IOWA DEPARTMENT OF NATURAL RESOURCES

2019 Iowa Statewide Greenhouse Gas Emissions Inventory Report

Required by Iowa Code 455B.104

December 31, 2020

Iowa Department of Natural Resources
502 E. 9th Street
Des Moines, IA 50319

Table of Contents

Background

This report is required by Iowa Code 455B.104, which requires the Iowa Department of Natural Resources (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 2019 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.

2019 Statewide GHG Emissions

In 2019, total gross Iowa greenhouse gas emissions were 130.07 million metric tons carbon dioxide equivalent ($MMtCO_2e$) as shown in Table 1 and Figure 1. This is a decrease of 2.35 $MMtCO_2e$ (1.77%) from 2018 and a decrease of 5.43% from 2010. The 2.35 $MMtCO_2e$ decrease in emissions since the end of 2018 is largely attributed to the following combination of reductions and partially offsetting increases:

- A 6.30 $MMtCO_2e$ decrease in emissions from power plants, due to decreased generation of electricity from fossil fuels,
- A 0.78 $MMtCO_2e$ decrease in emissions from the agriculture sector, due to decreased emissions from agriculture soil management,
- A 4.52 $MMtCO_2e$ increase in emissions from residential, commercial and industrial fuel use, and
- A 0.23 $MMtCO_2e$ increase in emissions from mobile combustion due to an increase in vehicle miles traveled.

Emissions fluctuations from other sectors were much smaller in magnitude, as shown in Figure 2, and differed by less than 0.10 $MMtCO_2e$ per sector from 2018.

Table 1: GHG Emissions 2009 – 2019 by Sector (Million Metric Tons Carbon Dioxide Equivalents ($MMtCO_2e$))[1]

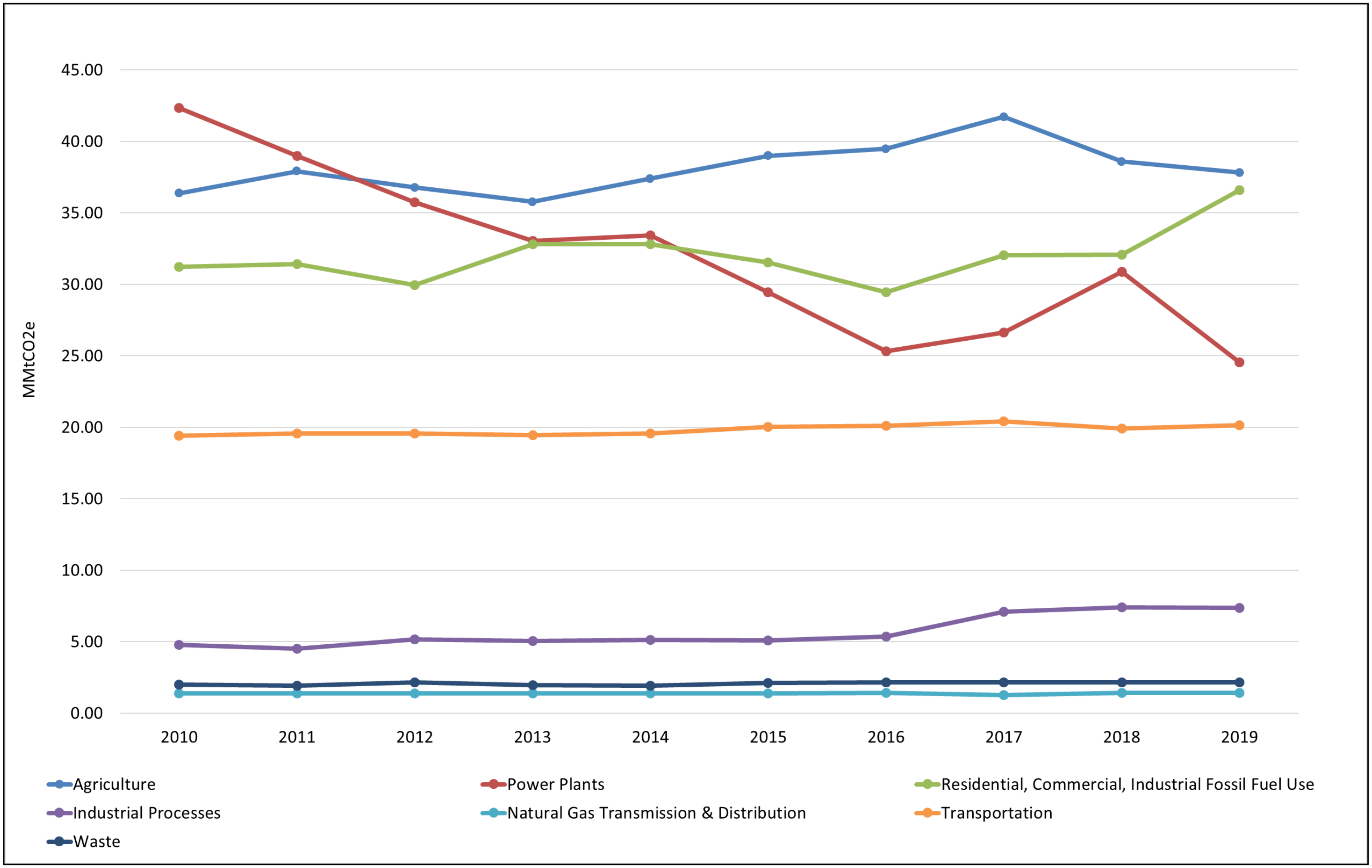
Emissions ($MMtCO_2e$)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change from 2018		
											$MMtCO_2e$	%	Trend
Agriculture	36.38	37.91	36.78	35.77	37.39	39.00	39.49	41.71	38.60	37.82	-0.78	-2.02%	↓
Power Plants	42.33	38.98	35.76	33.06	33.44	29.46	25.33	26.62	30.87	24.57	-6.30	-20.41%	↓
Residential, Commercial, and Industrial Fuel Use	31.23	31.44	29.96	32.82	32.82	31.54	29.45	32.05	32.07	36.58	4.52	14.08%	↑
Industrial Processes	4.79	4.50	5.18	5.07	5.12	5.09	5.34	7.10	7.40	7.37	-0.03	-0.35%	↓
Natural Gas Transmission and Distribution	1.39	1.40	1.40	1.40	1.40	1.40	1.41	1.27	1.41	1.42	0.01	0.64%	↑
Transportation	19.41	19.58	19.59	19.46	19.55	20.02	20.12	20.42	19.92	20.15	0.23	1.14%	↑
Waste	2.01	1.94	2.15	1.96	1.93	2.14	2.16	2.15	2.15	2.16	0.00	0.21%	↑
Total Gross Emissions	**137.54**	**135.74**	**130.82**	**129.55**	**131.67**	**128.65**	**123.30**	**131.32**	**132.42**	**130.07**	**-2.35**	**-1.77%**	↓
Carbon Stored in LULUCF[2]	-9.08	-11.78	-12.64	-8.46	-6.44	-7.26	-9.77	-9.49	-8.72	-8.82	-0.10	1.15%	↑
Total Net Emissions	128.45	123.96	118.18	121.09	125.23	121.39	113.53	121.83	123.70	121.25	-2.45	-1.98%	↓

