IOWA DEPARTMENT OF NATURAL RESOURCES

2020 Iowa Statewide Greenhouse Gas Emissions Inventory Report

Required by Iowa Code 455B.104

December 31, 2021

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 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 2020 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.

2020 Statewide GHG Emissions

In 2020, total gross Iowa greenhouse gas emissions were 120.77 million metric tons carbon dioxide equivalent ($MMtCO_2e$) as shown in Table 1 and Figure 1. This is a decrease of 9.87 $MMtCO_2e$ (7.56%) from 2019 and a decrease of 11.03% from 2011. The 9.87 $MMtCO_2e$ decrease in emissions is largely attributed to the following combination of reductions and partially offsetting increases:

- A 7.49 $MMtCO_2e$ decrease in emissions from power plants, due to decreased generation of electricity from fossil fuels,
- A 1.93 $MMtCO_2e$ decrease in emissions from mobile combustion due to a decrease in vehicle miles traveled,
- A 0.30 $MMtCO_2e$ decrease in emissions from residential, commercial and industrial fuel use,
- A 0.20 $MMtCO_2e$ decrease in emission from the agriculture sector, due to decreased emissions from enteric fermentation, manure management, and agriculture soil management, and
- A 0.18 $MMtCO_2e$ increase in emissions from industrial processes.

Emissions fluctuations from other sectors were smaller in magnitude, as shown in Figure 2, and differed by less than 0.15 $MMtCO_2e$ per sector from 2019.

Table 1: GHG Emissions 2011 – 2020 by Sector (Million Metric Tons Carbon Dioxide Equivalents ($MMtCO_2e$))[1]

Emissions ($MMtCO_2e$)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change from 2019		
											$MMtCO_2e$	%	Trend
Agriculture	37.91	36.78	35.77	37.39	39.00	39.49	41.71	38.60	37.85	37.65	-0.20	-0.53%	↓
Power Plants	38.98	35.76	33.06	33.44	29.46	25.33	26.62	30.87	24.57	17.07	-7.49	-30.51%	↓
Residential, Commercial, and Industrial Fuel Use	31.44	29.96	32.82	32.82	31.54	29.45	32.05	32.07	37.07	36.77	-0.30	-0.81%	↓
Industrial Processes	4.50	5.18	5.07	5.12	5.09	5.34	7.10	7.40	7.38	7.55	0.18	2.38%	↑
Natural Gas Transmission and Distribution	1.40	1.40	1.40	1.40	1.40	1.41	1.27	1.41	1.42	1.42	0.00	0.32%	↑
Transportation	19.58	19.59	19.46	19.55	20.02	20.12	20.42	19.92	20.20	18.28	-1.93	-9.53%	↓
Waste	1.94	2.15	1.96	1.93	2.14	2.16	2.15	2.15	2.16	2.03	-0.13	-5.98%	↓
Total Gross Emissions	**135.74**	**130.82**	**129.55**	**131.67**	**128.65**	**123.30**	**131.32**	**132.42**	**130.64**	**120.77**	**-9.87**	**-7.56%**	↓
Carbon Stored in LULUCF[2]	-11.78	-12.64	-8.46	-6.44	-7.26	-9.77	-9.49	-8.72	-8.88	-8.66	0.22	2.47%	↑
Total Net Emissions	123.96	118.18	121.09	125.23	121.39	113.53	121.83	123.70	121.76	112.11	-9.65	-7.93%	↓

[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 2020. 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 2011 – 2020 ($MMtCO_2e$)

