IOWA DEPARTMENT OF NATURAL RESOURCES

2011 Iowa Statewide Greenhouse Gas Emissions Inventory Report

Required by Iowa Code 455B.104
December 27, 2012

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 2011 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 from land use, land use change, and forestry (LULUCF). A majority of states have recently completed GHG inventories utilizing the SIT methodology. 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.

GHG 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). 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 at http://www.iowadnr.gov/InsideDNR/RegulatoryAir/GreenhouseGasEmissions/GHGInventories.aspx. 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).

2011 Statewide GHG Emissions

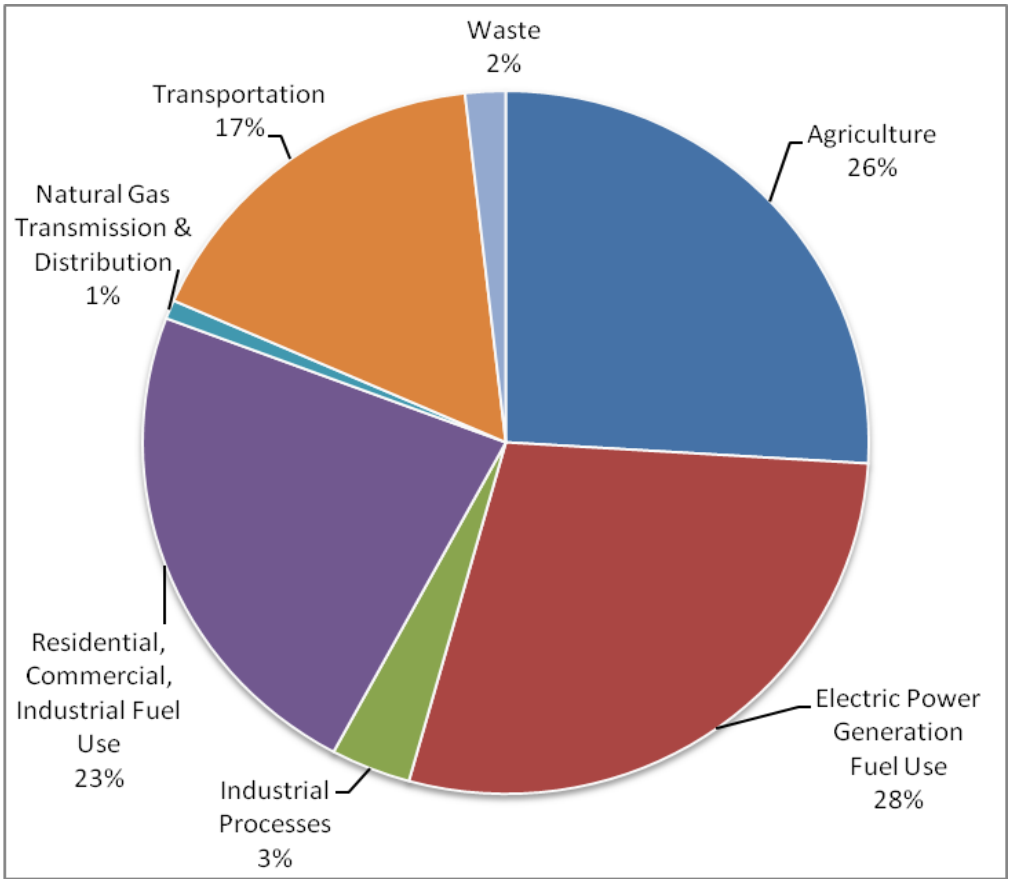
In 2011, total Iowa *gross* greenhouse gas emissions (i.e. excluding carbon sinks) were 135.32 million metric tons carbon dioxide equivalents ($MMtCO_2e$) as shown in Table 1 on the next page. Carbon sinks from land use, land use change, and forestry sequestered equaled 16.91 $MMtCO_2e$, making the total net emissions for Iowa 118.41 $MMtCO_2e$. Unless otherwise noted, the GHG emissions referred to in this report are gross emissions, prior to carbon sequestration.