[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 2019. Any adjustments are described in detail in the Technical Support Document.

[2] Carbon stored by the LULUCF sector is shown as a negative number.

Figure 1: Iowa Gross GHG Emissions 2010 – 2019 ($MMtCO_2e$)

Figure 2: Iowa Gross[3] GHG Emissions 2010 – 2019 by Sector ($MMtCO_2e$)

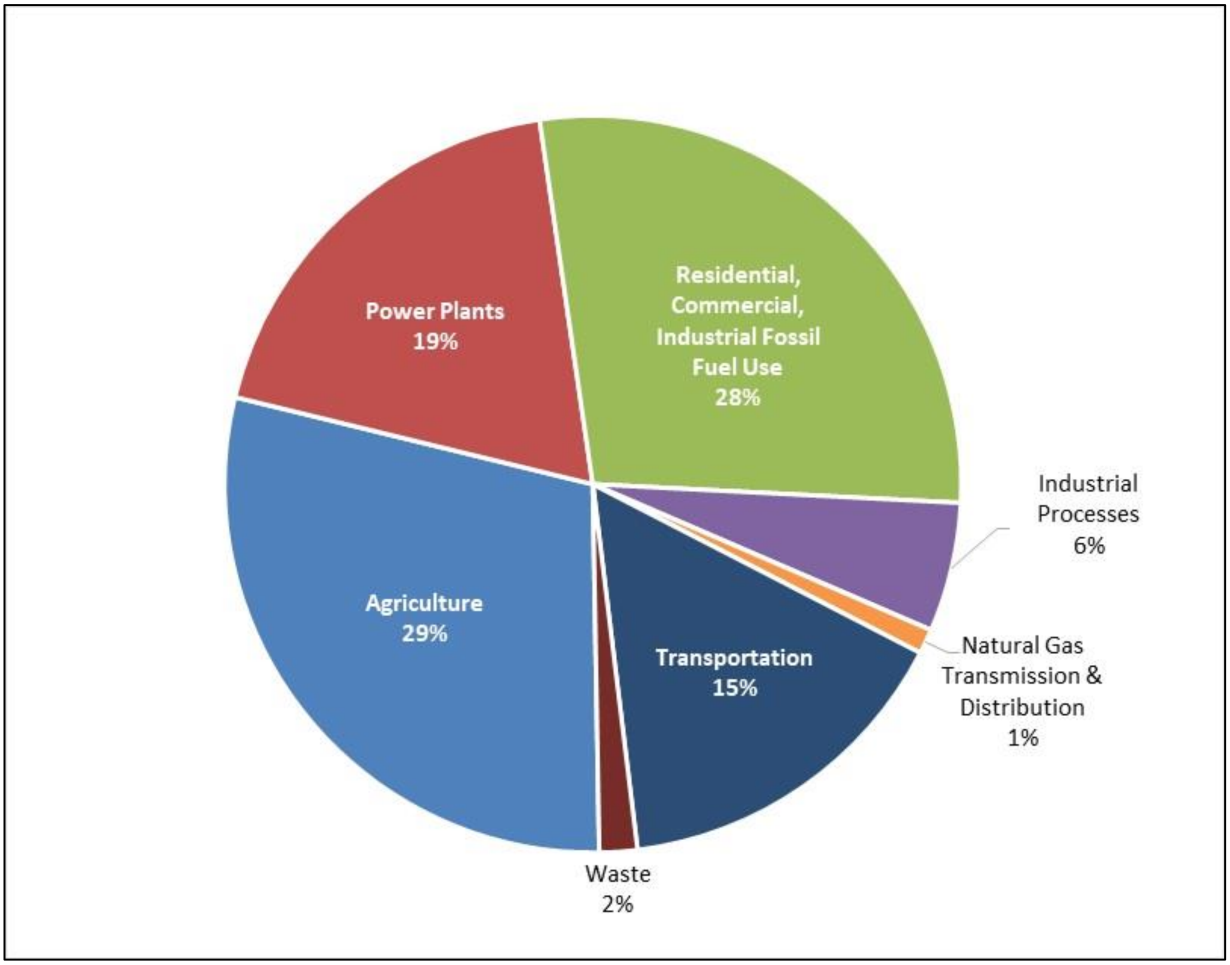


3 Does not include carbon storage from land use, land use change, and forestry (LULUCF).

GHG Emissions by Sector

The majority of GHG emissions in Iowa in 2019 were from the agriculture sector (29%), followed by emissions from the residential/commercial/industrial (RCI) sector (28%), and fossil fuel use by power plants (19%), 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 2019 GHG Inventory Technical Support Document for more information on a specific sector, such as sources of input data, calculations, and uncertainty.

Figure 3: 2019 Iowa GHG Emissions by Sector[4,5]



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

[4] 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.

[5] Does not include Land Use, Land Use Change, and Forestry (LULUCF). LULUCF was an emissions sink in 2019.

decreased 2.02% between 2018 and 2019. Emissions from agricultural soil management exhibited the largest change, decreasing 3.38%, due to a decrease in the amount of soybeans grown, which fix nitrogen but also emit N_2O from the integration of plant residues. Manure management emissions were lower, as the cattle population decreased. Emissions from enteric fermentation decreased slightly, due to the mainly stable animal census with a slight decrease in heifer stockers.

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

Category	2018	2019	% Change
Enteric Fermentation	8.69	8.66	-0.37%
Manure Management	8.20	8.19	-0.18%
Agricultural Soil Management	21.70	20.97	-3.38%
Total	**38.60**	**37.82**	**-2.02%**

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). Together, these four categories account for 47.01% of Iowa's total GHG emissions. Table 3 shows an increase of 14.08% in emissions from RCI and a decrease of 20.41% in power plant emissions between 2018 and 2019.

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

Category	2018	2019	% Change
Residential, Commercial, Industrial (RCI)	32.07	36.58	14.08%
Residential	*4.42*	*5.31*	*20.23%*
Commercial	*3.83*	*4.14*	*8.17%*
Industrial	*23.83*	*27.14*	*13.89%*
Power Plants	30.87	24.57	-20.41%
Total	**62.93**	**61.15**	**-2.83%**