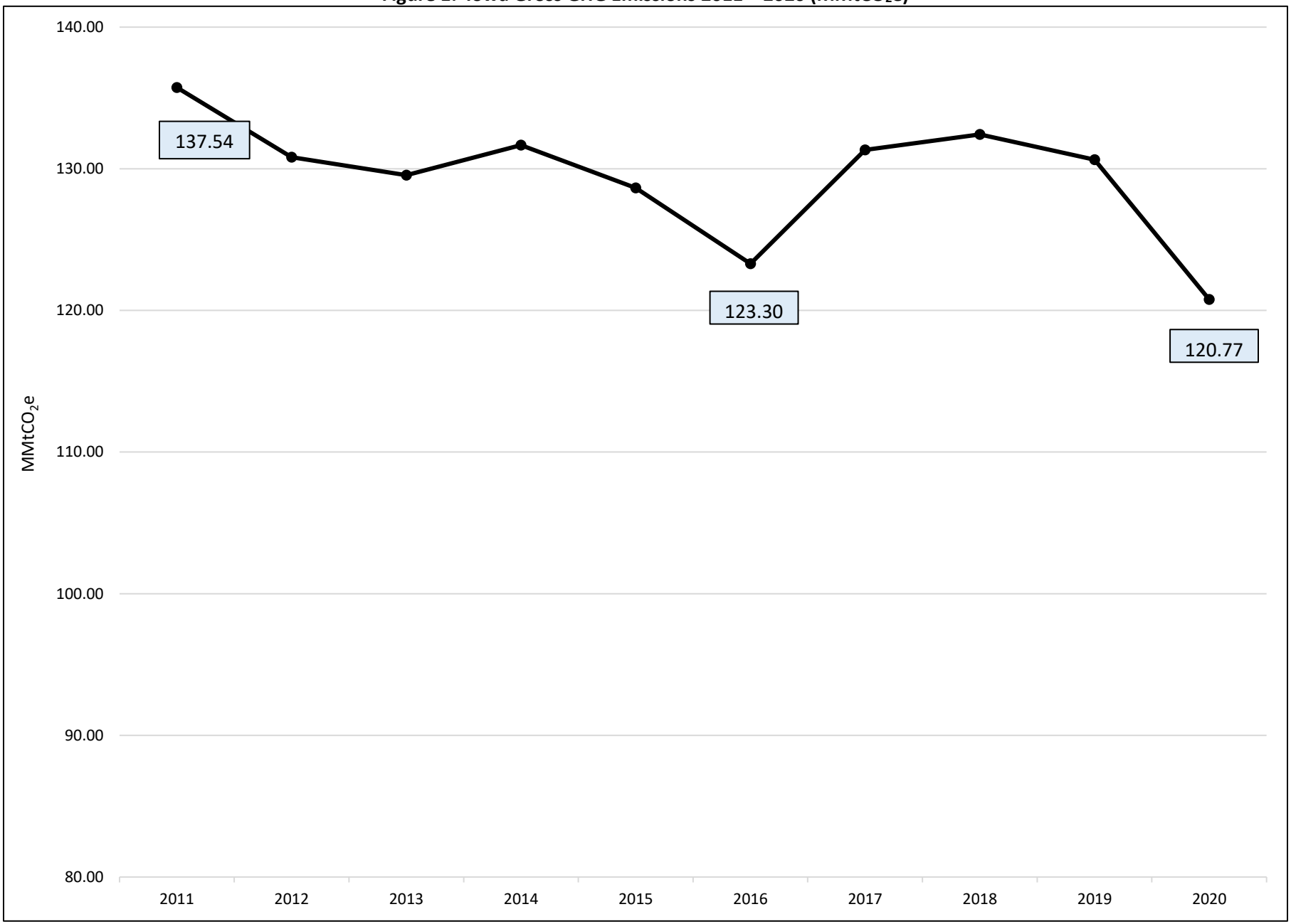
