



IOWA DEPARTMENT OF  
NATURAL RESOURCES

2017 Iowa Statewide  
Greenhouse Gas Emissions  
Inventory Report

Required by Iowa Code 455B.104

December 27, 2018

Iowa Department of Natural Resources  
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Des Moines, IA 50319

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## **Background**

This report is required by Iowa Code 455B.104, which requires the Iowa DNR to estimate greenhouse gas (GHG) emissions during the previous year and forecast trends in emissions. The report must be submitted to the Governor and Iowa General Assembly by December 31 each year and is beneficial because it provides an opportunity to evaluate Iowa-specific GHG emissions trends, is more detailed and more accurate than national efforts, and can be used to establish a baseline for tracking emissions reductions progress in Iowa. This report focuses on calendar year 2017 GHG emissions and includes emissions of six GHGs: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), perfluorocarbons (PFC), hydrofluorocarbons (HFC), and sulfur hexafluoride (SF<sub>6</sub>).

The emissions are based on statewide activity data from the following sectors:

- agriculture
- fossil fuel combustion
- industrial processes
- natural gas transmission and distribution
- transportation
- solid waste
- wastewater treatment
- land use, land use change, and forestry (LULUCF)

Emissions were calculated using the U.S. Environmental Protection Agency's (EPA) State Inventory Tool (SIT) and self-reported emissions data from landfills, industrial facilities, and power plants. The calculation method and uncertainty for each sector are discussed in depth in the Iowa DNR's Technical Support document (TSD), available on the DNR's [Greenhouse Gas Emissions Inventory webpage](#).

## **2017 Statewide GHG Emissions**

In 2017, total gross Iowa greenhouse gas emissions were 131.02 million metric tons carbon dioxide equivalent (MMtCO<sub>2</sub>e) as shown in Table 1 and Figure 1. This is an increase of 4.38 MMtCO<sub>2</sub>e (3.46%) from 2016. The overall increase can primarily be attributed to:

- A 1.75 MMtCO<sub>2</sub>e increase in the Industrial Processes sector, driven by increased production of ammonia,
- A 1.28 MMtCO<sub>2</sub>e increase in emissions from Power Plants, due to increased generation of electricity from natural gas, and
- A 0.62 MMtCO<sub>2</sub>e increase in waste emissions, due to the length of time the waste has been stored in the landfill and fluctuations in waste decomposition rates.

Emissions from the other emission sectors did not fluctuate significantly, changing less than 0.50 MMtCO<sub>2</sub>e per sector from 2016 as shown in Figure 2. Overall, total 2017 gross statewide GHG emissions have decreased 5.84% from 2008.

**Table 1: GHG Emissions 2008 – 2017 by Sector (Million Metric Tons Carbon Dioxide Equivalents (MMtCO<sub>2</sub>e))<sup>1</sup>**

Emissions (MMtCO <sub>2</sub> e)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Change from 2016		
											MMtCO <sub>2</sub> e	%	Trend
Agriculture	36.65	36.48	36.38	37.91	36.78	35.77	36.75	39.00	39.49	39.61	+0.13	+0.32%	↑
Power Plants	41.78	37.71	42.33	38.98	35.76	33.06	33.44	29.46	25.33	26.62	+1.28	+5.07%	↑
Residential, Commercial, and Industrial Fuel Use	31.34	30.73	31.23	31.44	29.96	32.82	32.82	31.54	29.45	29.81	+0.36	+1.24%	↑
Industrial Processes	4.89	4.21	4.79	4.50	5.18	5.20	5.28	5.28	5.51	7.25	+1.75	+31.73%	↑
Land Use, Land Use Change, and Forestry (LULUCF) <sup>2</sup>				0.67	0.48		3.27	2.99	3.18	3.33	+0.16	+4.88%	↑
Natural Gas Transmission and Distribution	1.40	1.40	1.39	1.40	1.40	1.40	1.40	1.40	1.41	1.27	-0.14	-10.06%	↓
Transportation	19.99	19.40	19.41	19.58	19.59	19.46	19.55	20.02	20.12	20.34	+0.22	+1.10%	↑
Waste	3.10	3.06	2.01	1.94	2.15	1.96	1.94	2.14	2.16	2.78	+0.62	+28.62%	↑
Total Gross Emissions	139.14	132.98	137.54	136.40	131.31	129.67	135.45	131.84	126.64	131.02	+4.38	+3.46%	↑
Carbon Stored in LULUCF <sup>3</sup>	-3.92	-5.00	-2.01	0	0	-0.71	0	0	0	0			
<b>Total Net Emissions</b>	<b>135.22</b>	<b>127.99</b>	<b>135.53</b>	<b>136.40</b>	<b>131.31</b>	<b>128.96</b>	<b>135.45</b>	<b>131.84</b>	<b>126.64</b>	<b>131.02</b>	<b>+4.38</b>	<b>+3.46%</b>	<b>↑</b>

<sup>1</sup> Totals may not equal the exact sum of subtotals in this table due to independent rounding. Values may not match values in the previous inventory published by the Department in December 2016. Any adjustments are described in detail in the Technical Support Document.

<sup>2</sup> Carbon is emitted in some years from the LULUCF sector, but carbon is stored in the LULUCF sector in other years. Emissions from the LULUCF sector are shown in this row as positive numbers.

<sup>3</sup> Carbon stored in LULUCF is shown in this row as a negative number.

Figure 1: Iowa Gross GHG Emissions 2008 – 2017 (MMtCO<sub>2</sub>e)