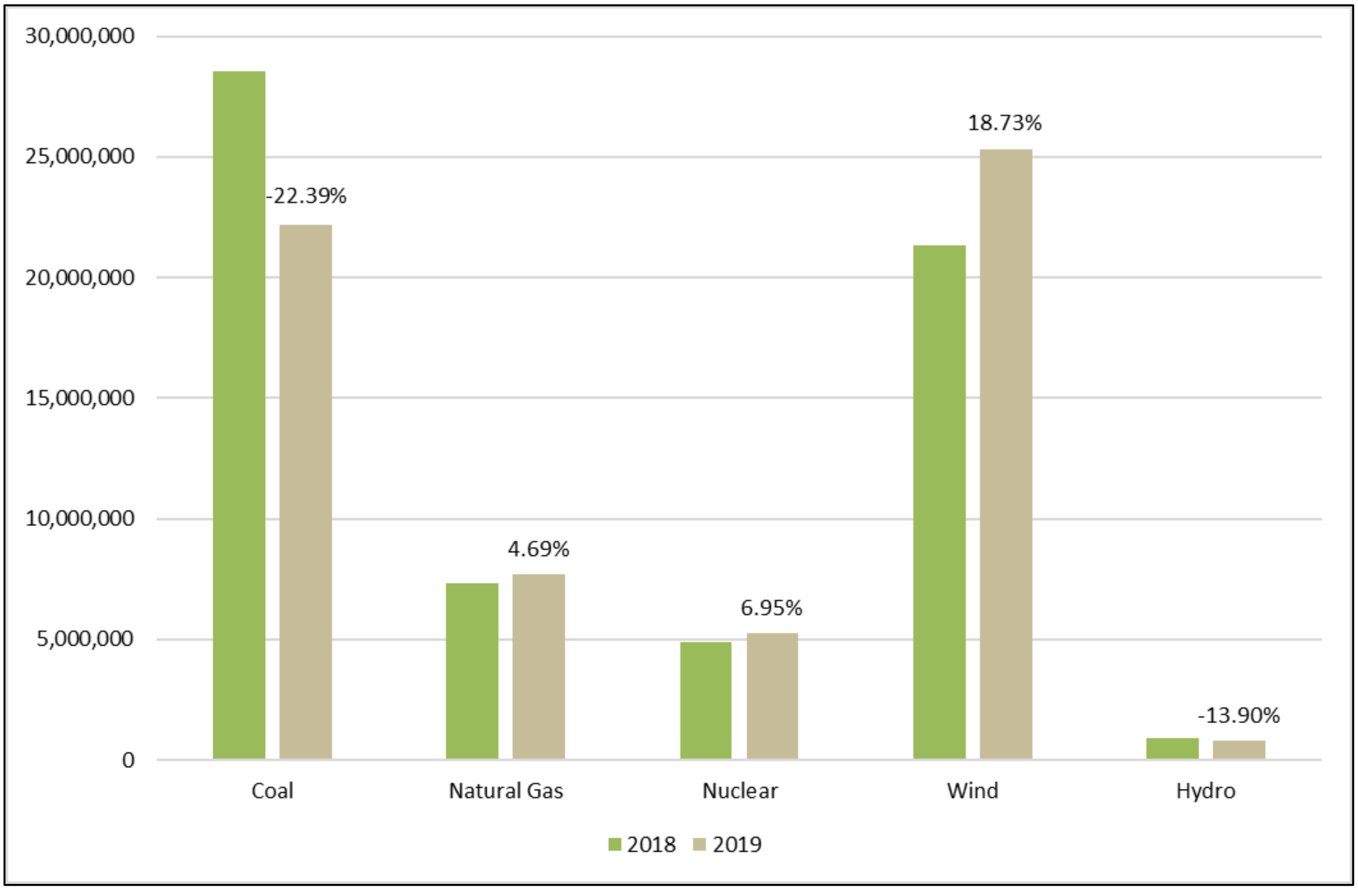
Residential, Commercial, and Industrial (RCI)

Actual fuel use data for 2019 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 2018 from the RCI sector in last year's inventory (32.06 $MMtCO_2e$) were replaced with actual 2018 consumption values now available from EIA. The resulting recalculated 2018 emissions were 32.07 $MMtCO_2e$.

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 decreased 6.30 $MMtCO_2e$ (20.41%) from the previous year. As shown in Figure 4, from 2018 to 2019 electricity generation from nuclear and wind increased by 6.95% and 18.73% respectively (electricity generated by these sources does not contribute to GHG emissions).

Figure 4: 2018 and 2019 Net Iowa Electric Generation by Energy Source (Million Megawatt Hours)[6]



<u>Industrial Processes</u>

This sector includes non-combustion GHG emissions from a variety of processes including cement production, lime manufacturing, 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 0.35% from 2018 to 2019, 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 manufacturing, iron and steel production, lime manufacturing, 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, September 22, 2020.

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

Category	2018	2019	% Change[7]
Ammonia and Urea Production	3.26	3.14	-3.58%
Cement Manufacturing	1.30	1.21	-6.98%
Electric Power Transmission & Distribution Systems	0.06	0.05	-13.14%
Iron and Steel Production	0.19	0.18	-2.70%
Lime Manufacturing	0.16	0.17	+1.93%
Limestone and Dolomite Use	0.21	0.21	NA
Nitric Acid Production	0.73	0.78	+6.99%
Ozone Depleting Substances Substitutes	1.47	1.61	+9.53%
Soda Ash Consumption	0.02	0.02	-1.30%
Total	**7.40**	**7.37**	**-0.35%**

<u>Natural Gas Transmission and Distribution (T & D)</u>

This sector includes emissions from natural gas transmission and distribution systems in the state. GHG emissions increased 0.64% from 2018 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$_2$e)[8]

Category	2018	2019	% Change
Transmission	0.7864	0.7842	-0.28%
Distribution	0.6209	0.6321	+1.80%
Total	**1.4073**	**1.4163**	**+0.64%**

<u>Transportation</u>

The transportation sector includes GHG emissions from both highway and non-highway vehicles. Non-highway vehicles include aviation, boats, locomotives, tractors, other utility vehicles, and alternative fuel 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 Iowans increased 0.81% between 2018 and 2019, which contributed significantly to the overall 1.14% increase in transportation GHG emissions shown in Table 6.