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 more than half (51.53%) of the state's GHG emissions.

Table 1: Iowa GHG Emissions[1]

Emissions ($MMtCO_2e$)	2010[2]	2011	Change	
Agriculture	34.07	35.07	+2.93%	↑
Electric Power Generation Fuel Use	41.49	38.30	-7.68%	↓
Residential, Commercial, and Industrial Fuel Use	28.56	31.43	+10.05%	↑
Industrial Processes	4.62	4.50	-2.58%	↓
Natural Gas and Oil Transmission and Distribution	1.17	1.18	+0.65%	↑
Transportation	22.07	22.41	+1.52%	↑
Waste	2.49	2.43	-2.24%	↓
Total Gross Emissions	**134.47**	**135.32**	**+0.64%**	**↑**
Sinks from Land Use, Land Use Change, and Forestry	-17.02	-16.91	-0.65%	↓
Total Net Emissions	**117.45**	**118.41**	**+0.82%**	**↑**

Figure 1: 2011 Iowa Gross* GHG Emissions ($MMtCO_2e$)



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

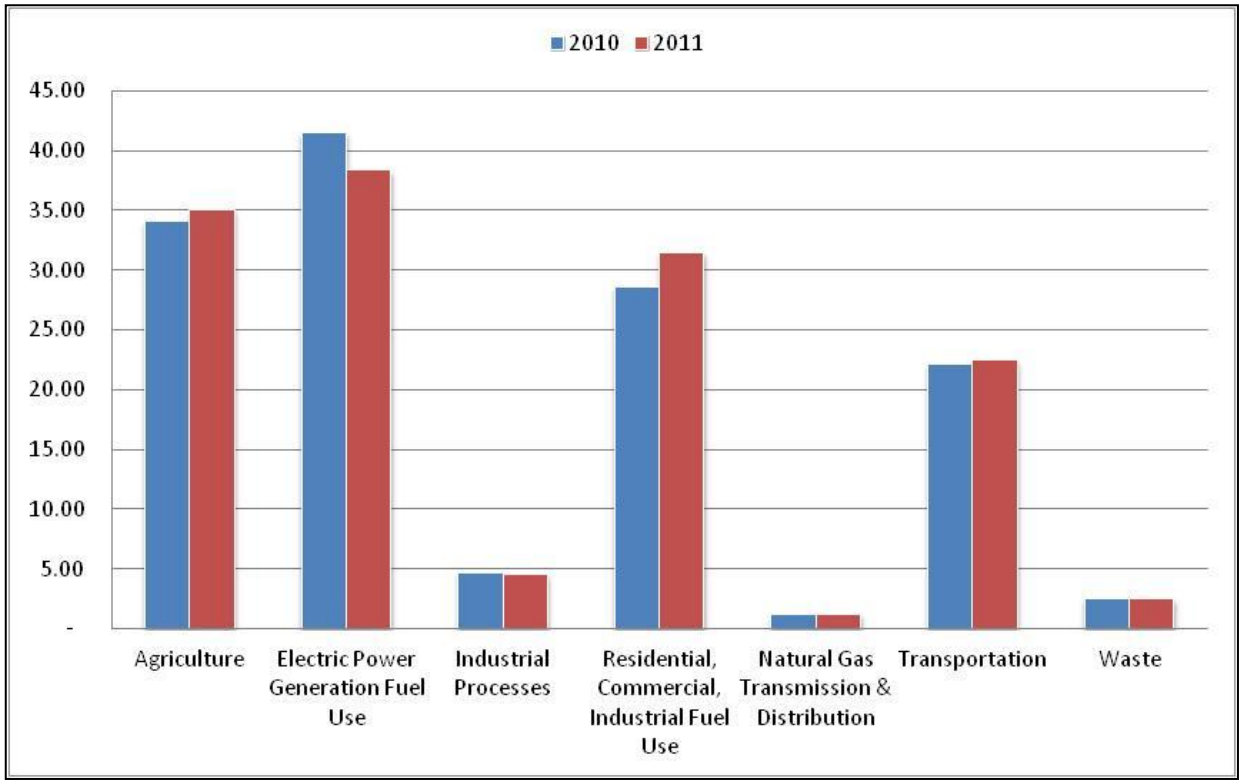
[1] Please also note that the totals in data tables may not equal the exact sum of subtotals within the table due to independent rounding.