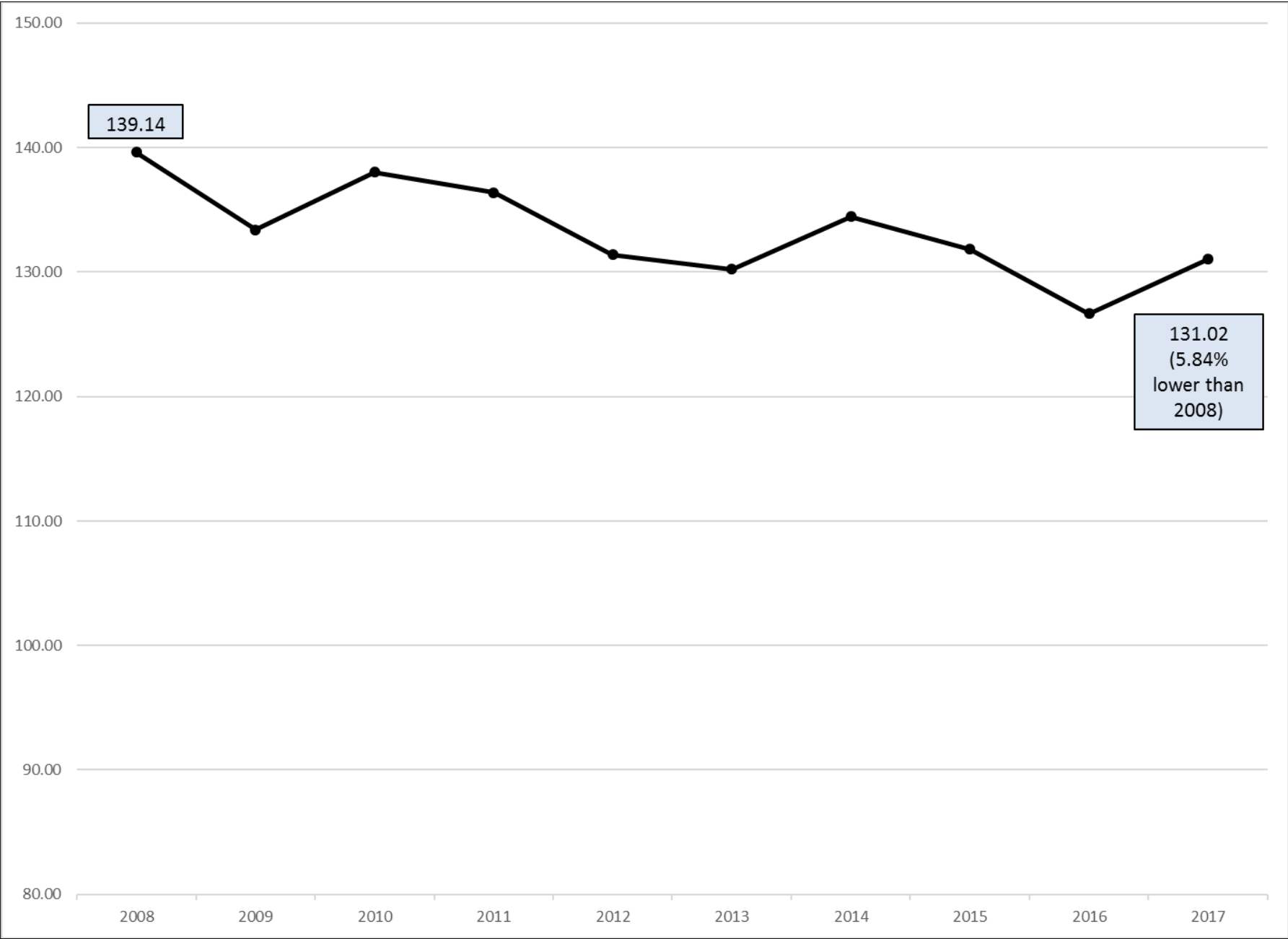
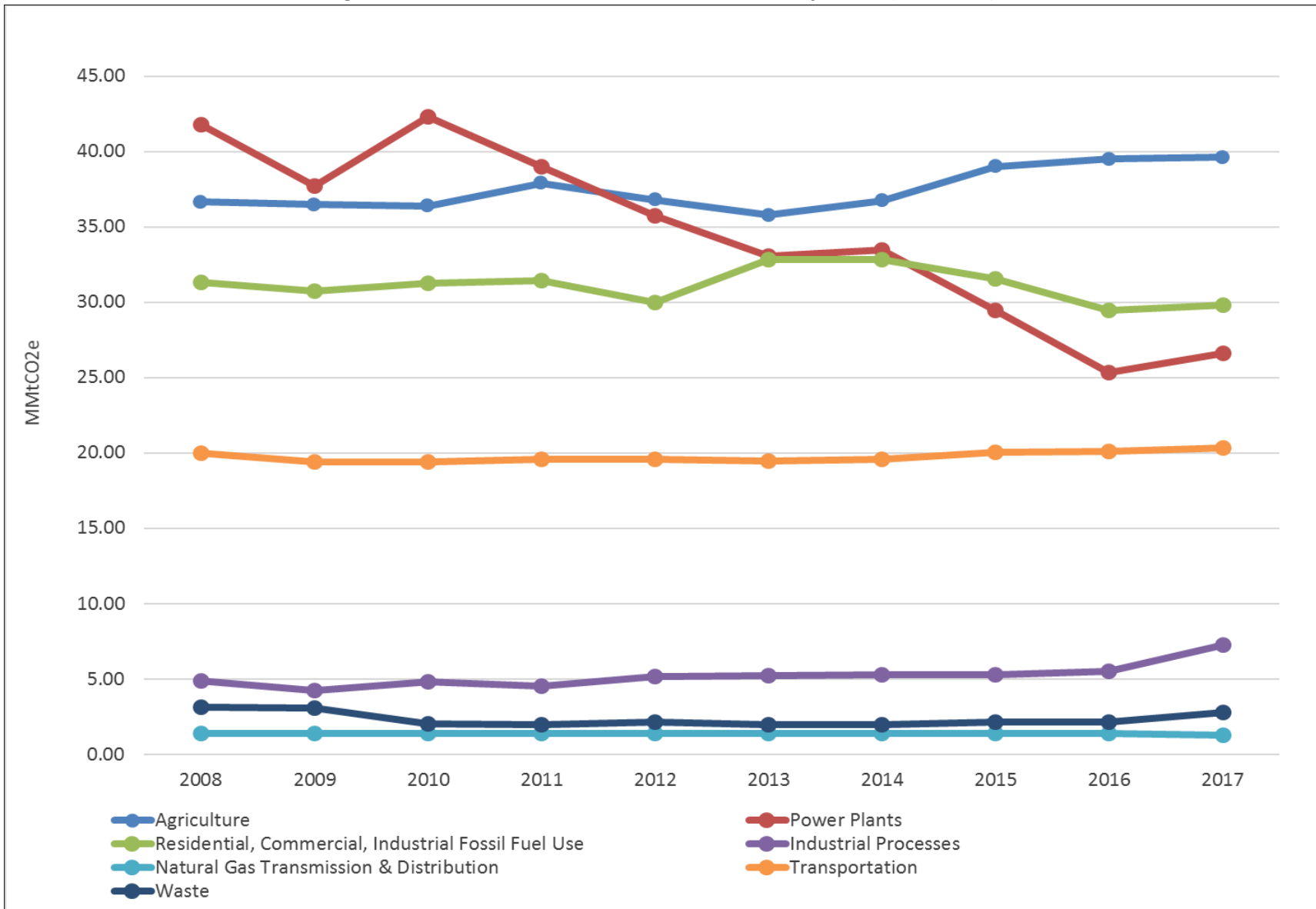