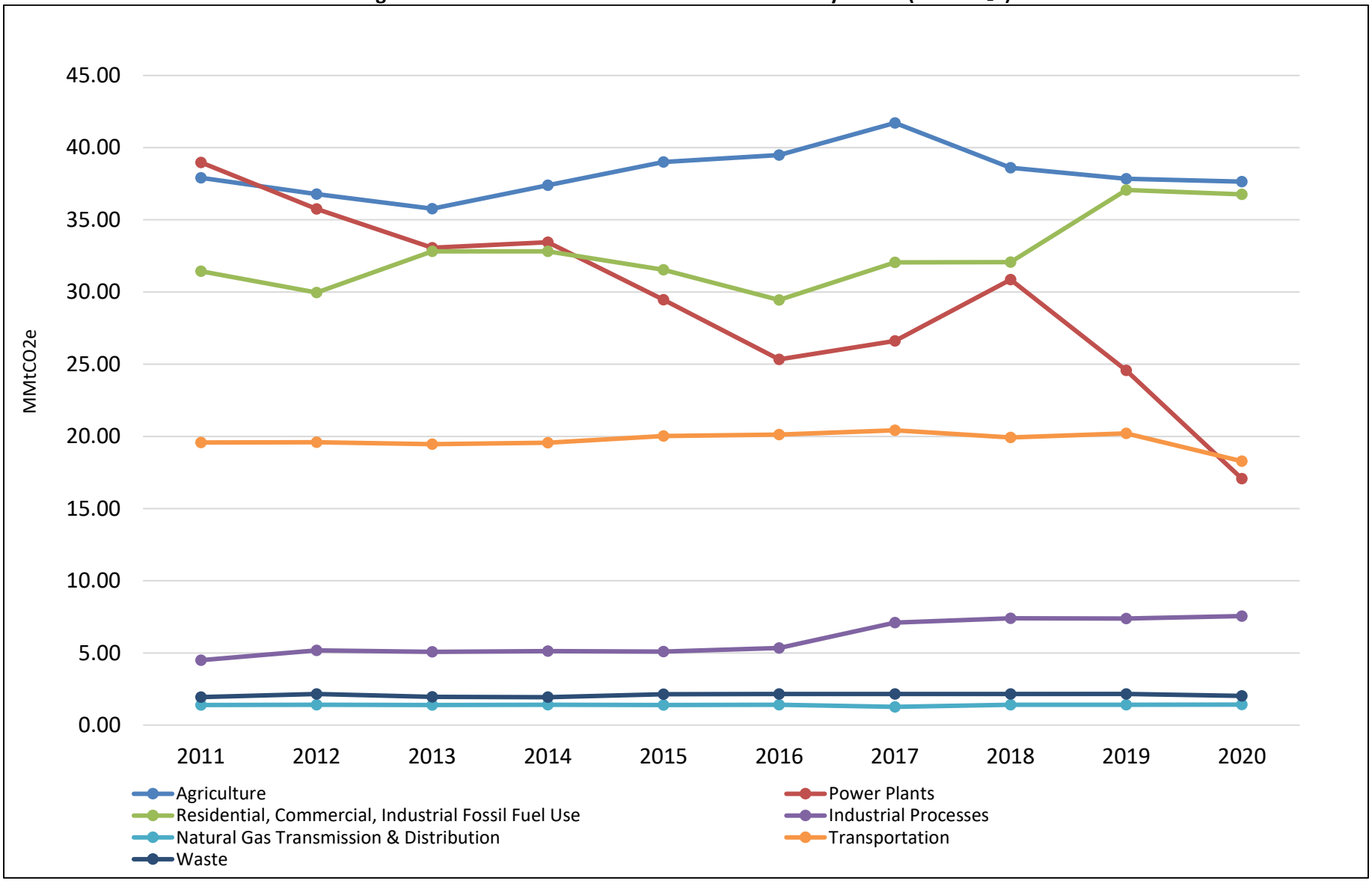