[2] The 2010 value is as revised by the Department. The 2010 GHG emissions presented in this inventory are lower (2.06 $MMtCO_2e$) than the emissions in the previous 2010 inventory published by the Department in December 2011. The difference can be attributed to improved activity data in the agriculture, fossil fuel combustion, and LULUCF sectors. This is further discussed in the Technical Support Document.

GHG Emissions By Sector

Changes in GHG emissions from 2010 – 2011 varied by sector as shown in Figure 2 below. GHG emissions increased in the agriculture, RCI, natural gas transmission and distribution, and transportation sectors. Emissions in the electric power generation fuel use, industrial processes, and waste sectors decreased.

Figure 2: 2011 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

2011 agriculture emissions increased 2.93% from the previous year, due to increases in animal populations and crop production as shown in Table 2 on the next page. 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 ($MMtCO_2e$)

Category	2010	2011	% Change
Enteric Fermentation	6.67	6.72	+0.75%
Manure Management	7.53	7.54	+0.12%
Agricultural Soil Management	19.86	20.80	+4.73%
Burning of Agricultural Crop Waste	0.007	0.008	+3.76%
Total	34.07	35.07	+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 over half (51.53% in 2011) of Iowa's GHG emissions.

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). Emissions from this category decreased by 7.68% from 2010 – 2011 as these facilities, in total, used less fossil fuels.

Actual fuel use data for 2011 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, except for industrial coal. Emissions from industrial coal were calculated using actual fuel throughput data reported to the Department by industrial facilities. Overall, GHG emissions from RCI were estimated to increase 10.05% overall from 2010, with industrial fuel emissions increasing 14.35% as shown in Table 3. This is based on the Energy Information Agency's projection[3] that emissions from industrial sources in the West North Central U.S. Census Region will increase in 2011. In total, GHG emissions from fossil fuel combustion decreased 0.45% from 2010 – 2011.

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

Category	2010	2011	% Change
Electric Power Generation	41.49	38.30	-7.68%
RCI	28.56	31.43	+10.05%
Residential	*4.94*	*4.94*	*-0.02%*
Commercial	*4.47*	*4.60*	*+2.87%*
Industrial	*19.15*	*21.77*	*+14.35%*
Total	70.05	69.74	-0.45%

[3] U.S. Energy Information Administration - *Annual Energy Outlook 2012 with Projections to 2035*, June 2012. DOE/EIA-0383(2012). Available at http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf.

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 2.58% from 2010 – 2011 as shown in Table 4. GHG emissions reported by industrial facilities to EPA as required by the federal GHG reporting program was 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 ($MMtCO_2e$)

Category	2010	2011	% Change
Ammonia & Urea Production	0.84	0.75	-9.93%
Cement Manufacture	0.72	0.79[4]	+9.91%
Electric Power Transmission and Distribution Systems	0.16	0.14	-8.06%
Iron and Steel Production	0.23	0.20	-14.16%
Lime Manufacture	0.18	0.18	-4.34%
Limestone and Dolomite Use	0.31	0.36	+16.22%
Nitric Acid Production	0.99	0.94	-4.83%
Ozone Depleting Substance Substitutes	1.18	1.13	-4.88%
Soda Ash Consumption	0.02	0.02	+3.59%
Total	4.62	4.50	-2.58%

Natural Gas Transmission and Distribution (T & D)

This sector includes emissions from natural gas transmission and distribution systems in the state. 2011 GHG emissions increased 0.65% from 2010 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 ($MMtCO_2e$)

Category	2010	2011	% Change
Transmission	0.66	0.66	-0.15%
Distribution	0.51	0.52	+1.58%
Total	1.17	1.18	+0.65%

[4] Emissions from fossil fuel combustion that were measured by the Continuous Emission Monitor on the kiln(s) were subtracted from the total as they are already counted in the Fossil Fuel Combustion Sector.

