IOWA DEPARTMENT OF NATURAL RESOURCES

2018 Iowa Statewide Greenhouse Gas Emissions Inventory Report

Required by Iowa Code 455B.104

December 31, 2019

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 requires the Iowa DNR (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 2018 GHG emissions and includes emissions of six GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFC), hydrofluorocarbons (HFC), and sulfur hexafluoride (SF_6).

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 DNR's Technical Support document (TSD), available on the DNR's Greenhouse Gas Emissions webpage.

2018 Statewide GHG Emissions

In 2018, total gross Iowa greenhouse gas emissions were 137.49 million metric tons carbon dioxide equivalent ($MMtCO_2e$) as shown in Table 1 and Figure 1. This is an increase of 4.49 $MMtCO_2e$ (3.38%) from 2017. The overall increase is largely accounted for by a 4.26 $MMtCO_2e$ increase in emissions from power plants, due to increased generation of electricity from fossil fuels. Emissions fluctuations from other sectors were much smaller in magnitude, as shown in Figure 2, and differed by less than 0.30 $MMtCO_2e$ per sector from 2017.

Overall, total 2018 gross statewide GHG emissions increased 3.39% from 2009 and 10.09% from 2016. The 12.60 $MMtCO_2e$ increase in emissions since the end of 2016 is largely attributed to:

- A 5.53 $MMtCO_2e$ increase in emissions from power plants, due to increased generation of electricity from fossil fuels,
- A 2.61 $MMtCO_2e$ increase in emissions from the residential/commercial/industrial (RCI) sector, due to increased use of fossil fuels,
- A 2.15 $MMtCO_2e$ increase in agriculture emissions, due to increased crop and livestock production, and
- A 2.06 $MMtCO_2e$ increase in the industrial processes sector, driven by increased production of ammonia.

Table 1: GHG Emissions 2009 – 2018 by Sector (Million Metric Tons Carbon Dioxide Equivalents ($MMtCO_2e$))[1]

Emissions ($MMtCO_2e$)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Change from 2017		
											$MMtCO_2e$	%	Trend
Agriculture	36.48	36.38	37.91	36.78	35.77	36.75	39.00	39.49	41.71	41.63	-0.08	-0.19%	↓
Power Plants	37.71	42.33	38.98	35.76	33.06	33.44	29.46	25.33	26.62	30.87	+4.25	+15.97%	↑
Residential, Commercial, and Industrial Fuel Use	30.73	31.23	31.44	29.96	32.82	32.82	31.54	29.45	32.05	32.06	+0.01	+0.03%	↑
Industrial Processes	4.21	4.79	4.50	5.18	5.07	5.12	5.09	5.34	7.10	7.40	+0.30	+4.20%	↑
Land Use, Land Use Change, and Forestry (LULUCF)[2]			0.67	0.48		3.27	2.99	1.59	1.05	0.94	-0.11	-10.46%	↓
Natural Gas Transmission and Distribution	1.40	1.39	1.40	1.40	1.40	1.40	1.40	1.41	1.27	1.41	+0.14	+11.19%	↑
Transportation	19.40	19.41	19.58	19.59	19.46	19.55	20.02	20.12	20.42	20.40	-0.02	-0.12%	↓
Waste	3.06	2.01	1.94	2.15	1.96	1.93	2.14	2.16	2.78	2.78	0.00	+0.14%	↑
Total Gross Emissions	**132.98**	**137.54**	**136.40**	**131.30**	**129.55**	**134.29**	**131.64**	**124.89**	**133.00**	**137.49**	**+4.49**	**+3.38%**	**↑**
Carbon Stored in LULUCF[3]	-5.00	-2.01	0	0	-0.71	0	0	0	0	0			
Total Net Emissions	**127.99**	**135.53**	**136.40**	**131.30**	**128.83**	**134.29**	**131.64**	**126.64**	**133.00**	**137.49**	**+4.49**	**+3.38%**	**↑**

[1] 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 DNR in December 2017. Any adjustments are described in detail in the Technical Support Document.

[2] 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.

[3] Carbon stored in LULUCF is shown in this row as a negative number.

Figure 1: Iowa Gross GHG Emissions 2009 – 2018 ($MMtCO_2e$)