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

Category	2018	2019	% Change[7]
Gasoline Highway	11.39	11.48	+0.75%
Diesel Highway	4.51	4.65	+3.15%
Non-Highway	4.00	4.00	NA
Alternative Fuel Vehicles	0.01	0.01	NA
Total	**19.92**	**20.15**	**1.14%**

[7] For categories marked as "NA," the DNR assumed 2019 values equal 2018 values due to a lack of more current data.

[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.

Waste

The waste sector includes GHG emissions from both solid waste landfills and the treatment of municipal and industrial wastewater. DNR used facility-specific emissions data directly reported to EPA by both solid waste landfills and industrial wastewater facilities. EPA's LandGEM model was used to estimate emissions from smaller landfills that are not required to report to EPA. Overall, GHG emissions from waste increased 0.21% from 2018 as shown in Table 7. Solid waste emissions increased because the quantity of waste landfilled increased 8.25%. Emissions from wastewater decreased primarily due to decreased wastewater emissions from industrial facilities

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

Category	2018	2019	% Change
Solid Waste	1.671	1.677	+0.32%
Wastewater	0.483	0.482	-0.15%
Total	**2.154**	**2.159**	**+0.21%**

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, carbon stored in yard trimmings and food scraps sent to landfills, and agricultural soil carbon flux.

Overall, 8.82 $MMtCO_2e$ of carbon was stored in the LULUCF sector in 2019, as shown in Table 8. This is a 1.15% increase in the amount of CO_2e being stored compared to 2018. This is attributed to a decrease in emissions from liming of agricultural soils.

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

Category	2018	2019	% Change[9]
Forest Carbon Flux	-2.66	-2.66	NA
Liming of Agricultural Soils	0.40	0.28	-29.91%
Urea Fertilization	0.13	0.13	NA
Urban Trees	0.34	0.34	NA
Yard Trimmings & Food Scraps in Landfills	-0.08	-0.08	+0.16%
Fertilization of Settlement Soils	0.48	0.50	3.97%
Agricultural Soil Carbon Flux	-6.65	-6.65	NA
Total	**-8.72**	**-8.82**	**1.15%**

In previous years, the DNR used data from the USDA Forest Inventory Data Online (2010 – 2015) or Design and Analysis Toolkit for Inventory and Monitoring (2016 – 2018) to calculate forest carbon flux. However, in October 2020, EPA updated it's methodologies for states to calculate forest carbon flux. The new methodologies are consistent with those used by EPA in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 -2018*[10] and produced substantially different results than the former method used in previous years. Because 2019 forest carbon flux data is not available, 2018 was used as a proxy for 2019. More details are included in the 2019 GHG Inventory Technical Support Document.

[9] For categories marked as "NA," the DNR assumed 2019 values equal 2018 values due to a lack of more current data.

[10] https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2018, April 13, 2020.

GHG Emissions by Pollutant

The 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.

Carbon dioxide is the greenhouse gas emitted in the highest amounts in Iowa, accounting for 65.67% of all greenhouse gas emissions in 2019. 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 percentage coming from 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 19.31 $MMtCO_2e$ or 14.79% of total 2019 GHG emissions. Nitrous oxide emissions in 2019 were 23.85 $MMtCO_2e$ or 18.26% 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 systems. In 2019, emissions of these three pollutants totaled 1.66 $MMtCO_2e$, or 1.27% of Iowa's 2019 total GHG emissions.

Table 9: 2019 GHG Emissions by Pollutant ($MMtCO_2e$)

Pollutant	2019
CO_2	85.75
CH_4	19.31
N_2O	23.85
HFC/PFC/SF_6	1.66
Total	**130.57**[11]

[11] Includes 0.50 $MMtCO_2e$ N_2O from settlement soils that is accounted for in the LULUCF category.