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 fuel use data for 2011 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.

GHG emissions were estimated to increase 1.52% from 2010 as shown in Table 6. This was based on the Energy Information Agency's projection[5] that the amount of motor gasoline, natural gas, and diesel fuel in the transportation will increase in the West North Central U.S. Census Region in 2011. However, this may be an over-estimate as the total highway vehicle miles traveled decreased by 0.53% from 2010 – 2011.

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

Category	2010	2011	% Change
Transportation	22.07	22.41	+1.52%

Waste

The waste sector includes GHG emissions from both municipal solid waste landfills and the treatment of municipal and industrial waste water. GHG emissions from municipal solid waste decreased 3.03%. This is because less municipal solid waste was burned by power plants to produce electricity. It is also because more methane emissions were avoided than last year by flaring landfill gas. Emissions were also avoided by converting landfill gas to energy at several sites. Emissions were calculated based on data submitted directly to the Department by landfills and other facilities in Iowa.

As shown in Table 7, emissions from wastewater increased 1.22% due to increases in Iowa's population and the amount of wastewater produced by industrial facilities.

Table 7: GHG Emissions from Waste ($MMtCO_2e$)

Category	2010	2011	% Change
Municipal Solid Waste	2.03	1.97	-3.03%
Wastewater	0.46	0.47	+1.22%
Total	2.49	2.43	-2.24%

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. The total amount of GHGs sequestered in 2011 was 16.91 $MMtCO_2e$, a decrease of 0.65% from 2010 – 2011 as shown in Table 8.

[5] U.S. Energy Information Administration - *Annual Energy Outlook 2012 with Projections to 2035*, June 2012. DOE/EIA-0383(2012). Available at http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf.

(Negative numbers indicate sequestration). This decrease in sequestration can be attributed to increases in liming of agricultural soils, urea fertilization, and fertilization of settlement soils. Sequestration from forests and urban trees was assumed to be the same as 2010. Emissions from forest fires were not calculated due to a lack of data.

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

Category	2010	2011	% Change
Forest Carbon Flux	-17.35	-17.35	0%
Liming of Agricultural Soils	0.47	0.51	+10.39
Urea Fertilization	0.11	0.12	+12.11
Urban Trees	-0.63	-0.63	0%
Yard Trimmings and Food Scraps Stored in Landfills	-0.05	-0.13	+155.60%[6]
Fertilization of Settlement Soils	0.43	0.56	+29.98%
Total Sequestration	-17.02	-16.91	-0.65%