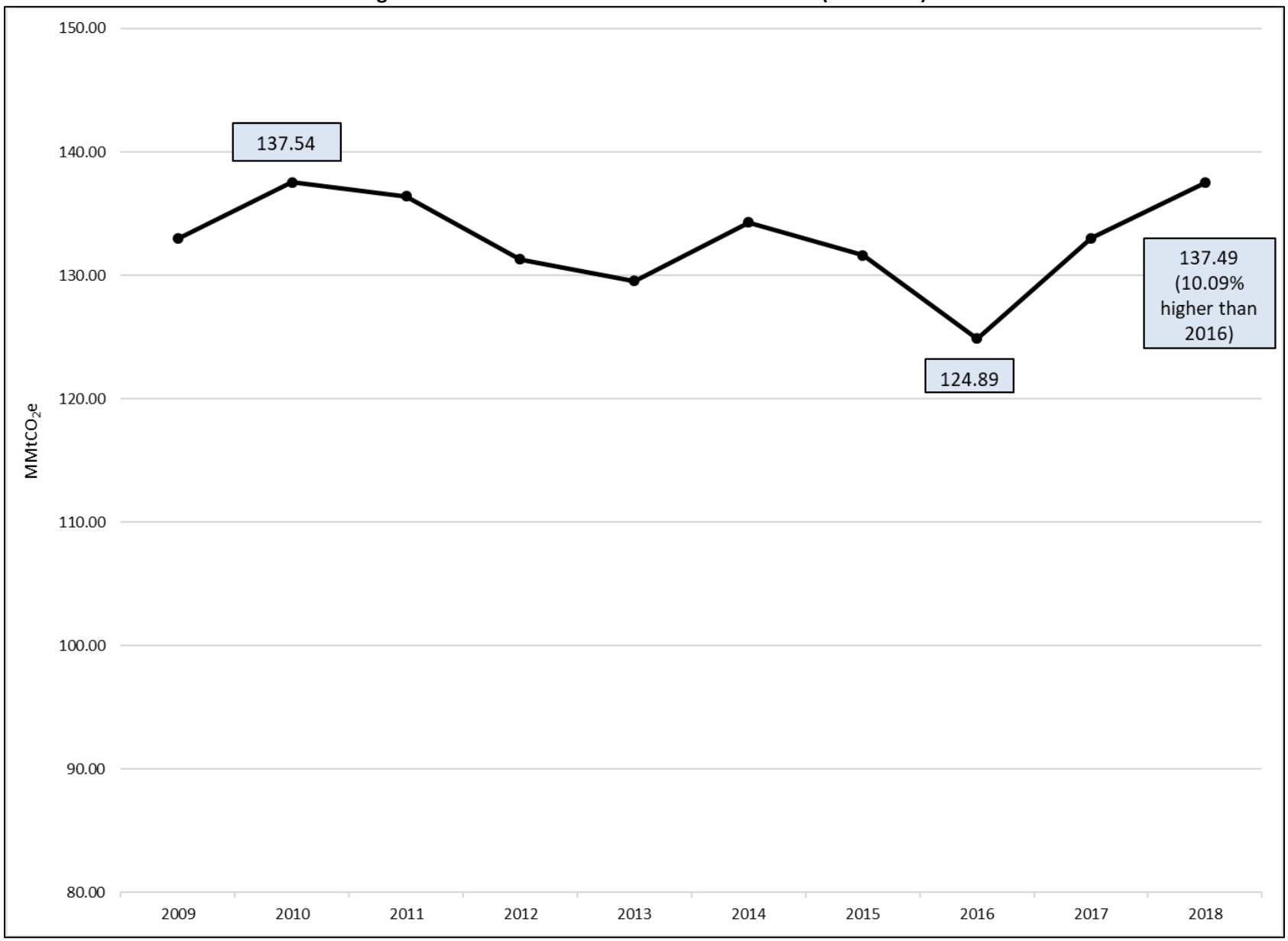
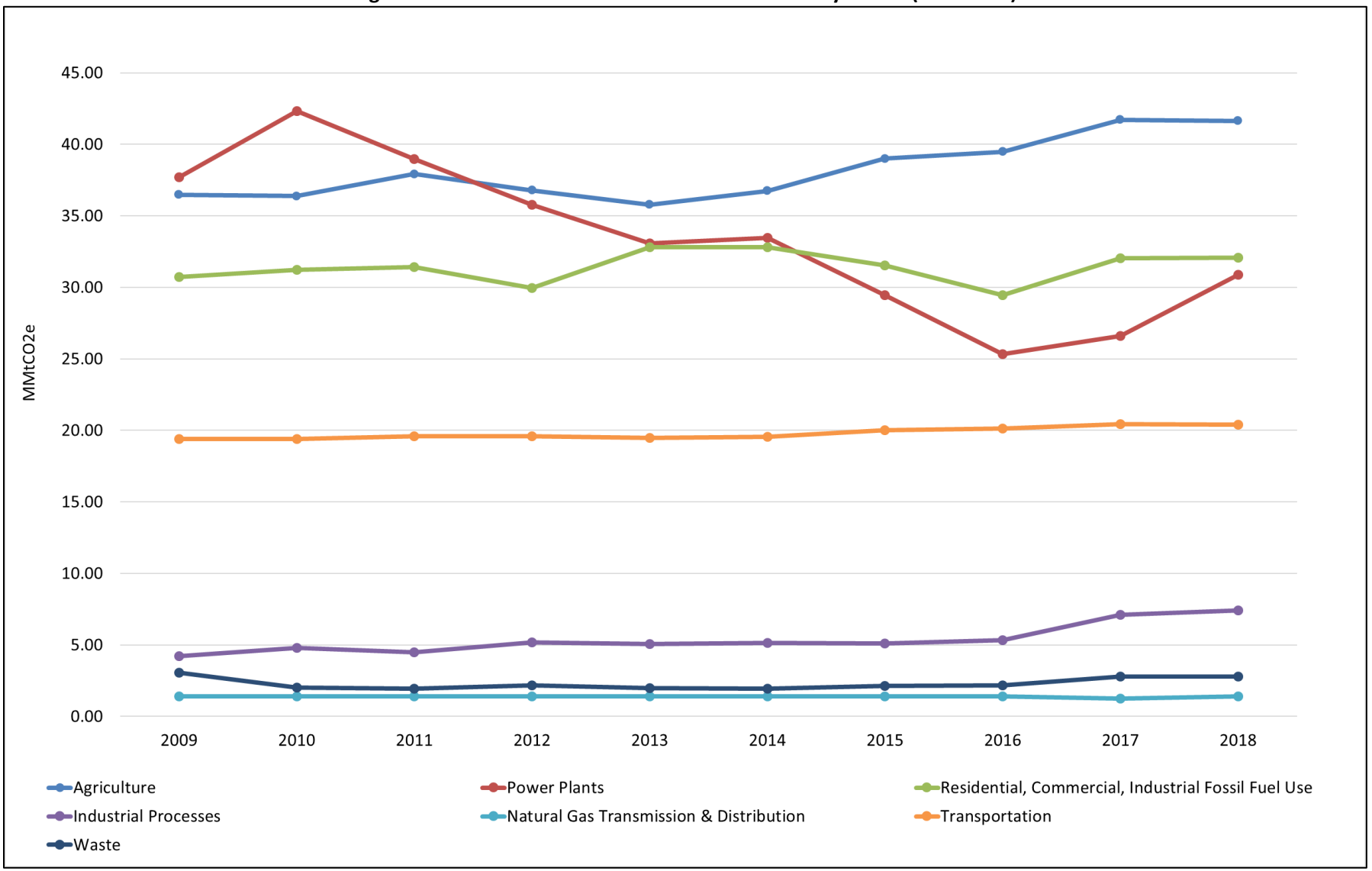