Figure 5: 2019 Carbon Dioxide Emissions by Sector

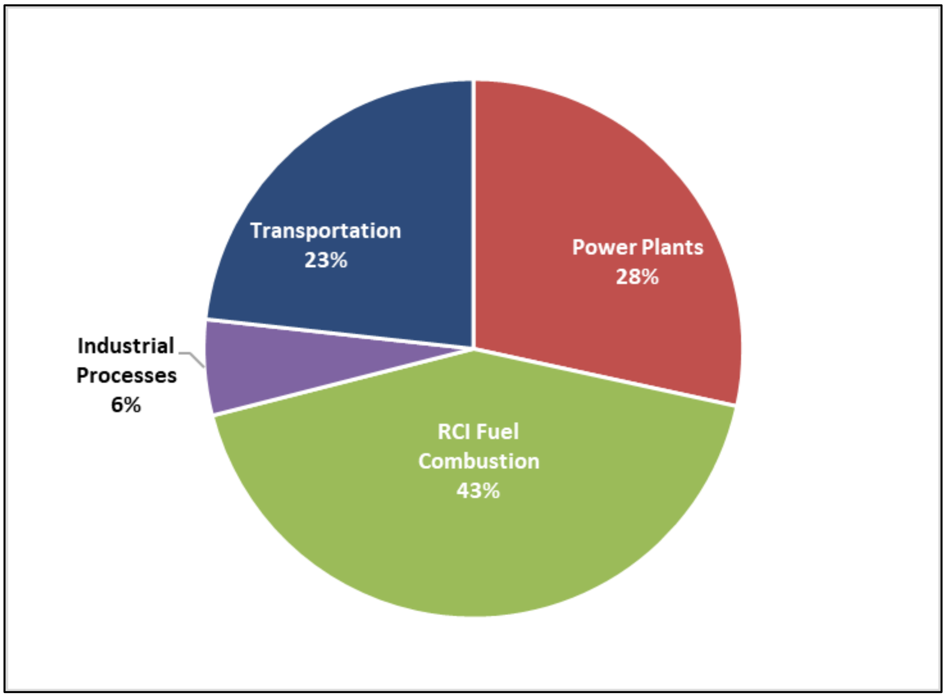


Figure 6: 2019 Methane Emissions by Sector

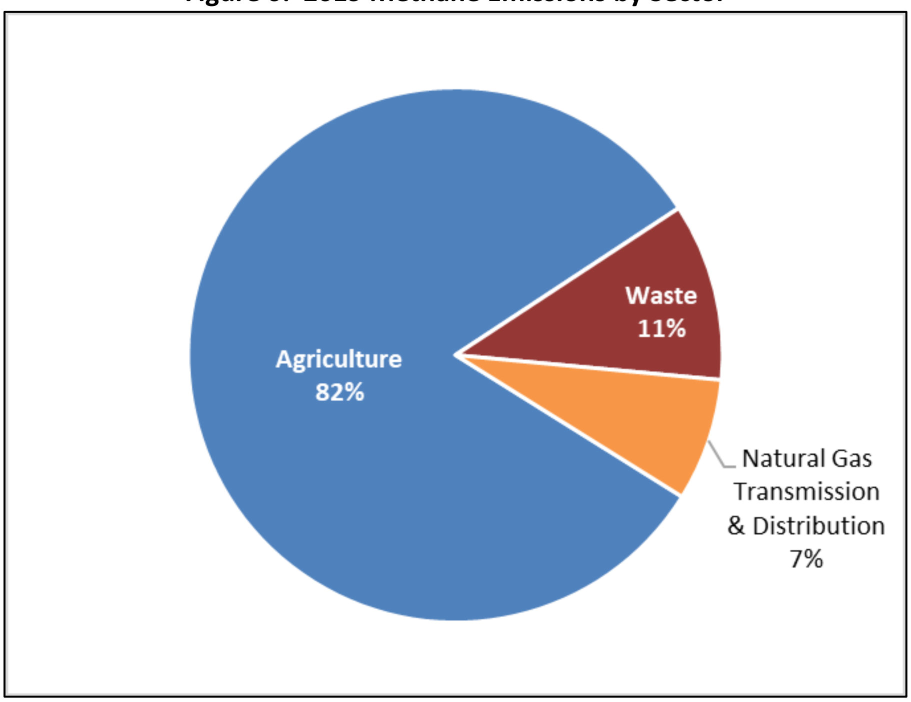


Figure 7: 2019 Nitrous Oxide Emissions by Sector

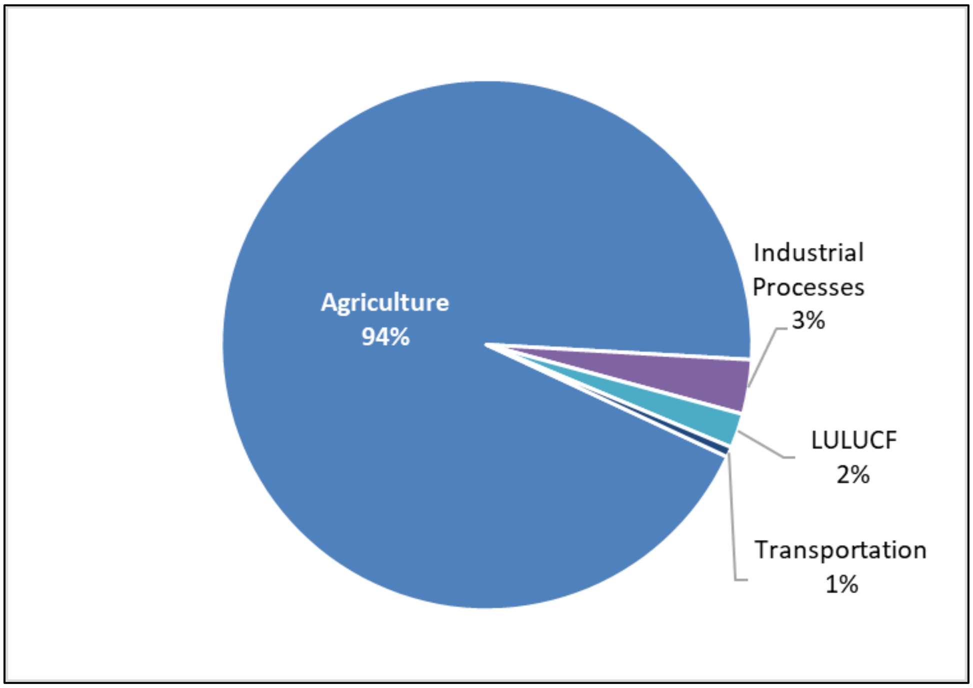