Figure 2: Iowa Gross<sup>4</sup> GHG Emissions 2008 – 2017 by Sector (MMtCO<sub>2</sub>e)

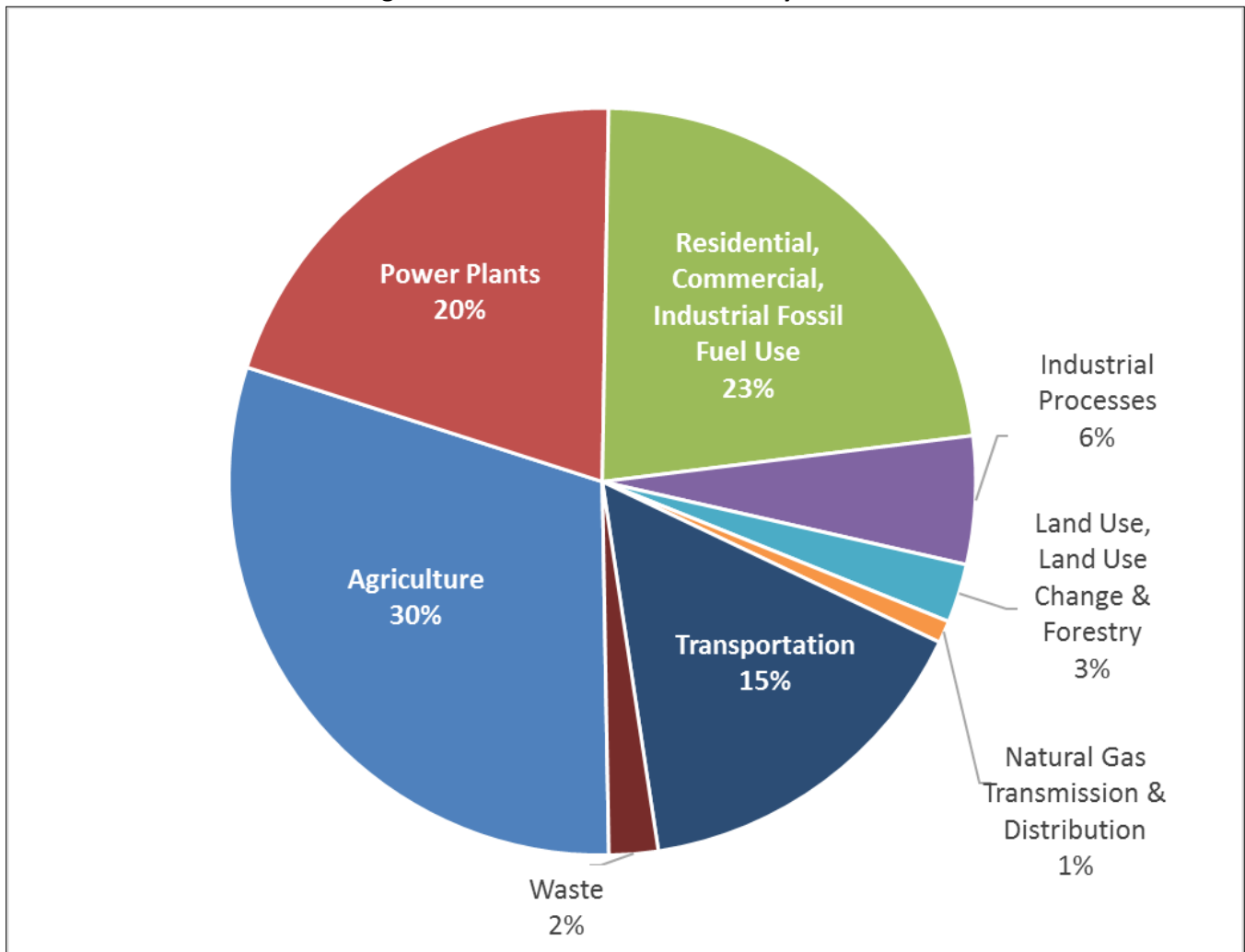


<sup>4</sup> Does not include carbon storage or emissions from land use, land use change, and forestry (LULUCF).

### **GHG Emissions by Sector**

The majority of GHG emissions in Iowa in 2017 were from the agriculture sector (30%), followed by emissions from the residential/commercial/industrial (RCI) sector (23%), and fossil fuel use by power plants (20%) as shown in Figure 3. The emissions from these, and each other sector, are summarized below. Please refer to the [2017 GHG Inventory Technical Support Document](#) for more information on a specific sector, such as sources of input data, calculations, and uncertainty.

**Figure 3: 2017 Iowa GHG Emissions by Sector<sup>5</sup>**



#### **Agriculture**

This sector includes GHG emissions from livestock and crop production, such as enteric fermentation, manure management, and agricultural soils. Enteric fermentation includes emissions from the digestive systems of ruminant animals. Emissions from agricultural soils include emissions from manure, runoff, plant fertilizers, plant residues, and cultivation of highly organic soils. GHG emissions from fossil-fuel fired agricultural equipment (such as tractors) are included in the transportation sector. As shown in Table 2, total agriculture emissions

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<sup>5</sup> Industrial fossil fuel use refers to GHG emissions from fossil fuels combusted by industrial facilities. Industrial processes means GHGs emitted during the production of or use of specific products such as ammonia, urea, nitrogen, cement, iron, steel, lime, etc.

increased 0.32% between 2016 and 2017. Emissions from manure management exhibited the largest change, increasing 5.64%, due to an increase in the amount of swine and poultry produced. Enteric fermentation emissions were lower, as the cattle population decreased. Emissions from agricultural soil management also decreased, as the production of corn, oats, soybeans, and wheat all decreased.

**Table 2: GHG Emissions from Agriculture (MMtCO<sub>2</sub>e)**

Category	2016	2017	% Change
Enteric Fermentation	8.43	8.33	-1.22%
Manure Management	10.96	11.58	+5.64%
Agricultural Soil Management	20.09	19.71	-1.93%
<b>Total</b>	<b>39.49</b>	<b>39.61</b>	<b>+0.32%</b>

### Fossil Fuel Combustion

This sector includes GHG emissions from fossil fuels combusted in four categories: power plants, residential, industrial, and commercial (the residential, industrial, and commercial categories are often combined into one category called RCI). Table 3 shows that emissions from these sources increased by 3.01% between 2016 and 2017. Together, these four categories account for 43.07% of Iowa's GHG total emissions.

