Figure 5: 2012 Iowa Gross GHG Emissions ($MMtCO_2e$)



Emissions Trends

Total 2012 statewide GHG emissions decreased 3.27% from 2011 but were 8.30% above 2005 levels as shown in Figure 6 below and in Table 9 on the next page.

Figure 6: Iowa Gross* GHG Emissions 2005 – 2012 ($MMtCO_2e$)



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

Table 9: GHG Emissions 2005 – 2012 by Sector ($MMtCO_2e$)[7]

Emissions ($MMtCO_2e$)	2005	2006	2007	2008	2009	2010	2011	2012
Agriculture	32.14	34.25	38.73	34.81	34.63	34.07	**36.61**	35.53
Electric Power Generation Fuel Use	36.84	36.35	40.04	41.78	37.71	**42.33**	**38.98**	35.76
Residential, Commercial, and Industrial Fuel Use	24.07	24.32	26.21	27.75	27.66	28.56	31.31	30.23
Industrial Processes	**4.63**	**4.78**	**4.77**	**4.86**	**4.14**	**4.63**	**4.23**	4.96
Land Use, Land Use Change, and Forestry (LULUCF)	**-20.54**	**-5.79**	**3.41**	**-3.91**	**-5.00**	**-2.00**	**0.66**	**0.80**
Natural Gas Transmission and Distribution	1.15	1.15	1.16	**1.17**	1.17	1.17	1.18	1.18
Transportation	21.88	22.38	22.81	21.97	21.42	22.07	**22.68**	22.45
Waste	2.62	2.56	2.60	2.62	2.59	2.49	2.43	2.65
Total Gross Emissions	**123.32**	**125.80**	**139.74**	**134.97**	**129.34**	**135.32**	**138.08**	**133.56**
Sinks from LULUCF	-20.54	-5.79	0	-3.91	-5.00	-2.00	0	0
Total Net Emissions	**102.78**	**120.01**	**139.74**	**131.06**	**124.34**	**133.32**	**138.08**	**133.56**

Comparison with U.S. Emissions

Figure 7 and Figure 8 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 2011 are used for this comparison as the 2012 national GHG inventory has not yet been published. Overall, Iowa emits 1.98% of U.S. GHG emissions.

Figure 7: 2011 Iowa GHG Emissions by Sector

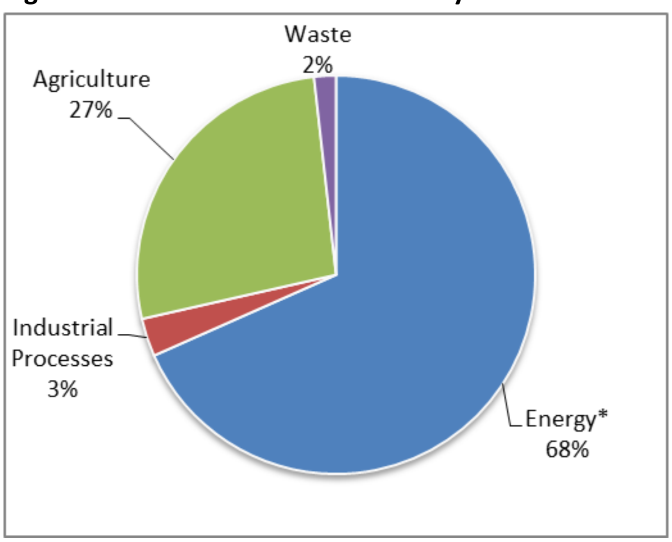
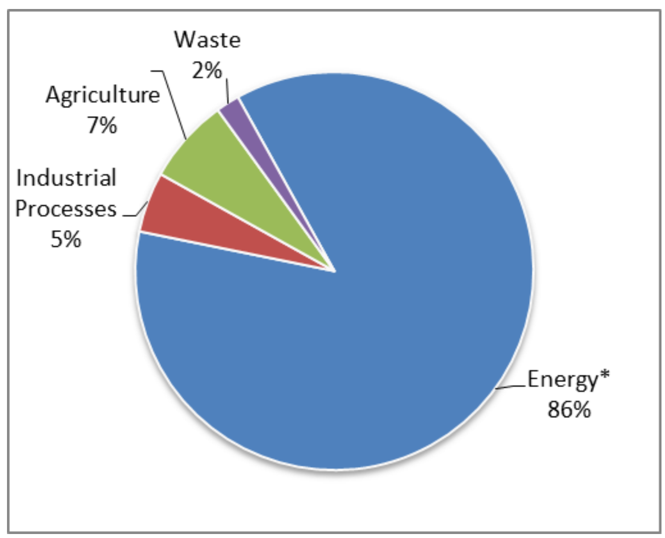