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

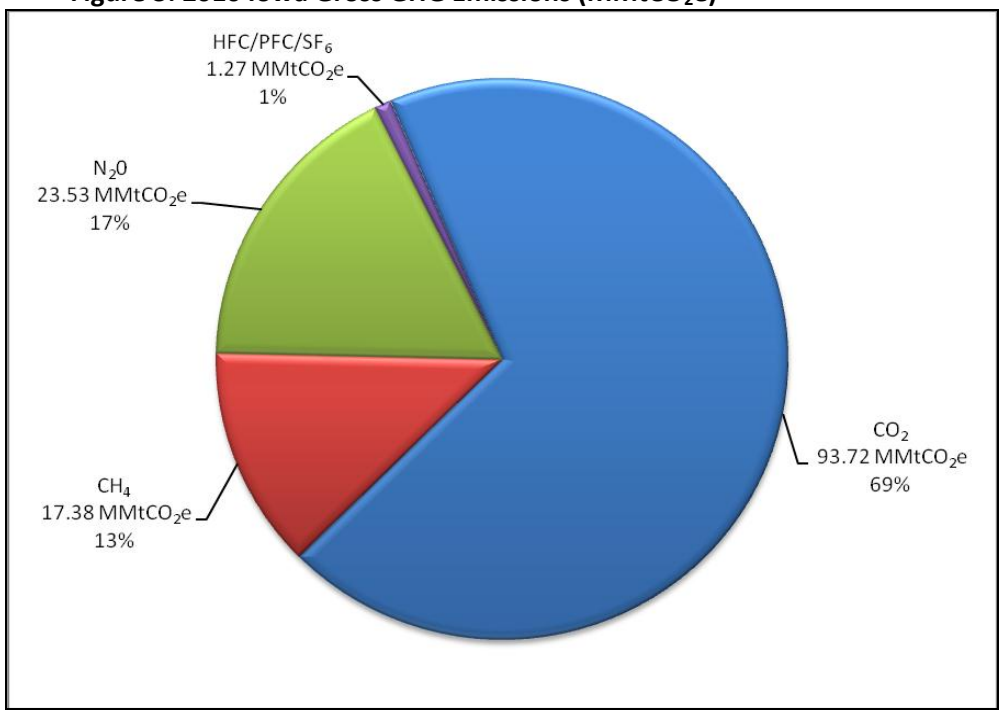
GHGs included in the inventory are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFC), hydrofluorocarbons (HFC), and sulfur hexafluoride (SF_6). Figure 3 on the next page shows the distribution of GHG pollutants in 2011. The majority of CO_2 emissions (97.39%) are from fossil fuel combustion. The majority of all N_2O emissions (88.41%) are from agricultural soils, and the majority of CH_4 emissions (78.67%) are from enteric fermentation and manure management in the agriculture sector.

EPA's Greenhouse Gas Equivalencies Calculator [7] estimates that the quantity of gross GHG emissions (i.e. excluding carbon sinks) emitted in Iowa in 2011 is equivalent to:

- Annual GHG emissions from 26.5 million passenger vehicles
- CO_2 emissions from the electricity use of 16.9 million homes for one year
- CO_2 emissions from the energy use of 11.7 million homes for one year
- The carbon sequestered by 3.5 billion tree seedlings grown for ten years
- GHG emissions avoided by recycling 47.2 million tons of waste instead of sending it to the landfill

[6] Change is based on a new waste characterization study for 2011.
[7] U.S. EPA Greenhouse Gas Equivalencies Calculator. Available at http://www.epa.gov/cleanenergy/energy-resources/calculator.html.

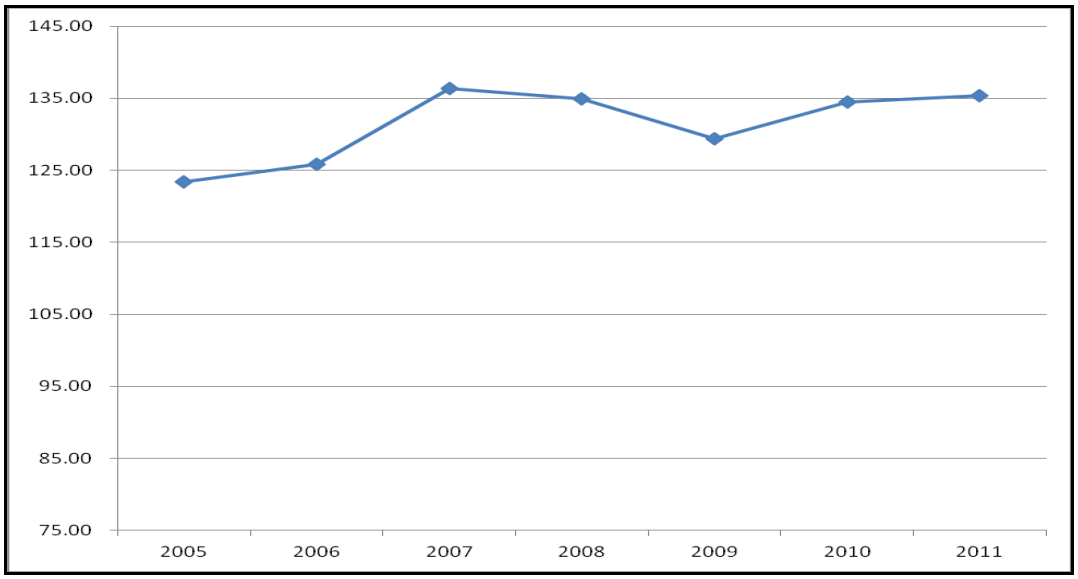
Figure 3: 2010 Iowa Gross GHG Emissions ($MMtCO_2e$)



Emissions Trends

Total 2011 statewide GHG emissions increased 0.64% from 2010 and 9.69% from 2005 as shown in Figure 4 below and in Table 9 on the next page.