**Table 3: GHG Emissions from Fossil Fuel Combustion (MMtCO<sub>2</sub>e)**

Category	2016	2017	% Change
Power Plants	25.33	26.62	+5.07%
Residential, Commercial, Industrial (RCI)	29.45	29.81	+1.24%
<i>Residential</i>	4.48	4.84	+8.14%
<i>Commercial</i>	3.77	3.77	+0.02%
<i>Industrial</i>	21.21	21.21	0.00%
<b>Total</b>	<b>54.78</b>	<b>56.43</b>	<b>+3.01%</b>

### *Residential, Commercial, and Industrial (RCI)*

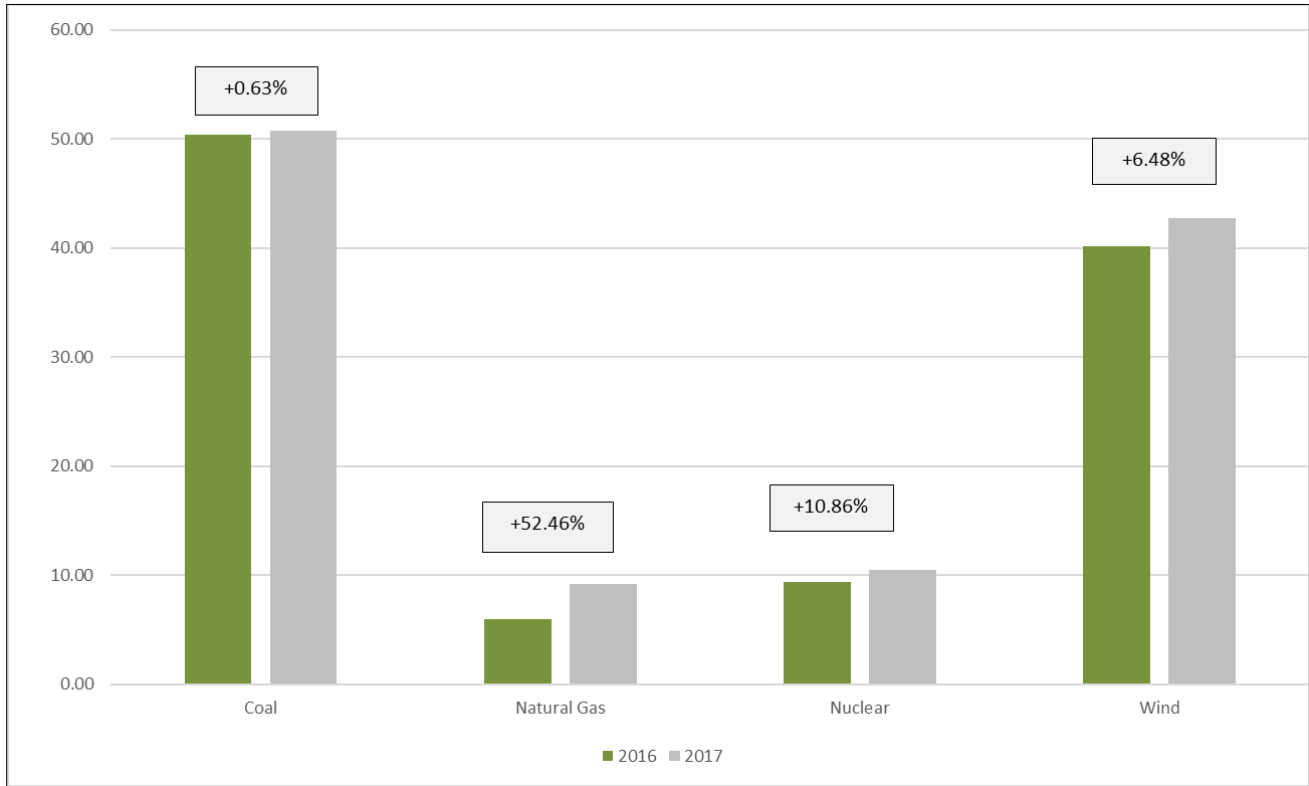
Actual fuel use data for 2017 for the RCI sector was not available from the U.S. Energy Information Administration (EIA), so emissions were calculated based on projected energy consumption values from the EIA's *Annual Energy Outlook 2018 with Projections to 2040*. Emissions predicted for 2016 from the RCI sector in last year's inventory (31.90 MMtCO<sub>2</sub>e) were replaced with actual 2016 consumption values now available from EIA. The resulting recalculated 2016 emissions were 29.45 MMtCO<sub>2</sub>e. Emissions from this sector increased because the consumption of fossil fuels by the residential category increased 8.14%.

### *Power Plants*

This category includes emissions from fossil fuels that are combusted at power plants to generate electricity. The DNR used emissions reported by power plants to EPA as required by the federal GHG reporting program (40 Code of Federal Regulations 98). The CO<sub>2</sub> emissions for these facilities are measured by continuous emission monitoring systems (CEMS). Emissions from power plants increased 1.28 MMtCO<sub>2</sub>e (5.07%) from the previous year, primarily due to a 52.46% increase in the amount of electricity generated from natural gas as shown in Figure 4. Electricity generation from coal, wind, and nuclear also increased (electricity generated by wind and nuclear sources does not contribute to GHG emissions).



**Figure 4: 2016 and 2017 Net Iowa Electric Generation by Energy Source (Million Megawatt Hours)<sup>6</sup>**



**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 31.73% from 2016 - 2017 as shown in Table 4. This increase was driven by a 181.09% increase in CO<sub>2</sub> emissions from ammonia production, as production at two facilities increased significantly.

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<sub>2</sub>e)**

Category	2016	2017	% Change
Ammonia and Urea Production	0.92	2.60	+181.09%
Cement Manufacture	1.58	1.66	+5.36%
Electric Power Transmission & Distribution Systems	0.06	0.06	NA <sup>7</sup>
Iron and Steel Production	0.19	0.20	+5.09%
Lime Manufacture	0.15	0.18	+22.58%
Limestone and Dolomite Use	0.21	0.21	NA <sup>7</sup>
Nitric Acid Production	0.75	0.70	-6.16%

<sup>6</sup> U.S. EIA: [Net Generation by State by Type of Producer by Energy Source](#), October 12, 2018.

<sup>7</sup> Due to lack of current data, the DNR assumed 2016 emissions = 2017 emissions.