Figure 2: Iowa Gross[3] GHG Emissions 2011 – 2020 by Sector ($MMtCO_2e$)

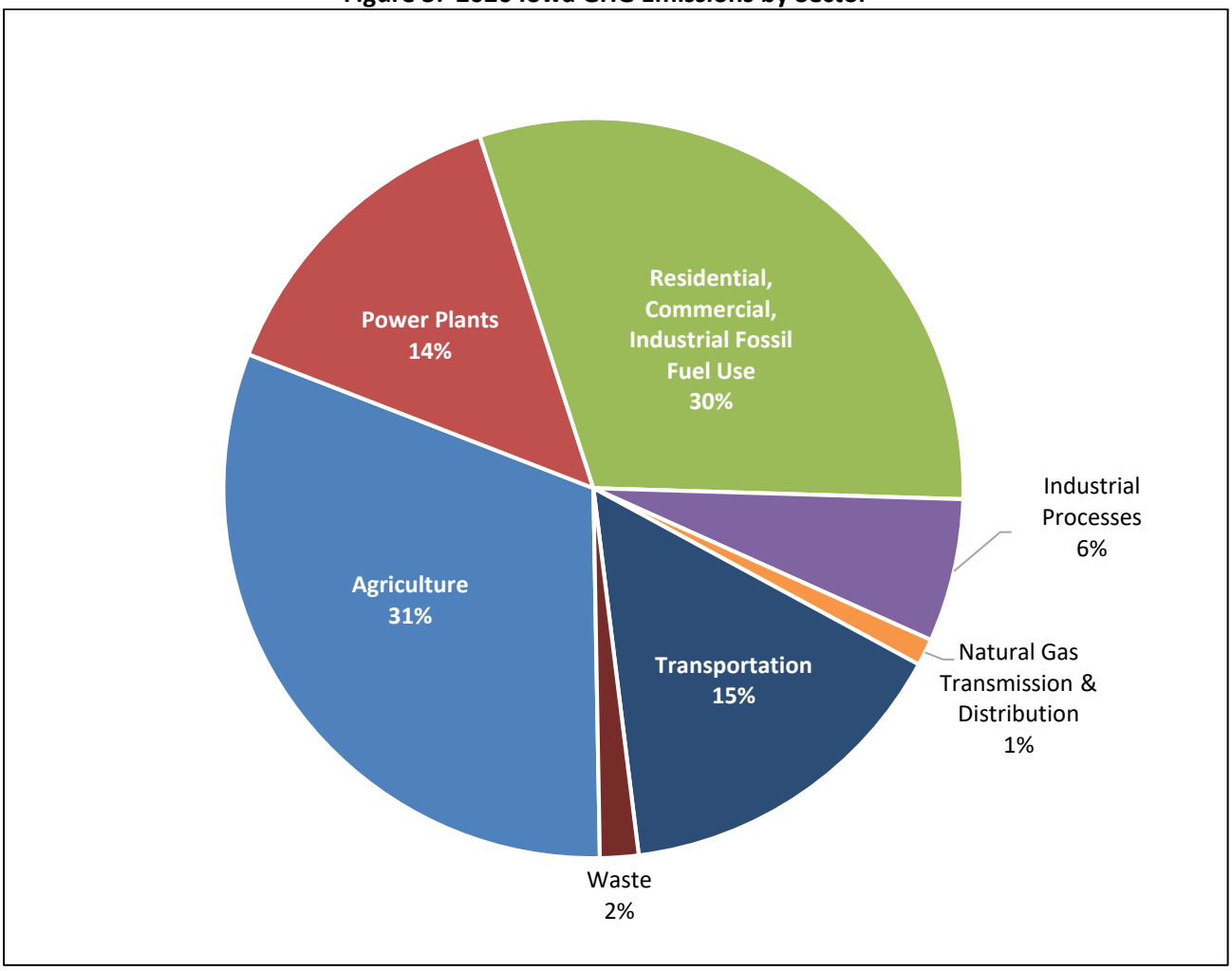


[3] Does not include carbon storage from land use, land use change, and forestry (LULUCF).

GHG Emissions by Sector

The majority of GHG emissions in Iowa in 2020 were from the agriculture sector (31%), followed by emissions from the residential/commercial/industrial (RCI) sector (30%), transportation (15%), and fossil fuel use by power plants (14%), 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 2020 GHG Inventory Technical Support Document for more information on a specific sector, such as sources of input data, calculations, and uncertainty.

Figure 3: 2020 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

[4] Industrial fossil fuel use refers to GHG emissions from fossil fuels combusted by industrial facilities. Industrial processes mean 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 sequestered carbon in 2020.

(such as tractors) are included in the transportation sector. As shown in Table 2, total agriculture emissions decreased 0.53% between 2019 and 2020. Emissions from enteric fermentation exhibited the largest change, decreasing 1.45%, due to a decrease in the animal population, particularly the number of cattle. Manure management emission were lower as well due to the decrease in cattle population.

Emissions from agricultural soil management decreased due to reduced emissions from production. In 2020, the amount of corn harvested decreased 11.63% while the volume of soybeans harvested increased 0.87%. It should be noted that emissions calculations for agricultural soil management have a higher level of uncertainty than those for enteric fermentation and manure management, because the agriculture fertilizer data used to calculate emissions is not as current as the animal population data used.