Figure 2: Iowa Gross[4] GHG Emissions 2009 – 2018 by Sector ($MMtCO_2e$)

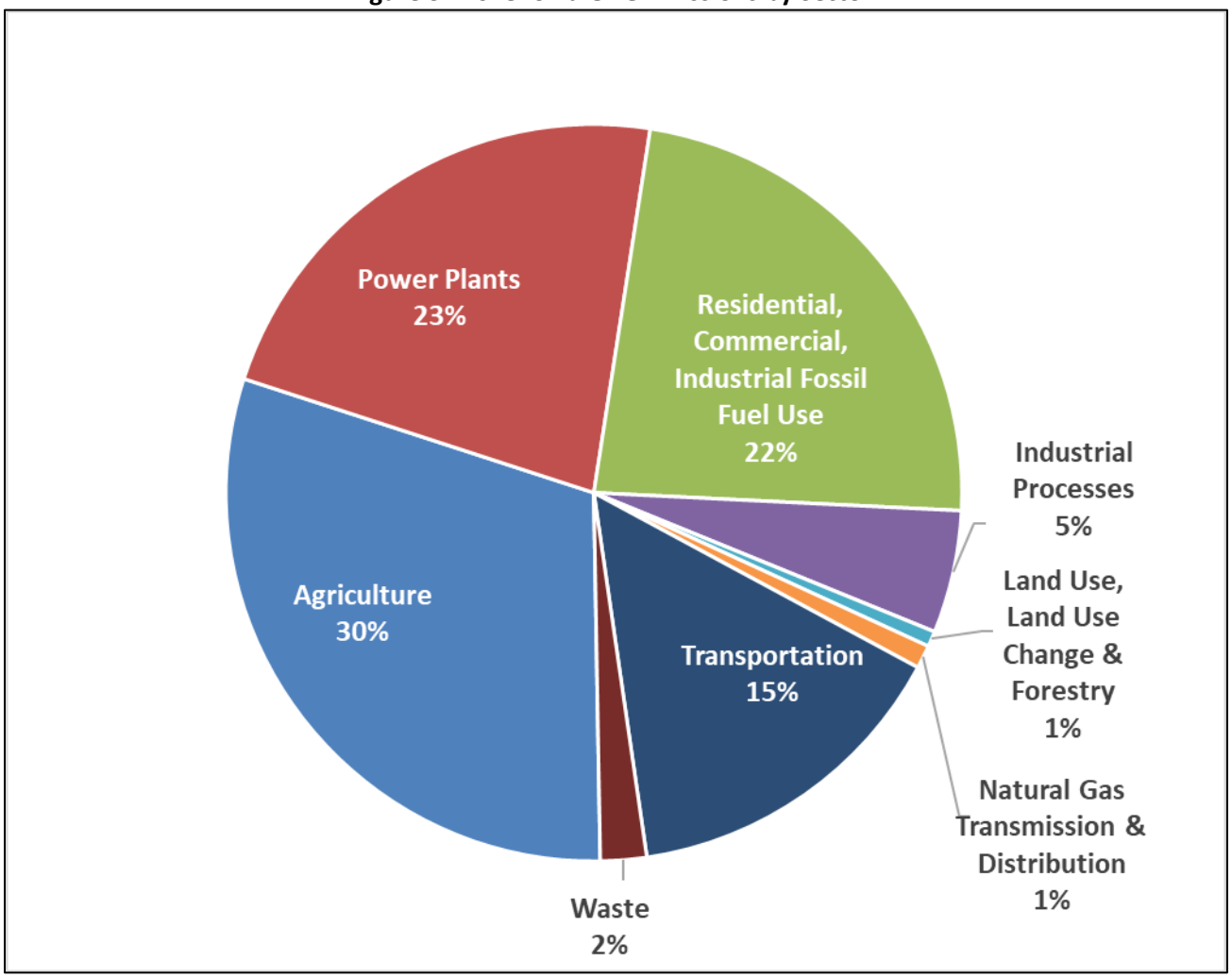


[4] Does not include carbon storage or emissions from land use, land use change, and forestry (LULUCF).

GHG Emissions by Sector

The majority of GHG emissions in Iowa in 2018 were from the agriculture sector (30%), followed by emissions from the residential/commercial/industrial (RCI) sector (23%), and fossil fuel use by power plants (22%) as shown in Figure 3. The emissions from these, and other sectors, are summarized below and are ordered as presented in the TSD. Please refer to the 2018 GHG Inventory Technical Support Document for more information on a specific sector, such as sources of input data, calculations, and uncertainty.