Category	2016	2017	% Change
Ozone Depleting Substance Substitutes	1.63	1.63	0%
Soda Ash Consumption	0.02	0.02	-2.63%
<b>Total</b>	<b>5.51</b>	<b>7.25</b>	<b>31.73%</b>

#### Natural Gas Transmission and Distribution (T & D)

This sector includes emissions from natural gas transmission and distribution systems in the state. GHG emissions decreased 10.06% from 2016 as shown in Table 5, due to decreases in the miles of pipeline and the number of customers/entities connected to natural gas service in the state.

**Table 5: GHG Emissions from Natural Gas Transmission and Distribution (MMtCO<sub>2</sub>e)<sup>8</sup>**

Category	2016	2017	% Change
Transmission	0.7867	0.7868	+0.01%
Distribution	0.6205	0.4789	-22.82%
<b>Total</b>	<b>1.4073</b>	<b>1.2657</b>	<b>-10.06%</b>

#### 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 non-highway vehicles. Emissions from highway vehicles are calculated based on vehicle miles traveled, while emissions from non-highway vehicles are calculated based on fuel consumption. Total vehicle miles traveled by lowans increased 1.47% between 2016 and 2017, resulting in a 1.10% increase in GHG emissions as shown in Table 6.

**Table 6: GHG Emissions from Transportation (MMtCO<sub>2</sub>e)**

Category	2016	2017	% Change
Gasoline Highway	11.32	11.48	+1.42%
Diesel Highway	4.43	4.49	+1.39%
Non-Highway	4.34	4.34	NA <sup>9</sup>
Alternative Fuel Vehicles	0.03	0.03	NA <sup>9</sup>
<b>Total</b>	<b>20.12</b>	<b>20.34</b>	<b>+1.10%</b>

#### 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 increased 28.62% from 2016 as shown in Table 7. The cumulative amount of waste in landfills increased by 6.30%, but emissions from solid waste landfills increased 34.61% due to the length of time the waste has been stored in the landfill and changes in decomposition rates. Decomposition fluctuates according to the amount of waste in the landfill, the climate, the quantity of CH<sub>4</sub> that is recovered and flared, and varying oxidation rates. Emissions from wastewater increased primarily due to increased wastewater emissions from industrial facilities. DNR used facility-specific emissions data directly

<sup>8</sup> 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.

<sup>9</sup> Due to a lack of current data, the DNR assumed 2016 values = 2017 values.

reported by facilities to EPA. Emissions from smaller landfills that are not required to report to EPA were estimated using the LandGEM model.

**Table 7: GHG Emissions from Waste (MMtCO<sub>2</sub>e)**

Category	2016	2017	% Change
Solid Waste	1.71	2.30	+34.61%
Wastewater	0.45	0.48	+5.93%
<b>Total</b>	<b>2.14</b>	<b>2.78</b>	<b>+28.62%</b>

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

The LULUCF sector includes emissions from liming agricultural soils and fertilizing lawns, golf courses, and other landscaping (settlement soils). It also includes carbon sequestered by forests and urban trees, as well as carbon stored in yard trimmings and food scraps that are sent to landfills.

Overall, total 2017 emissions from LULUCF were 3.33 MMtCO<sub>2</sub>e as shown in Table 8. This is a 4.97% increase in the CO<sub>2</sub>e being emitted. This can be attributed to increases in emissions from yard trimmings and food scraps in landfills, and fertilizing settlement soils (e.g. landscaping, lawns, and golf courses). The largest change in the LULUCF category was in emissions from yard trimmings and food scraps that were sent to landfills. This is based on a new study of the contents of Iowa landfills.<sup>10</sup> Due to a lack of current data, carbon sequestration from forest carbon flux and urban trees was assumed unchanged from 2016.

**Table 8: GHG Emissions by LULUCF (MMtCO<sub>2</sub>e)**

Category	2016	2017	% Change
Forest Carbon Flux	2.87	2.87	NA <sup>11</sup>
Liming of Agricultural Soils	0.46	0.45	-1.43%
Urea Fertilization	0.19	0.18	-7.48%
Urban Trees	-0.74	-0.74	NA <sup>11</sup>
Yard Trimmings & Food Scraps in Landfills	-0.12	+0.04	+134.08%
Fertilization of Settlement Soils	0.51	0.53	+3.90%
<b>Total</b>	<b>3.18</b>	<b>3.33</b>	<b>+4.97%</b>

Carbon emitted or sequestered from agricultural soil carbon flux is 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. 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 [2017 GHG Inventory Technical Support Document](#).

**GHG Emissions by Pollutant**

GHGs included in the inventory are carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), perfluorocarbons (PFC), hydrofluorocarbons (HFC), and sulfur hexafluoride (SF<sub>6</sub>). Table 9 shows the distribution of GHGs by pollutant in Iowa while Figures 5-8 show the distribution by both pollutant and by category.

<sup>10</sup> SCS (2017). [2017 Iowa Statewide Waste Characterization Study](#). Prepared for the Iowa Department of Natural Resources by SCS Engineers, Clive, Iowa. December 2017.

<sup>11</sup> Due to a lack of current data, the DNR assumed 2016 values = 2017 values.

Carbon dioxide is the greenhouse gas emitted in the highest amounts in Iowa, accounting for 64.09% of all greenhouse gas emissions in 2017. Nearly all CO<sub>2</sub> emissions are from fossil fuel combustion (at power plants and in the RCI sector) and transportation as shown in Figure 5, with a small percentages coming from LULUCF, and industrial processes such as the production of cement, lime, ammonia, urea, iron and steel, as well as the use of limestone, dolomite, and soda ash in manufacturing.