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

Category	2019	2020	% Change
Enteric Fermentation	8.66	8.54	-1.45%
Manure Management	8.62	8.57	-0.50%
Agricultural Soil Management	20.57	20.54	-0.16%
Total	**37.85**	**37.65**	**-0.53%**

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 44.58% of Iowa's total GHG emissions. Table 3 shows a decrease of 0.81% in emissions from RCI and a decrease of 30.51% in power plant emissions between 2019 and 2020.

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

Category	2019	2020	% Change
Residential, Commercial, Industrial (RCI)	37.07	36.77	-0.81%
Residential	5.67	5.23	-7.87%
Commercial	4.14	4.06	-2.03%
Industrial	27.26	27.49	0.85%
Power Plants	24.57	17.07	-30.51%
Total	61.64	53.84	-12.65%

Residential, Commercial, and Industrial (RCI)

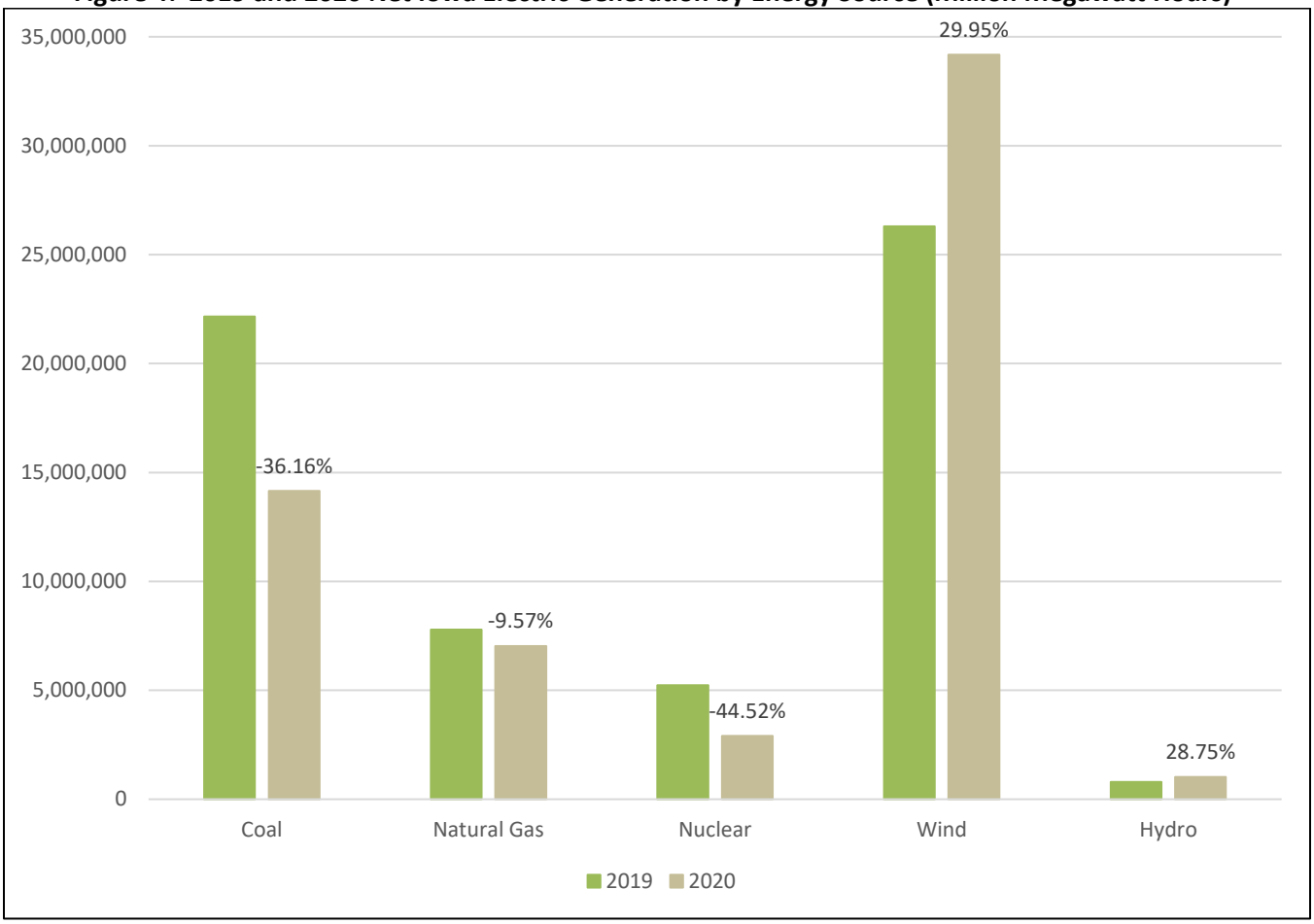
Actual fuel use data for 2020 for the RCI sector was not available from the U.S. Energy Information Administration (EIA), so emissions were calculated based on projected energy consumption values from the EIA's *Annual Energy Outlook 2019 with Projections to 2040.* Emissions predicted for 2019 from the RCI sector in last year's inventory (36.85 $MMtCO_2e$) were replaced with actual 2019 consumption values now available from EIA. The resulting recalculated 2019 emissions were 37.07 $MMtCO_2e$.