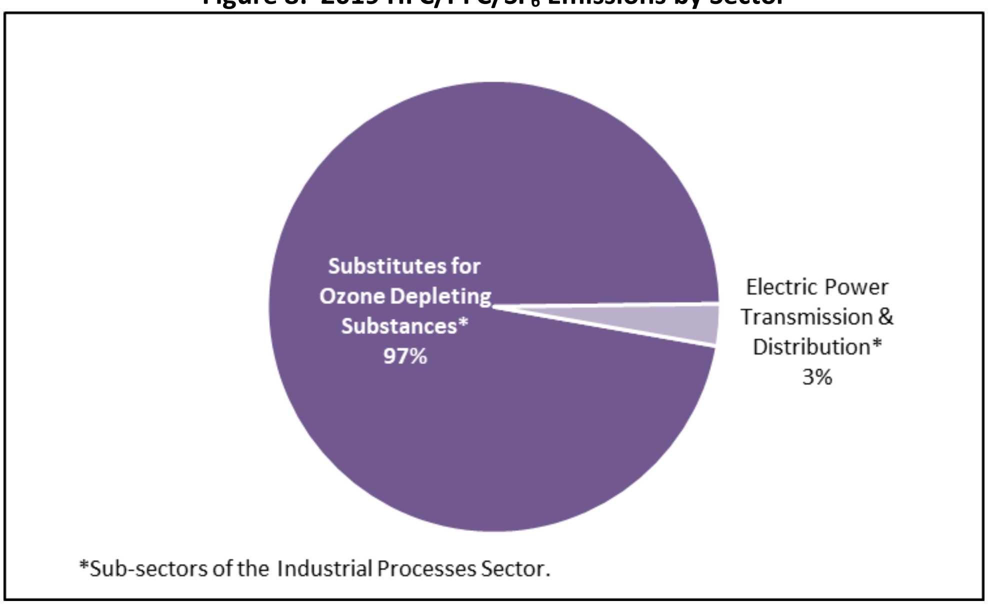


Figure 8: 2019 HFC/PFC/SF_6 Emissions by Sector



Comparison with U.S. Emissions

Comparing Iowa's GHG emissions with U.S. emissions requires the use of 2018 data because the 2019 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 