Figure 4: Iowa Gross* GHG Emissions 2005 – 2011 ($MMtCO_2e$)



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

Table 9: GHG Emissions 2005 – 2011 by Sector ($MMtCO_2e$)

Emissions ($MMtCO_2e$)	2005	2006	2007	2008	2009	2010[8]	2011
Agriculture	32.14	34.25	38.73	34.81	34.63	34.07	35.07
Electric Power Generation Fuel Use	36.84	36.35	40.04	41.78	37.71	41.49	38.30
Residential, Commercial, and Industrial Fuel Use	24.07	24.32	26.21	27.75	27.66	28.56	31.43
Industrial Processes	4.67	4.81	4.83	4.93	4.22	4.62	4.50
Natural Gas Transmission and Distribution	1.15	1.15	1.16	1.07	1.17	1.17	1.18
Transportation	21.88	22.38	22.81	21.97	21.42	22.07	22.41
Waste	2.62	2.56	2.60	2.62	2.59	2.49	2.43
Total Gross Emissions	**123.37**	**125.83**	**136.39**	**134.94**	**129.41**	**134.47**	**135.32**
Sinks from Land Use, Land Use Change, and Forestry	-16.97	-16.93	-16.96	-17.09	-17.15	-17.02	-16.91
Total Net Emissions	**106.40**	**108.91**	**119.43**	**117.84**	**112.26**	**117.45**	**118.41**

Comparison with U.S. Emissions

Figure 5 and Figure 6 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 2010 are used for this comparison as the 2011 national GHG inventory has not yet been published. Overall, Iowa emits 1.97% of U.S. GHG emissions.[9]

Figure 5: 2010 Iowa GHG Emissions by Sector

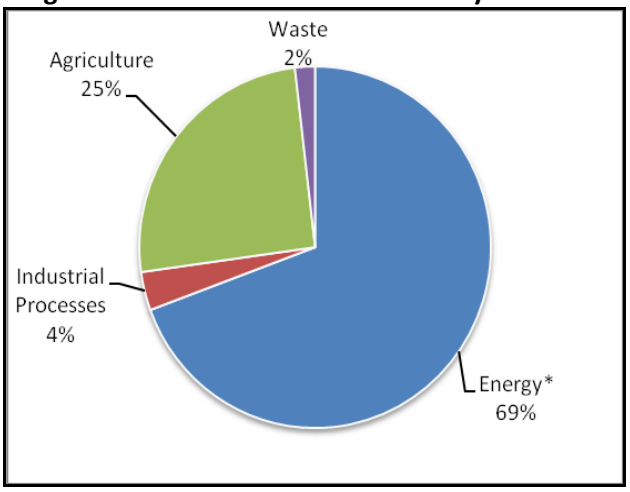
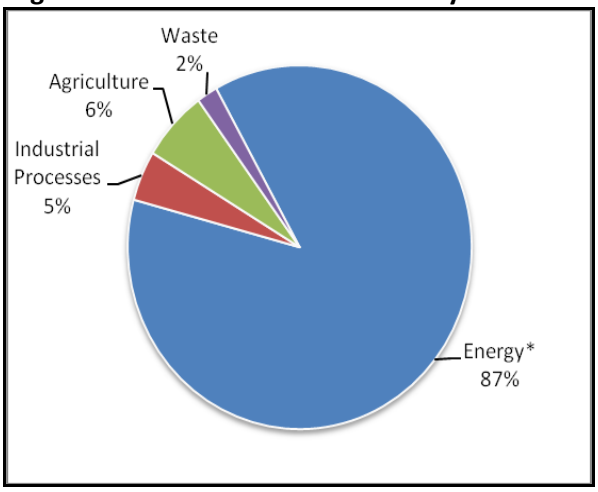