Figure 3: 2018 Iowa GHG Emissions by Sector[5]



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

[5] 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. Note, sector percentages may not sum to 100% due to rounding.

decreased 0.19% between 2017 and 2018. Emissions from enteric fermentation exhibited the largest change, increasing 0.57%, due to an increase in the number of cattle produced. Manure management emissions were lower, as the swine population decreased. Emissions from agricultural soil management also decreased, as the production of alfalfa, corn, oats, soybeans, and wheat all decreased.

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

Category	2017	2018	% Change
Enteric Fermentation	8.40	8.45	+0.57%
Manure Management	11.75	11.70	-0.39%
Agricultural Soil Management	21.56	21.48	-0.38%
Total	**41.71**	**41.63**	**-0.19%**

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 combine into one category called RCI). Table 3 shows little change in emissions from RCI and an increase of 15.97% in power plant emissions between 2017 and 2018. Together, these four categories account for 45.77% of Iowa's total GHG emissions.

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

Category	2017	2018	% Change
Residential, Commercial, Industrial (RCI)	32.05	32.06	+0.03%
Residential	*4.41*	*4.41*	*+0.10%*
Commercial	*3.82*	*3.83*	*+0.05%*
Industrial	*23.82*	*23.83*	*0.01%*
Power Plants	26.62	30.87	+15.97%
Total	**58.97**	**62.93**	**+7.26%**

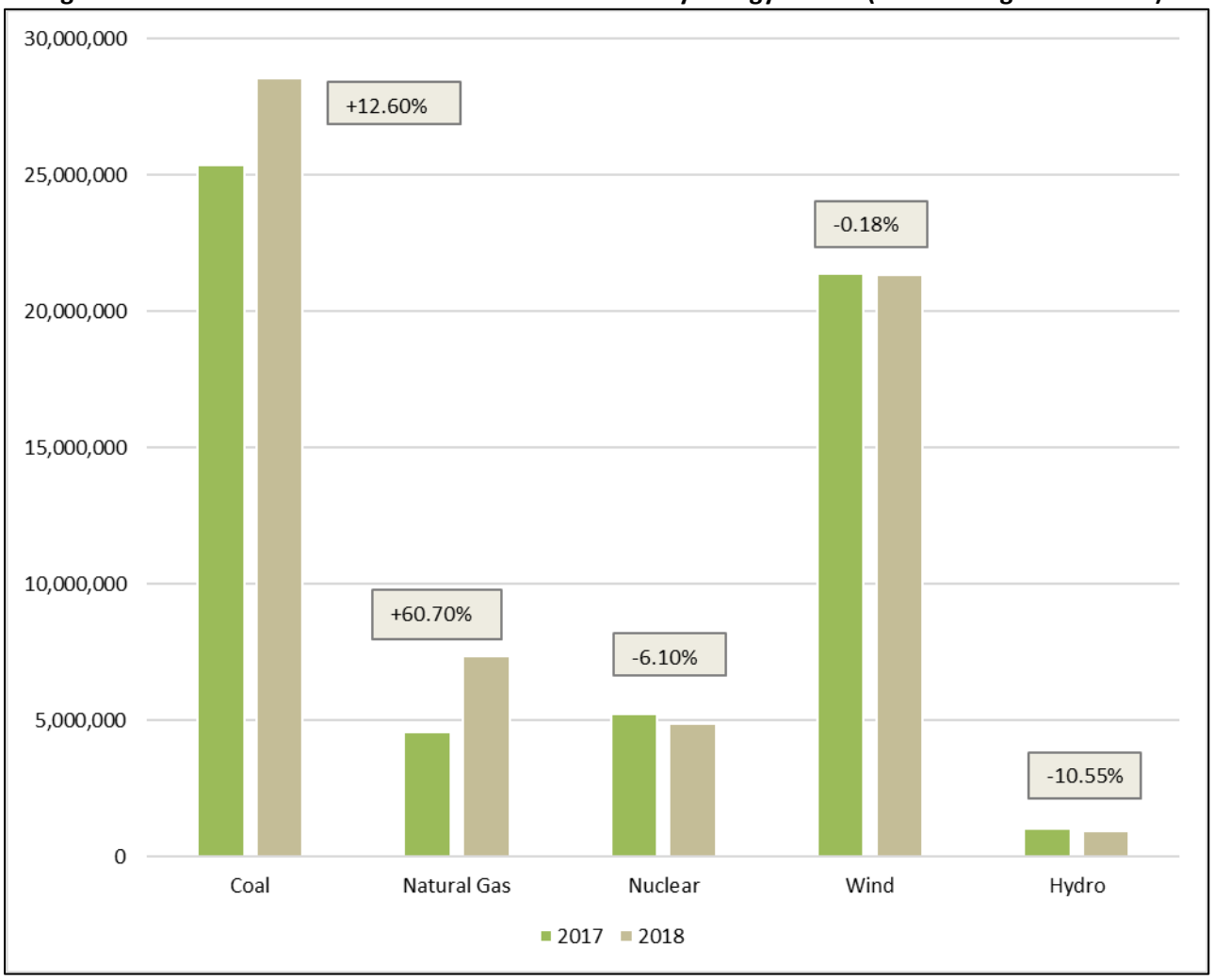
Residential, Commercial, and Industrial (RCI)

Actual fuel use data for 2018 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 2019 with Projections to 2040.* Emissions predicted for 2017 from the RCI sector in last year's inventory (29.81 $MMtCO_2e$) were replaced with actual 2017 consumption values now available from EIA. The resulting recalculated 2017 emissions were 32.05 $MMtCO_2e$.