2018 were 132.42 $MMtCO_2e$. This represents 1.98% of the total 2018 U.S. gross GHG emissions of 6,676.60 $MMtCO_2e$.

Figure 9: 2018 U.S. GHG Emissions by Sector

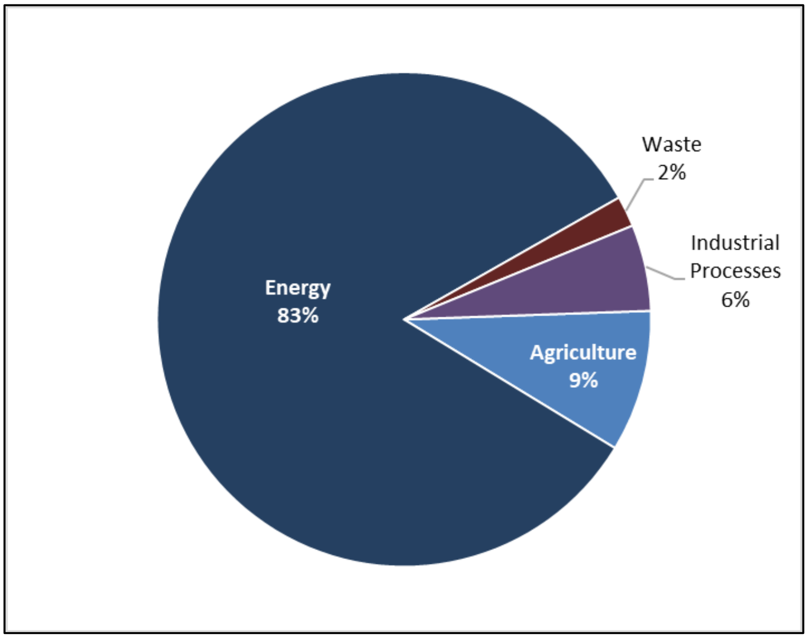
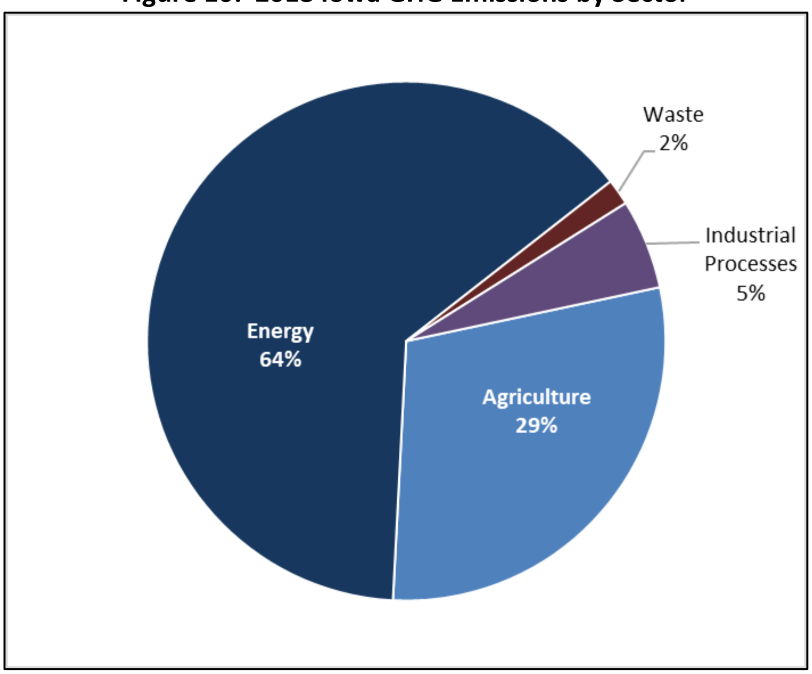