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 7.49 $MMtCO_2e$ (30.51%) from the previous year. As shown in Figure 4, from 2019 to 2020 electricity generation from wind increased by 29.95% (electricity generated by this source does not contribute to GHG emissions).

Figure 4: 2019 and 2020 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 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 increased 2.38% from 2019 to 2020, 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, October 8, 2021.

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

Category	2019	2020	% Change[7]
Ammonia and Urea Production	3.14	3.37	7.27%
Cement Manufacturing	1.21	1.25	3.20%
Electric Power Transmission & Distribution Systems	0.05	0.06	9.61%
Iron and Steel Production	0.18	0.20	10.39%
Lime Manufacturing	0.17	0.18	5.18%
Limestone and Dolomite Use	0.21	0.21	NA
Nitric Acid Production	0.78	0.66	-15.98%
Ozone Depleting Substances Substitutes	1.61	1.62	0.14%
Soda Ash Consumption	0.02	0.02	-8.21%
Total	**7.38**	**7.55**	**2.38%**

Natural Gas Transmission and Distribution (T & D)

This sector includes emissions from natural gas transmission and distribution systems in the state. GHG emissions increased 0.32% from 2019 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	2019	2020	% Change
Transmission	0.7842	0.7845	0.04%
Distribution	0.6321	0.6363	0.66%
Total	**1.4163**	**1.4208**	**0.32%**

Transportation

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 decreased 11.54% between 2019 and 2020, which contributed significantly to the overall 9.59% decrease in transportation GHG emissions shown in Table 6.

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

Category	2019	2020	% Change[8]
Gasoline Highway	11.47	10.14	-11.56%
Diesel Highway	4.66	4.04	-13.27%
Non-Highway	4.13	4.13	NA
Alternative Fuel Vehicles	0.01	0.01	NA
Total	**20.26**	**18.32**	**-9.59%**

[7] For categories marked as "NA," the DNR assumed 2020 values equal 2019 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 decreased 5.98% from 2019 as shown in Table 7. Solid waste emissions decreased because GHG emissions decrease as the waste in place at landfills ages. Emissions from wastewater decreased because in the 2020 inventory DNR corrected for double counting of sewage sludge that has been land applied, which has already been included in the agriculture chapter.

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

Category	2019	2020	% Change
Solid Waste	1.677	1.595	-4.85%
Wastewater	0.482	0.435	-9.89%
Total	**2.159**	**2.030**	**-5.98%**

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, 8.66 $MMtCO_2e$ of carbon was stored in the LULUCF sector in 2020, as shown in Table 8. This is a 2.47% decrease in the amount of CO_2e being stored compared to 2019. This is attributed to an increase in emissions from liming of agricultural soils.