Figure 6: 2010 U.S. GHG Emissions by Sector



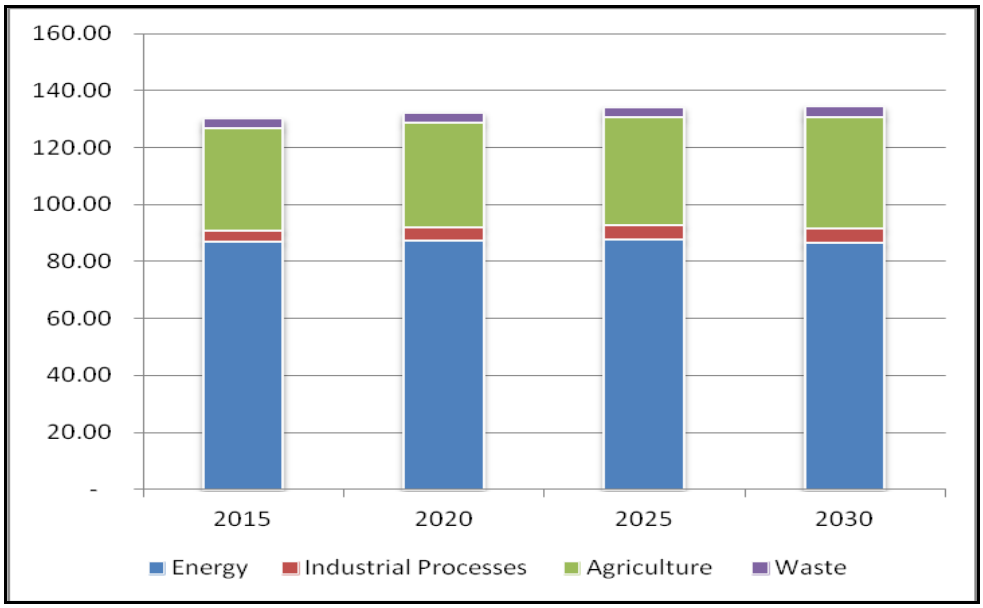
[8] The 2010 value is as revised by the Department. The 2010 GHG emissions presented in this inventory are lower (2.06 $MMtCO_2e$) than the emissions in the previous 2010 inventory published by the Department in December 2011. The difference can be attributed to improved activity data in the agriculture, fossil fuel combustion, and LULUCF sectors. This is further discussed in the Technical Support Document.

[9] U.S. EPA – *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012*, April 2012. Available at http://epa.gov/climatechange/ghgemissions/usinventoryreport.html.

Future Emissions

Iowa Code 455B.104 requires that the Department forecast trends in GHG emissions. The Department projected emissions from 2015 – 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 7 below. The SIT Projection Tool forecasts emissions from industrial processes, agriculture, and waste based on historical emissions from 1990 – 2009, using a combination of data sources, national projections for activity data, etc.

Figure 7: Projected Gross GHG Emissions 2015 – 2030 ($MMtCO_2e$)