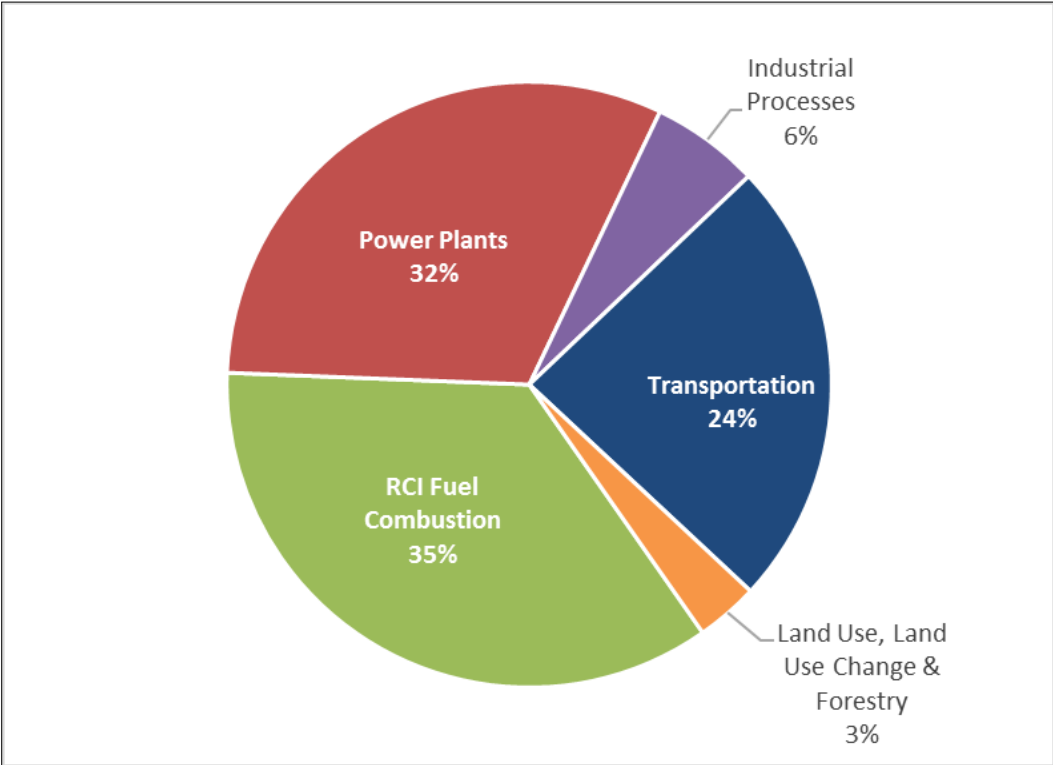
Methane and nitrous oxide were emitted in smaller amounts, and the majority of these two pollutants are from agriculture as shown in Figures 6 and 7. Methane emissions were 22.85 MMtCO<sub>2</sub>e or 17.44% of total 2017 GHG emissions. Nitrous oxide emissions in 2017 were 22.52 MMtCO<sub>2</sub>e or 17.19% of total GHG emissions.

Emissions of Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF<sub>6</sub>) are accounted for in sub-sectors of the Industrial Processes sector as shown in Figure 8. They are emitted either from substitutes for ODS or from insulation (SF<sub>6</sub>) in electric power transmission and distribution lines. In 2017, emissions of these three pollutants totaled 1.68 MMtCO<sub>2</sub>e, or 1.29% of Iowa’s 2017 total GHG emissions.

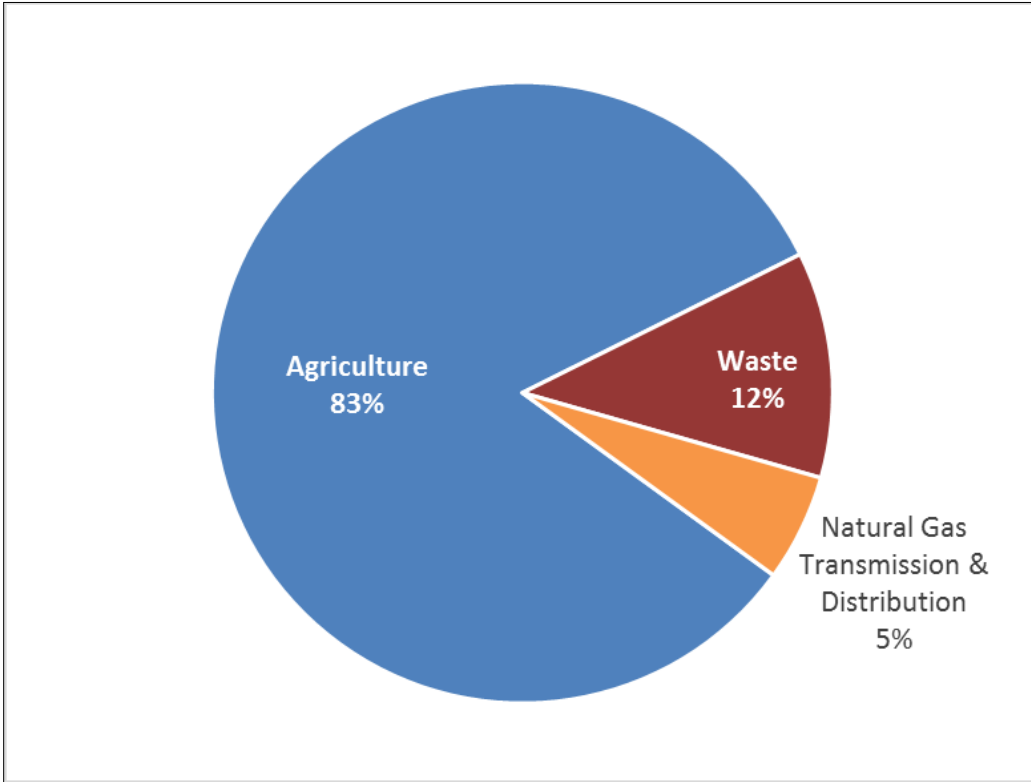
**Table 9: 2017 GHG Emissions by Pollutant (MMtCO<sub>2</sub>e)**

Pollutant	2017	% of Total
CO <sub>2</sub>	83.96	64.09%
CH <sub>4</sub>	22.85	17.44%
N <sub>2</sub> O	22.52	17.19%
HFC/PFC/SF <sub>6</sub>	1.68	1.29%
<b>Total</b>	<b>131.02</b>	<b>100%</b>