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 Part 98). Continuous emission monitoring systems (CEMS) measure the CO_2 emissions from these facilities. Emissions from power plants increased 4.25 $MMtCO_2e$ (15.97%) from the previous year, primarily due to a 12.60% increase in the amount of electricity generated from coal and a 60.70% increase in the amount generated from natural gas as shown in Figure 4. Electricity generation from nuclear, wind, and hydroelectric (hydro) decreased by 6.10%, 0.18%, and 10.55%, respectively (electricity generated by these sources does not contribute to GHG emissions).

Figure 4: 2017 and 2018 Net Iowa Electric Generation by Energy Source (Million Megawatt Hours)[6]



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 4.20% from 2017 - 2018 as shown in Table 4.

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

[6] U.S. EIA: Net Generation by State by Type of Producer by Energy Source, October 22, 2019.

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

Category	2017	2018	% Change
Ammonia and Urea Production	2.60	3.26	+25.27%
Cement Manufacture	1.66	1.30	-21.65%
Electric Power Transmission & Distribution Systems	0.06	0.06	+0.98%
Iron and Steel Production	0.20	0.19	-4.42%
Lime Manufacture	0.18	0.16	-8.82%
Limestone and Dolomite Use	0.21	0.21	NA[7]
Nitric Acid Production	0.70	0.73	+3.88%
Ozone Depleting Substance Substitutes	1.47	1.47	-0.11%
Soda Ash Consumption	0.02	0.02	-0.11%
Total	**7.10**	**7.40**	**+4.20%**

Natural Gas Transmission and Distribution (T & D)

This sector includes emissions from natural gas transmission and distribution systems in the state. GHG emissions increased 0.87% from 2017 as shown in Table 5, due to increases 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 ($MMtCO_2e$)[8]

Category	2017	2018	% Change
Transmission	0.7868	0.7864	-0.05%
Distribution	0.4789	0.6209	+2.06%
Total	**1.2657**	**1.4073**	**+0.87%**

Transportation

The transportation sector includes GHG emissions from both highway and non-highway vehicles. Non-highway vehicles are aviation, boats, locomotives, tractors, other utility vehicles, and alternative fuel vehicles. Emissions from highway vehicles are calculated based on vehicle miles traveled, while fuel consumption. Total vehicle miles traveled by Iowans decreased 0.72% between 2017 and 2018, which contributed significantly to the overall 0.12% decrease in transportation GHG emissions shown in Table 6.

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

Category	2017	2018	% Change
Gasoline Highway	11.49	11.43	-0.47%
Diesel Highway	4.49	4.52	+0.67%
Non-Highway	4.43	4.43	NA[9]
Alternative Fuel Vehicles	0.01	0.01	NA[9]
Total	**20.42**	**20.40**	**-0.12%**

[7] Due to lack of current data, the DNR assumed 2017 emissions = 2018 emissions.

[8] DNR generally 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.

[9] Due to a lack of current data, the DNR assumed 2017 values = 2018 values.

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 0.14% from 2017 as shown in Table 7. Solid waste emissions decreased because emissions from combustion of municipal solid waste (MSW) decreased. Emissions from wastewater increased primarily due to increased wastewater emissions from industrial facilities. DNR used facility-specific emissions data directly reported by facilities to EPA. EPA's LandGEM model was used to estimate emissions from smaller landfills that are not required to report to EPA.

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

Category	2017	2018	% Change
Solid Waste	2.302	2.299	-0.14%
Wastewater	0.477	0.484	+1.51%
Total	**2.779**	**2.783**	**+0.14%**

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 sent to landfills.

Overall, total 2018 emissions from LULUCF were 0.94 $MMtCO_2e$ as shown in Table 8. This is a 10.46% decrease in the CO_2e being emitted. This is attributed to decreases in emissions from liming of agricultural soils and fertilization of settlement soils (e.g. landscaping, lawns, and golf courses).

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

Category	2017	2018	% Change
Forest Carbon Flux	-0.61	-0.61	NA[10]
Liming of Agricultural Soils	0.45	0.40	-11.60%
Urea Fertilization	0.18	0.18	NA[10]
Urban Trees	0.59	0.59	NA[10]
Yard Trimmings & Food Scraps in Landfills	-0.09	-0.10	+4.26%
Fertilization of Settlement Soils	0.53	0.48	-10.00%
Total	**1.05**	**0.94**	**-10.46%**

Carbon emitted or sequestered from agricultural soil carbon flux is not included in the inventory because of the uncertainty and that SIT lacks a calculation function for 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 2018 GHG Inventory 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). Table 9 shows the distribution of GHGs by pollutant in Iowa while Figures 5-8 show the distribution by both pollutant and by category.

[10] Due to a lack of current data, the DNR assumed 2017 values = 2018 values.

Carbon dioxide is the greenhouse gas emitted in the highest amounts in Iowa, accounting for 64.28% of all greenhouse gas emissions in 2018. Nearly all CO_2 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 23.19 $MMtCO_2e$ or 16.86% of total 2018 GHG emissions. Nitrous oxide emissions in 2018 were 24.40 $MMtCO_2e$ or 17.75% of total GHG emissions.

Emissions of HFCs, PFCs and SF_6 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_6) in electric power transmission and distribution lines. In 2018, emissions of these three pollutants totaled 1.53 $MMtCO_2e$, or 1.11% of Iowa's 2018 total GHG emissions.