Figure 10: 2018 Iowa GHG Emissions by Sector



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. The Projection Tool forecasts emissions from industrial processes, agriculture, and waste based on historical emissions from 1990 – 2018, using a combination of data sources and national projections for activity data. A 2019 "forecast" was also produced to help gauge the reasonableness of the projections.

While the DNR cannot predict with certainty what the effects on future emissions will be, the DNR has identified three factors that may affect future GHG emissions:

1. Global Pandemic
   The global pandemic has affected the way Americans use energy. The U.S. Energy Information Administration (EIA) released its *Short-Term Energy Outlook* on December 9, 2020, predicting that U.S. CO_2 emissions will "fall by 19% for coal, by 13% for petroleum, and by 2% for natural gas. Many of this year's changes in energy-related CO_2 emissions are attributable to the economic and behavioral effects the COVID-19 pandemic has had on energy consumption"[12] such as working at home and driving less.

2. Derecho
   On August 10th, a derecho caused severe crop and tree damage across portions of central and eastern Iowa. The DNR estimates 724,480 acres of forest and trees were lost across the 27 counties most directly impacted.[13] This will likely reduce the amount of carbon sequestered by forests in 2020, and it may continue to decrease in future years as damaged trees are affected by pests and disease. GHG emissions from crop production and agricultural soils will likely also be affected as about 20% of Iowa's total cropland was damaged by the derecho, affecting yields.[14]

3. Emissions from Power Plants
   Emissions from power plants will likely decrease as Iowa utilities shift away from burning coal to burning natural gas and installing renewable generation. However, emissions from power plants may also be affected by the economy, weather, future environmental regulations, electricity demand by customers, how electricity generation is dispatched by the grid operator, and other market forces.

Table 10: Projected Gross GHG Emissions 2019 – 2030 ($MMtCO_2e$)

	Calculated	Projected			
Sector	**2019**	**2019**	**2020**	**2025**	**2030**
Agriculture	37.82	43.35	44.48	50.16	55.84
Power Plants	24.57	25.56	22.78	21.91	22.21
RCI Fossil Fuel Use	36.58	33.25	32.77	33.12	33.43
Industrial Processes	7.37	5.93	6.48	7.90	8.99
Natural Gas T & D	1.42	1.35	1.54	1.64	1.65
Transportation	20.15	22.20	22.23	20.91	19.93
Waste	2.16	3.11	3.14	3.27	3.41
Total	**130.07**	**134.74**	**133.41**	**138.92**	**145.46**

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

[12] EIA expects U.S. energy-related carbon dioxide emissions to fall 11% in 2020, December 9, 2020.
[13] Iowa DNR rises to meet derecho challenges, helps Iowans and their trees recover, September 10, 2020.
[14] Iowa derecho in August was most costly thunderstorm disaster in U.S. history, October 17, 2020.

the 2019 GHG inventory and the assumptions within the SIT Projection Tool reduce confidence in the projections as the Tool is not configured to include 2019 activity data. For example, the Tool projects that agriculture emissions will continue to increase at the rate they did from 1990 – 2017, when 2018 and 2019 calculated agriculture emissions actually decreased. The TSD provides a more detailed discussion of forecast uncertainty.

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 calculation methodologies for the wastewater sector to address land application of biosolids and improved forecasting.