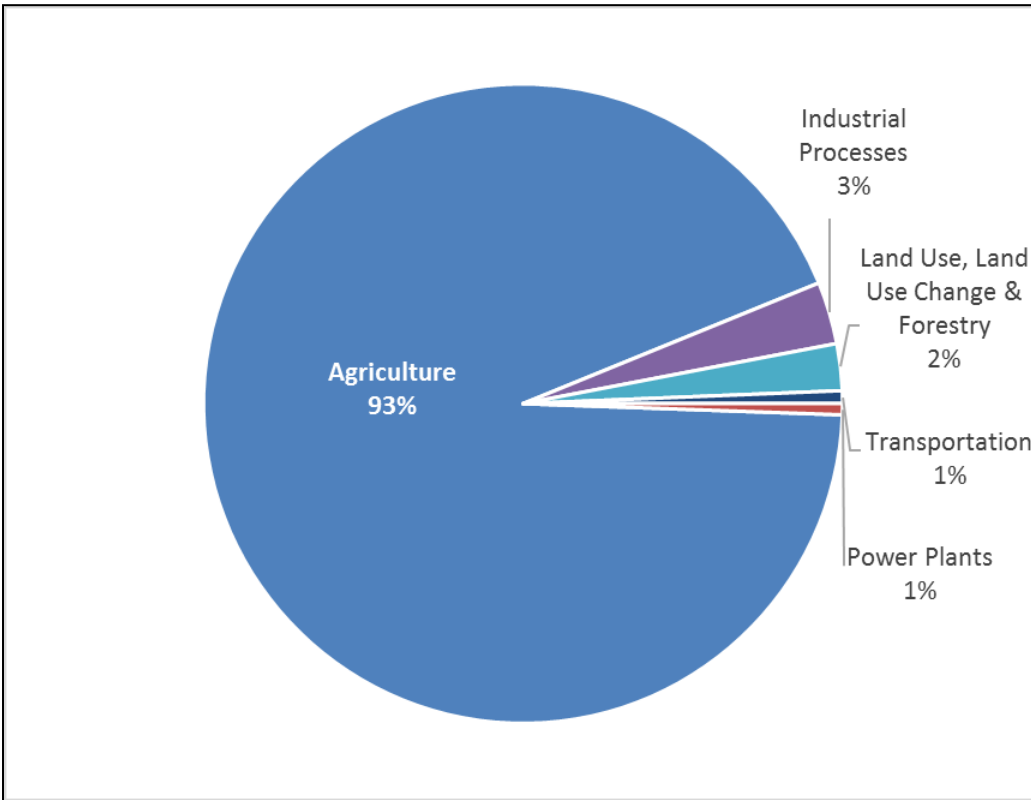
**Figure 5: 2017 Carbon Dioxide Emissions by Sector**



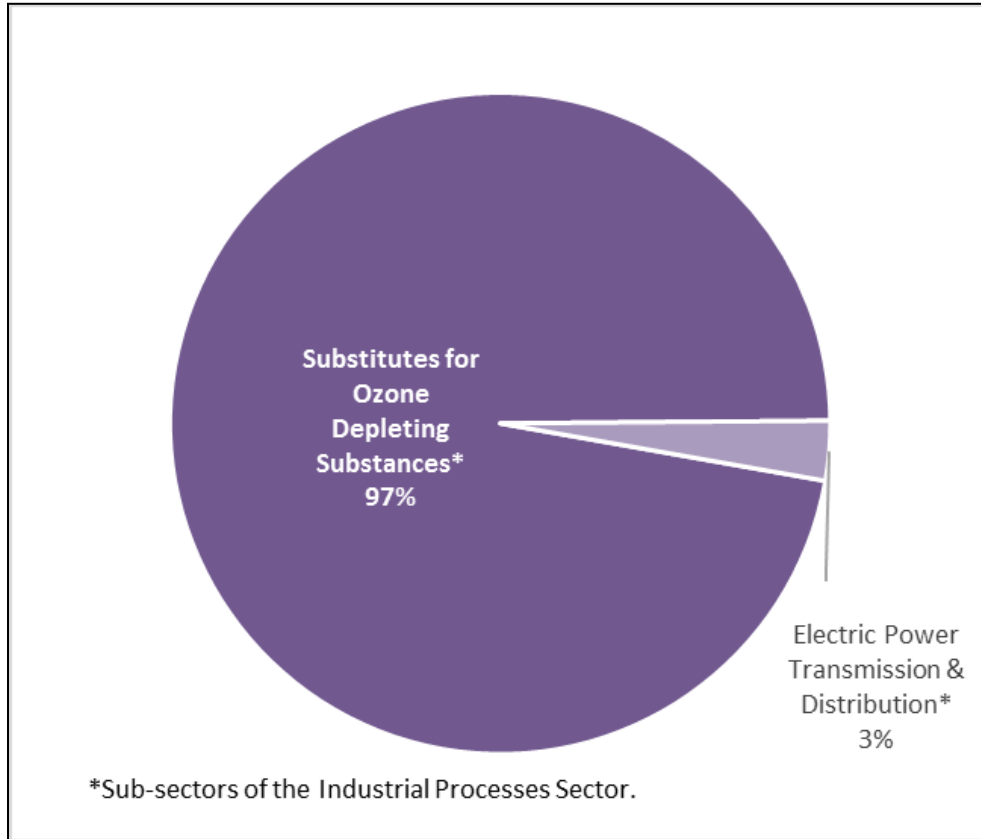
**Figure 6: 2017 Methane Emissions by Sector**



**Figure 7: 2017 Nitrous Oxide Emissions by Sector**



**Figure 8: 2017 HFC/PFC/SF<sub>6</sub> Emissions by Sector**



### **Comparison with U.S. Emissions**

Comparing Iowa's GHG emissions with U.S. emissions requires the use of 2016 data because the 2017 national GHG inventory has not yet been published. Figures 9 and 10 compare national and Iowa GHG emissions by sector. Overall, Iowa's gross GHG emissions in 2016 were 126.65 MMtCO<sub>2</sub>e, which represents 2.01% of the total 2016 U.S. gross GHG emissions of 6,511.40 MMtCO<sub>2</sub>e.

The fossil fuel combustion, natural gas transmission and distribution, and transportation sectors have been combined into one sector called "Energy" to be consistent with the national GHG inventory. Nationally, the Energy sector represents a larger fraction of total GHG emissions than in Iowa. Agricultural emissions account for a greater percentage of GHG emissions in Iowa than in the total U.S., which is logical given Iowa's substantial agricultural economy.