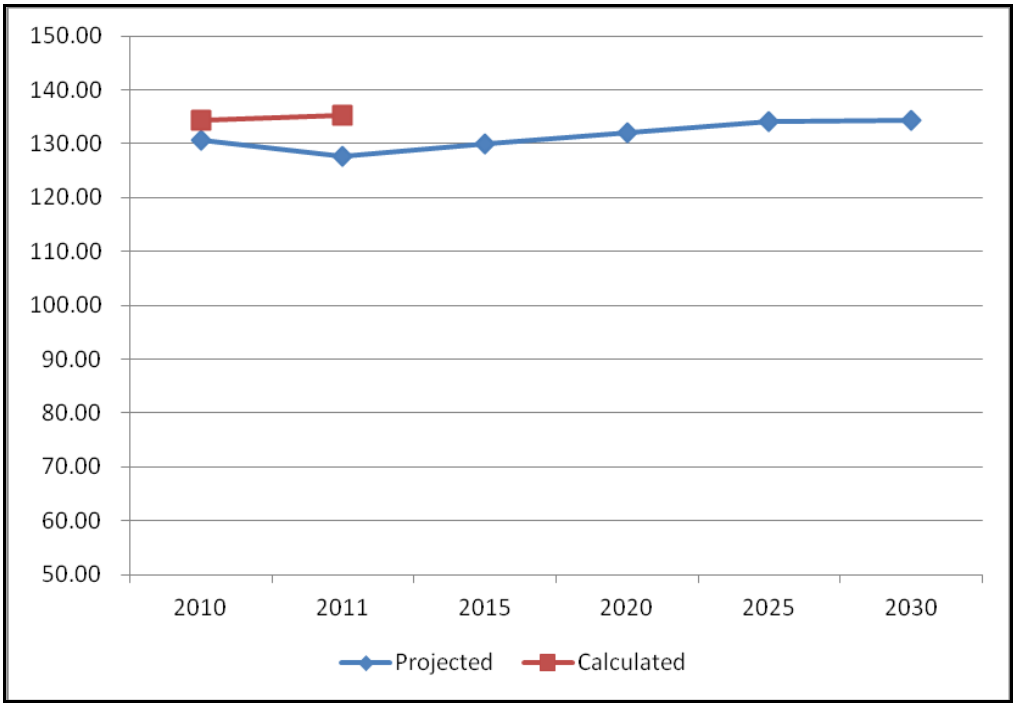
The energy forecast is based on projected energy consumption values from the EIA's *Annual Energy Outlook (2012) with Projections to 2035.* The AEO2012 includes thirty different projection cases, which each address different uncertainties. The Department used the AEO2012 "Reference Case", which assumes that the laws and regulations in effect in 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 AEO2012 includes six key findings:

1. "The rate of growth in energy use slows over the projection period, reflecting moderate population growth, an extended economic recovery, and increasing energy-efficiency in end-use applications.
2. Domestic crude oil production increases.
3. With modest economic growth, increased efficiency, growing domestic production, and continued adoption of nonpetroleum liquids, net importers of petroleum and other liquids make up a smaller share of total U.S. energy consumption.
4. Natural gas production increases throughout the projection period, allowing the United States to transition from a net importer to a net exporter of natural gas.

5. Power generation from renewables and natural gas continues to increase.
6. Total energy-related emissions of carbon dioxide in the United States remain below their 2005 level through 2035."[10]

Because the Projection Tool 's energy projections are done at the regional level and because the Tool does not account for 2010 and 2011 emissions when making its projections for other categories, the emissions predicted for future years have a significant level of uncertainty as shown in Figure 8. In addition, 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.

Figure 8: Projected vs. Calculated GHG Emissions ($MMtCO_2e$, Gross)



Retired and Converted Electricity Generating Units

For the short term, the Department predicts approximately an 11.29% decrease in 2011 - 2012 CO_2 emissions from the electric power sector. This is based CO_2 emissions reported to EPA as required by the federal Acid Rain Program (40 CFR 75), comparing the first three quarters of 2012 compared to the first three quarters of 2011. This estimate has some uncertainty as emissions are not evenly dispersed among the quarters. However, emissions in the fourth quarter (October – December) are typically lower than summertime emissions. Emissions are also expected to decrease in the future as older, less-efficient coal-fired units are switched to less carbon-intensive natural gas, or are replaced with new natural gas-fired units.

[10] U.S. Energy Information Administration - *Annual Energy Outlook 2012 with Projections to 2035 (AEO2012)*, June 2012, pages 2 - 4. DOE/EIA-0383(2012). Available at http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf.

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 first states to blend SIT-calculated data, CEM data, and facility-level data into one comprehensive GHG inventory. Other areas for improvement include improved forecasting and further development of soil carbon flux emissions or sinks.