Figure 8: 2011 U.S. GHG Emissions by Sector

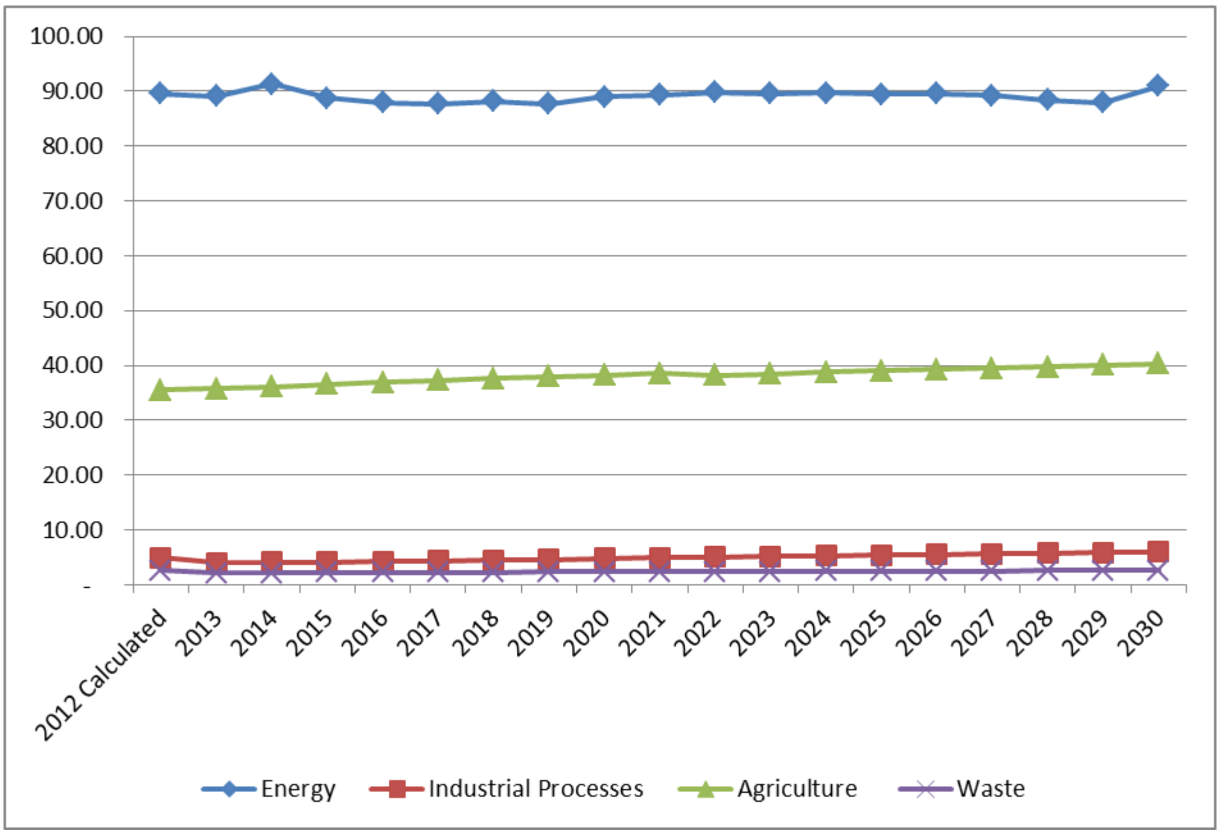


[7] Totals may not equal the exact sum of subtotals in this table due to independent rounding. Values that are bolded have been adjusted since the previous 2011 inventory published by the Department in December 2012. The adjustments are described in detail in the Technical Support Document. Negative numbers indicate carbon sequestration.