Figure 9: 2016 U.S. GHG Emissions by Sector

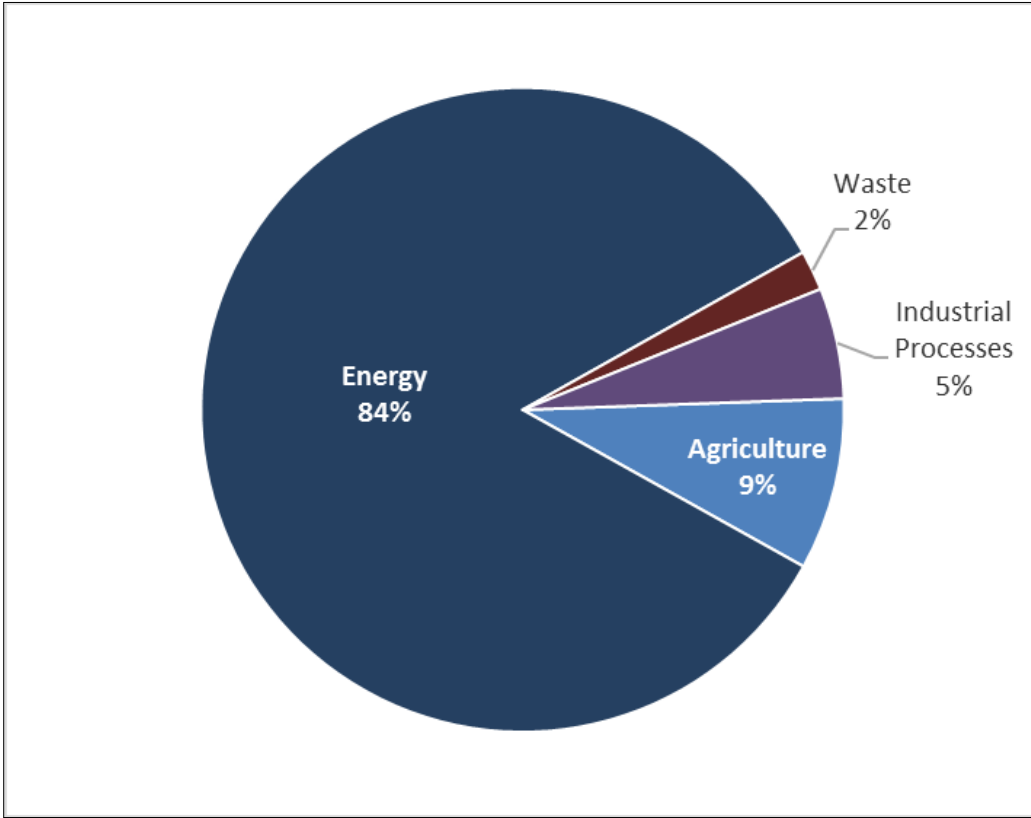
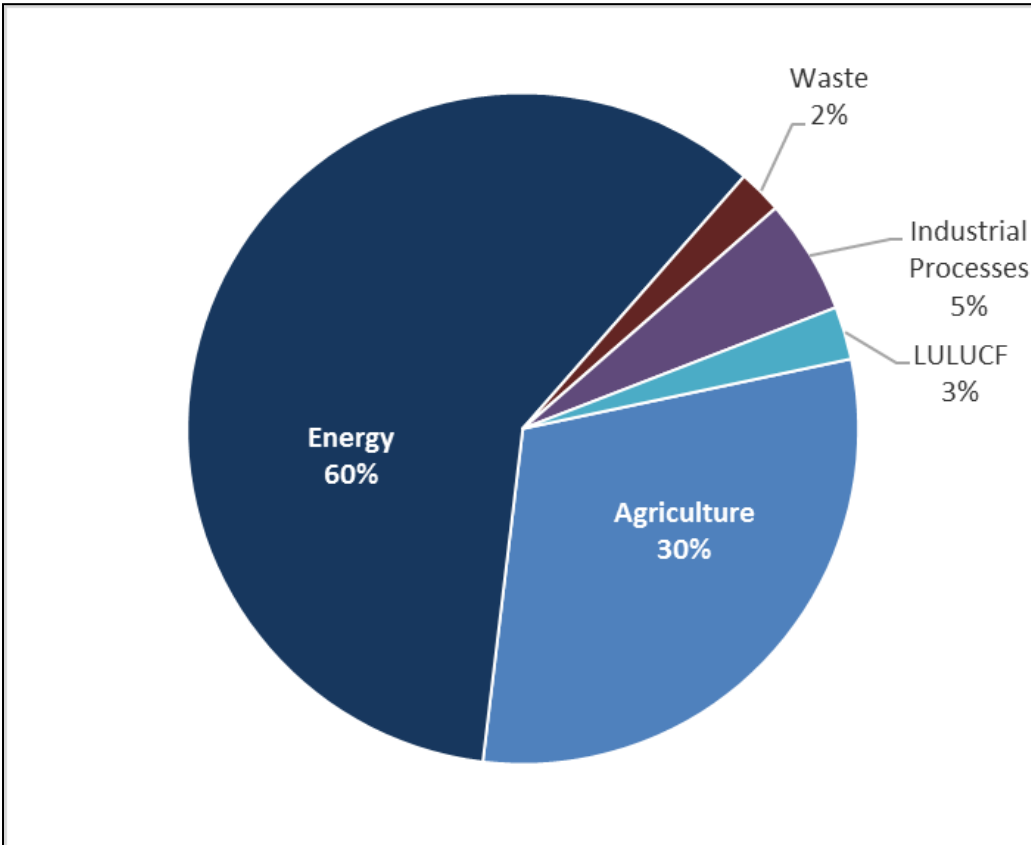


Figure 10: 2016 Iowa GHG Emissions by Sector



## **Future Emissions**

Iowa Code 455B.104 requires that the DNR forecast trends in GHG emissions. Using the SIT Projection tool, the DNR projected emissions to 2020, 2025, and 2030 as shown in Table 10. As with many forecasts, numerous factors affect the uncertainty of the predictions. Such factors include the economy, weather, current and future environmental regulations, energy efficiency and conservation practices, driving practices, use of renewable fuels, and other variables. Additional loss in forecast confidence is introduced by discrepancies between the data used to calculate the 2017 GHG inventory and data within the SIT Projection Tool. For example, the SIT Projection Tool has not yet been updated to include 2017 activity data or more recent energy forecasts from the EIA's Annual Energy Outlook. A more detailed discussion of forecast uncertainty is provided in the TSD.

**Table 10: Projected Gross GHG Emissions 2017 – 2030 (MMtCO<sub>2</sub>e)**

<b>Sector</b>	<b>Calculated</b>	<b>Projected</b>		
	<b>2017</b>	<b>2020</b>	<b>2025</b>	<b>2030</b>
Agriculture	39.61	39.43	39.31	39.97
Power Plants	26.60	29.19	26.06	24.03
RCI Fossil Fuel Use	29.83	29.16	30.06	29.73
Industrial Processes	7.25	3.99	4.84	5.59
Natural Gas T & D	1.27	1.21	1.30	1.30
Transportation	20.34	23.50	22.36	20.88
Waste	2.78	3.69	3.87	4.05
<b>Total</b>	<b>127.69</b>	<b>130.17</b>	<b>127.79</b>	<b>125.55</b>

## **Future Improvements**

The DNR continually strives to make the annual statewide GHG inventory as accurate and timely as possible. Possible areas for enhancement include improved forecasting and a more extensive literature review of research regarding soil carbon.