Table 9: 2018 GHG Emissions by Pollutant ($MMtCO_2e$)

Pollutant	2018	% of Total
CO_2	88.37	64.28%
CH_4	23.19	16.86%
N_2O	24.40	17.75%
$HFC/PFC/SF_6$	1.53	1.11%
Total	**137.49**	**100.00%**

Figure 5: 2018 Carbon Dioxide Emissions by Sector

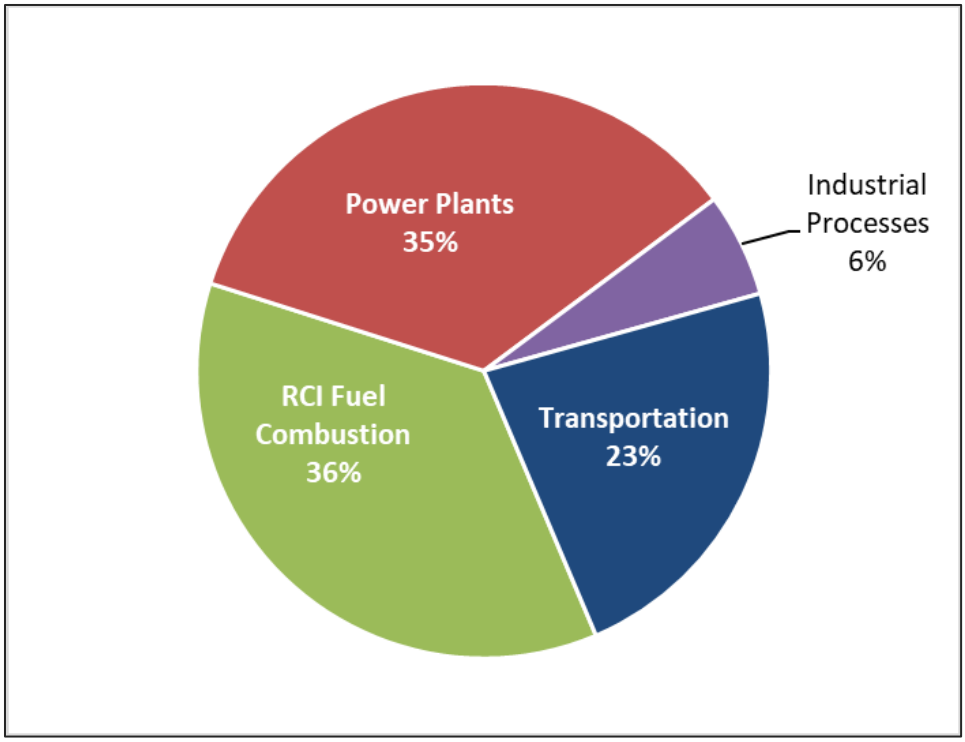


Figure 6: 2018 Methane Emissions by Sector

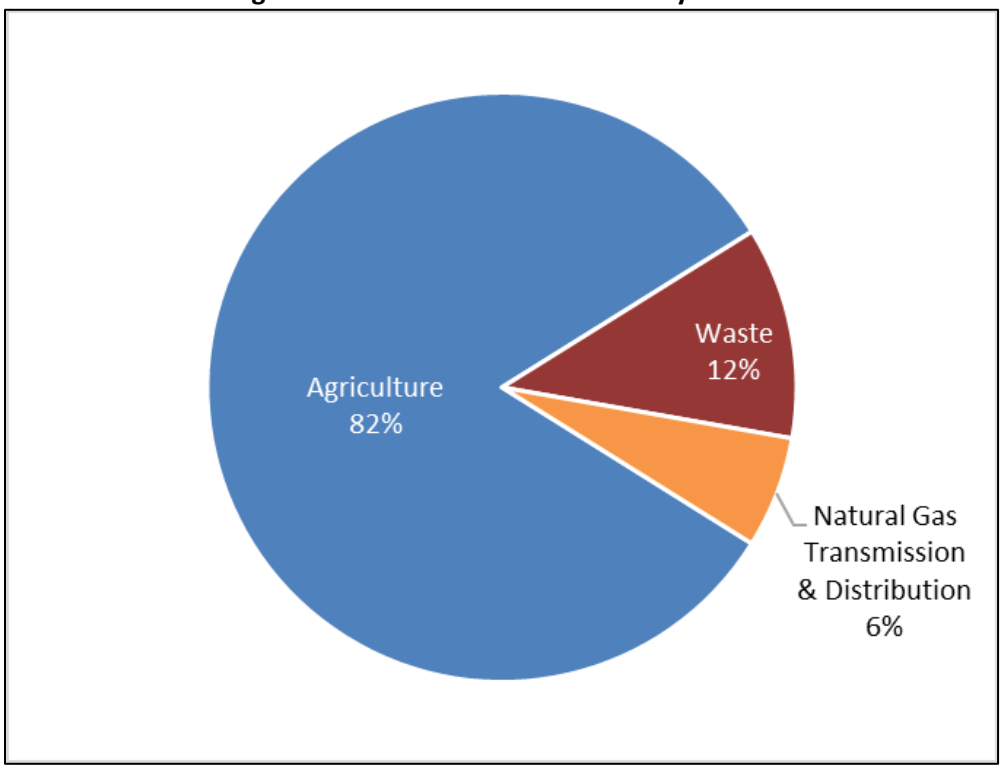


Figure 7: 2018 Nitrous Oxide Emissions by Sector

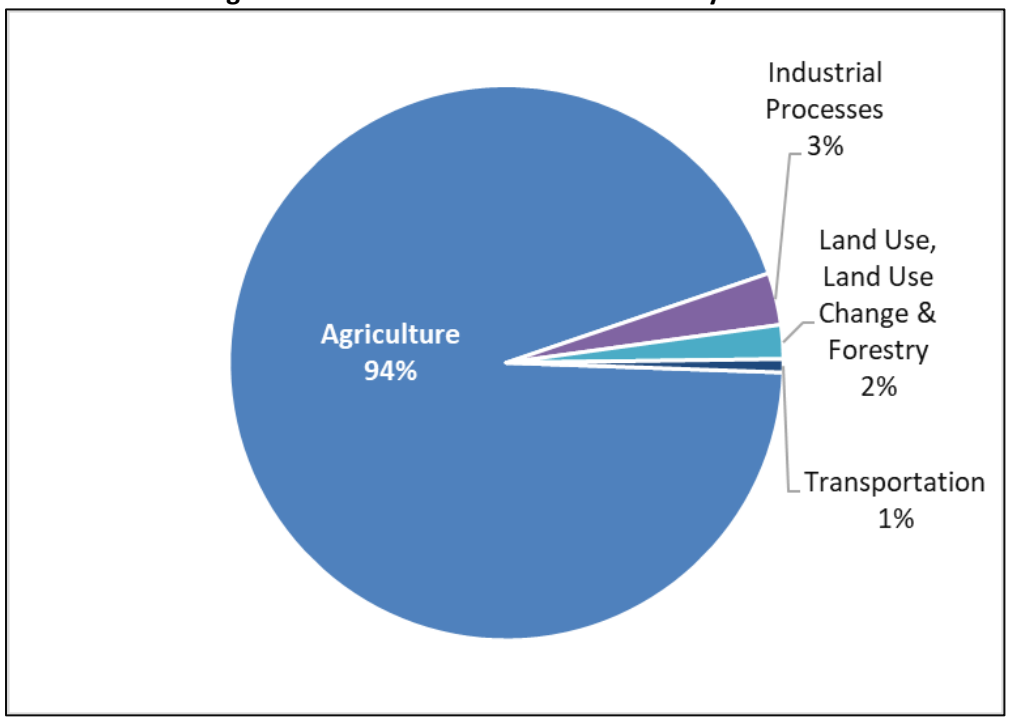
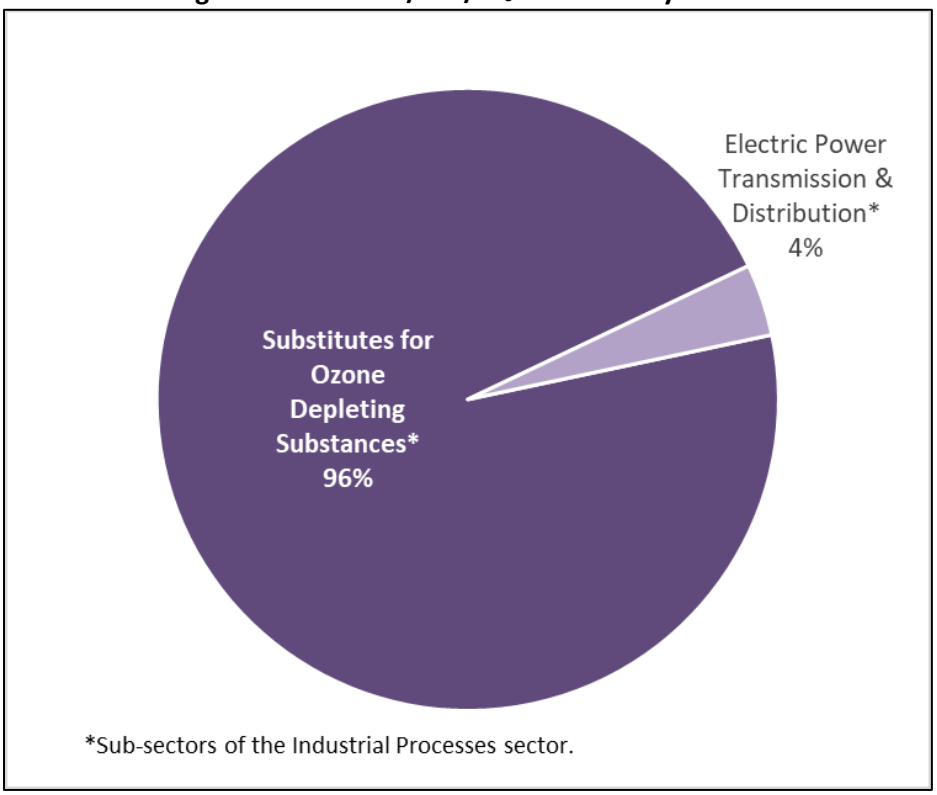


Figure 8: 2018 HFC/PFC/SF_6 Emissions by Sector



Comparison with U.S. Emissions

Comparing Iowa's GHG emissions with U.S. emissions requires the use of 2017 data because the 2018 national GHG inventory is not available yet. Figures 9 and 10 compare national and Iowa GHG emissions by sector. The fossil fuel combustion, natural gas transmission and distribution, and transportation sectors are 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. Overall, Iowa's gross GHG emissions in 2017 were 133.00 $MMtCO_2e$. This represents 2.06% of the total 2017 U.S. gross GHG emissions of 6,456.70 $MMtCO_2e$.