Future Emissions

Iowa Code 455B.104 requires that the Department forecast trends in GHG emissions. The Department 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 9 below. 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 9: Projected Gross GHG Emissions 2013 – 2030 ($MMtCO_2e$)



The energy forecast is based on projected energy consumption values from the EIA's *Annual Energy Outlook (2013) with Projections to 2040.* The AEO2013 includes twenty-eight different projection cases, which each address different uncertainties. The Department used the AEO2013 "Reference Case", which assumes that the laws and regulations in effect as of the end of September 2012 remain unchanged throughout the projections. 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 AEO2013 includes five key findings:

1. "Continued strong growth in domestic crude oil production over the next decade–largely as a result of rising production from tight formations–and increased domestic production of natural gas;

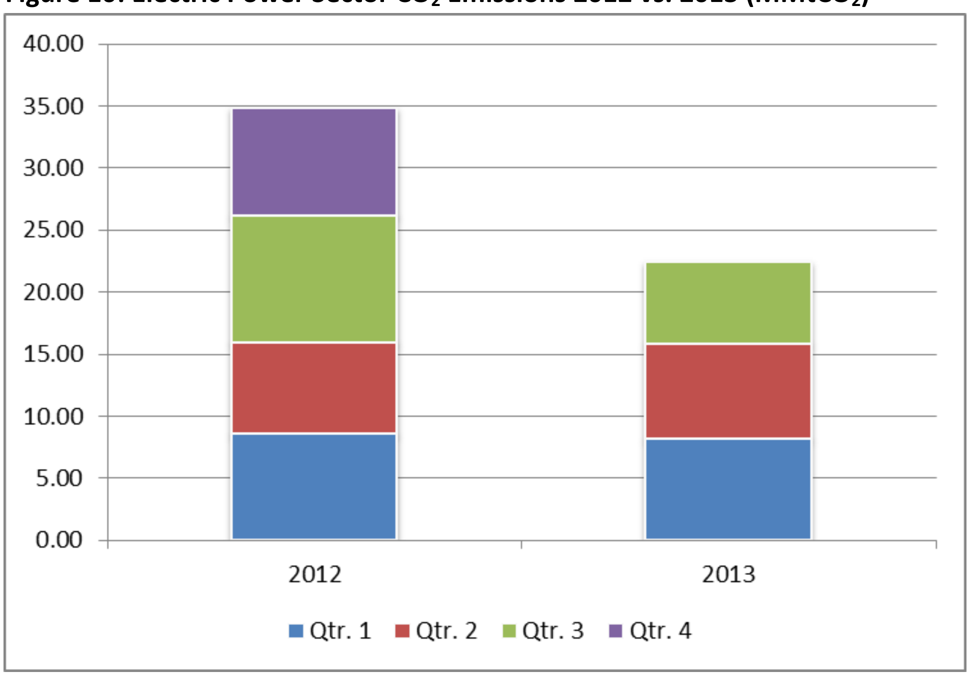
2. The potential for even stronger growth in domestic crude oil production under alternative conditions;
3. Evolving natural gas markets that spur increased use of natural gas for electric power generation and transportation and an expanding natural gas export market;
4. A decline in motor gasoline consumption over the projection period, reflecting the effects of more stringent corporate average fuel economy (CAFÉ) standards, as well as growth in diesel fuel consumption and increased use of natural gas to power heavy-duty vehicles; and
5. Low electricity demand growth, and continued increases in electricity generation capacity fueled by natural gas and renewable energy, which when combined with environmental regulations put pressure on coal use in the electric power sector. In some cases, coal's share of total electricity generation falls below the natural gas share through the end of the projection period."[8]

Short-term Projections for the Electric Power Sector

CO_2 emissions from the electric power sector are likely to decrease in 2013 based on CO_2 data submitted by electric generating stations to EPA's Clean Air Markets Division (CAMD) for the first three quarters of 2013. However, if temperatures are unusually cold during October – December this year, demand for electricity could increase, resulting in an increase in emissions.

CO_2 emissions are 14.25% lower so far this year than during the first three quarters of 2012 as shown in Figure 10 below. Coal usage in the third quarter of 2013 was also 35.68% lower than the previous year, and natural gas usage decreased in 2013 as well.

Figure 10: Electric Power Sector CO_2 Emissions 2012 vs. 2013 ($MMtCO_2$)



[8] U.S. Energy Information Administration - *Annual Energy Outlook 2013 with Projections to 2040*. Available online at <http://www.eia.gov/forecasts/aeo/>.

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 Department 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.