Figure 9: 2017 U.S. GHG Emissions by Sector[11]

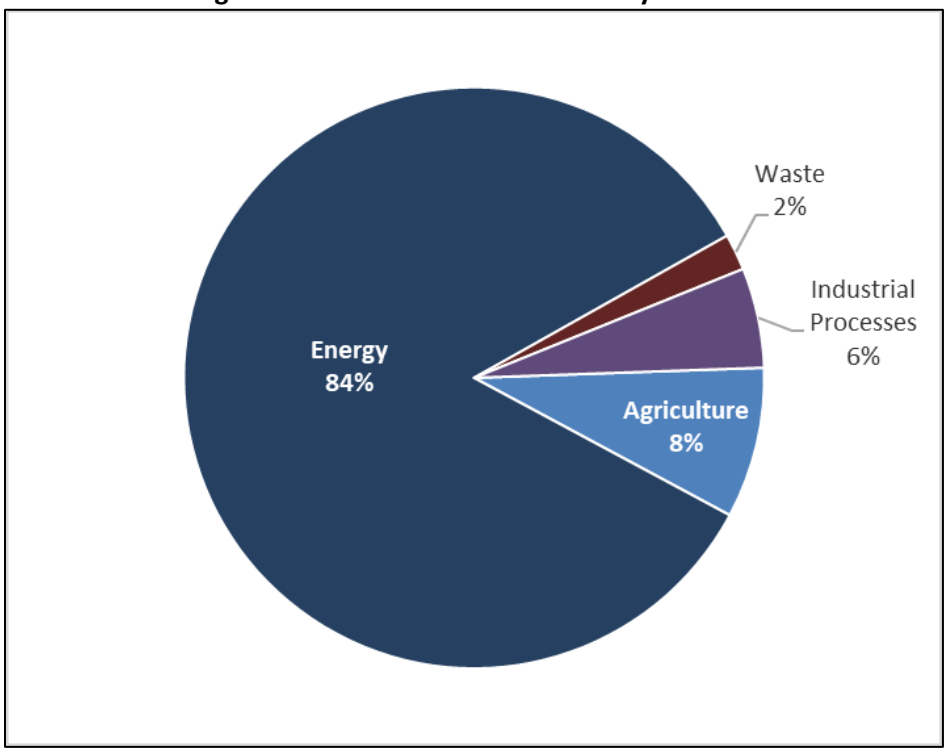
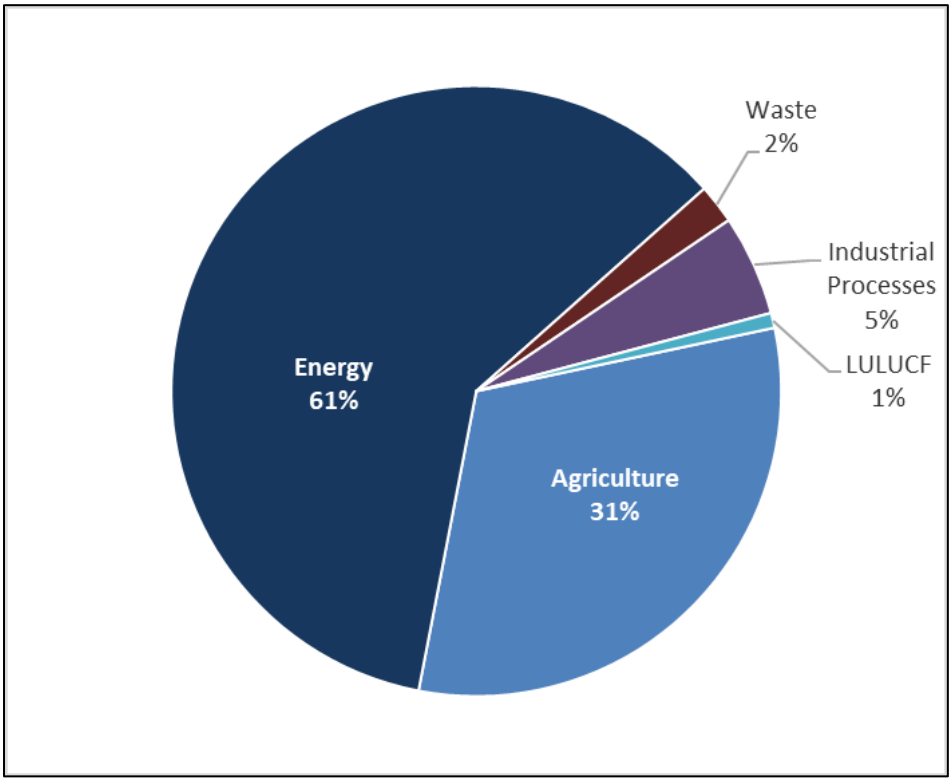


Figure 10: 2017 Iowa GHG Emissions by Sector



[11] LULUCF is not included in the chart for U.S. emissions, as nationally 714.1 $MMtCO_2e$ is sequestered/stored by the LULUCF sector instead of emitted.

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. The Projection Tool forecasts emissions from industrial processes, agriculture, and waste based on historical emissions from 1990 – 2017, using a combination of data sources and national projections for activity data. A 2018 "forecast" was also produced to help gauge the reasonableness of the projections. As with many forecasts, numerous factors affect the certainty 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. Discrepancies between the data used to calculate the 2018 GHG inventory and data within the SIT Projection Tool reduce confidence in the projections. For example, the SIT Projection Tool is not configured to include 2018 activity data. The TSD provides a more detailed discussion of forecast uncertainty.

Table 10: Projected Gross GHG Emissions 2018 – 2030 ($MMtCO_2e$)

	Calculated	Projected			
Sector	**2018**	**2018**	**2020**	**2025**	**2030**
Agriculture	41.63	41.71	43.98	49.67	55.37
Power Plants	30.87	25.21	23.65	25.55	25.73
RCI Fossil Fuel Use	32.06	31.70	30.49	31.71	32.10
Industrial Processes	7.40	4.07	4.56	5.54	6.43
Natural Gas T & D	1.41	1.45	1.51	1.49	1.59
Transportation	20.40	22.75	22.65	21.22	20.02
Waste	2.78	4.06	4.13	4.34	4.54
Total	**137.49**	**130.94**	**130.96**	**139.62**	**145.79**

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 sequestration in the agricultural sector.