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

Category	2019	2020	% Change[9]
Forest Carbon Flux	-2.66	-2.66	NA
Liming of Agricultural Soils	0.28	0.54	91.10%
Urea Fertilization	0.08	0.08	NA
Urban Trees	0.34	0.34	NA
Yard Trimmings & Food Scraps in Landfills	-0.08	-0.07	-17.94%
Fertilization of Settlement Soils	0.50	0.45	-10.14%
Agricultural Soil Carbon Flux	-6.65	-6.65	NA
Total	**-8.82**	**-8.66**	**-2.47%**

Forest carbon flux was calculated using methodologies consistent with those used by EPA in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 -2019.*[10] Because 2019 or 2020 forest carbon flux and urban tree data is not available for the full year, 2018 was used as a proxy for 2020. The DNR plans to incorporate the changes to carbon flux resulting from the August 10, 2020 derecho in next year's report when additional data is available

[9] For categories marked as "NA," the DNR assumed 2019 and 2020 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-1990-2019, April 2021.

from EPA and the U.S. Forest Service. DNR and Trees Forever have estimated the future loss in carbon dioxide sequestration to be 22,870.8 tons per year.[11] More details included in the 2020 GHG Inventory Technical Support Document.

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 63.5% of all greenhouse gas emissions in 2020. 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 19.47 $MMtCO_2e$ or 16.06% of total 2020 GHG emissions. Nitrous oxide emissions in 2020 were 23.10 $MMtCO_2e$ or 19.05% 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 2020, emissions of these three pollutants totaled 1.67 $MMtCO_2e$, or 1.38% of Iowa's 2020 total GHG emissions.

Table 9: 2020 GHG Emissions by Pollutant ($MMtCO_2e$)

Pollutant	2020
CO_2	76.97
CH_4	19.47
N_2O	23.10
HFC/PFC/SF_6	1.67
Total	**121.22**[12]

[11] Iowa DNR and Trees Forever, Assessment of urban tree canopy damage in incorporated communities resulting from the August 2020 Midwest Derecho, September 15, 2021.

[12] Includes 0.45 $MMtCO_2e$ N_2O from settlement soils that is accounted for in the LULUCF category.

Figure 5: 2020 Carbon Dioxide Emissions by Sector

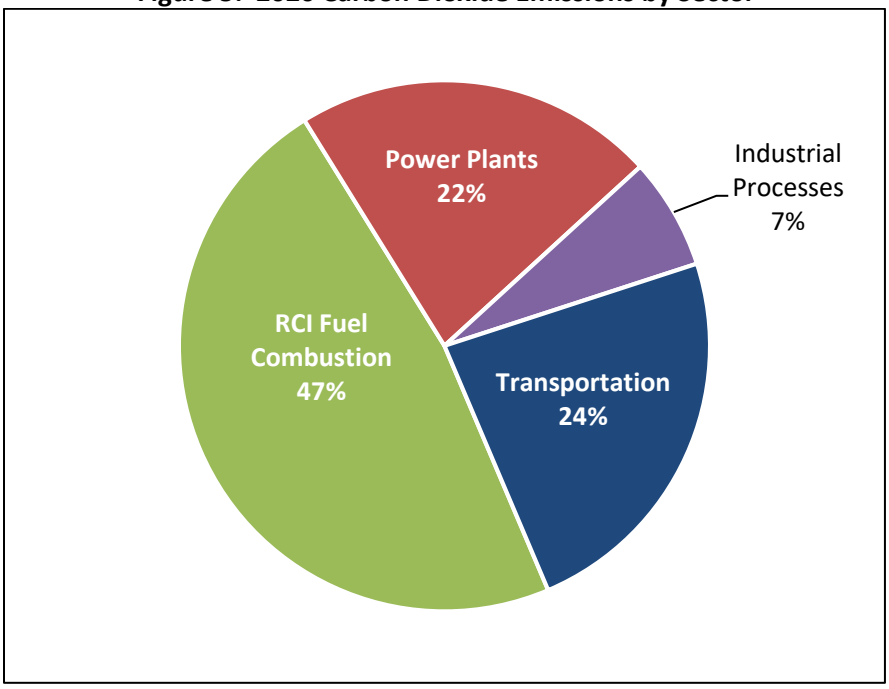


Figure 6: 2020 Methane Emissions by Sector

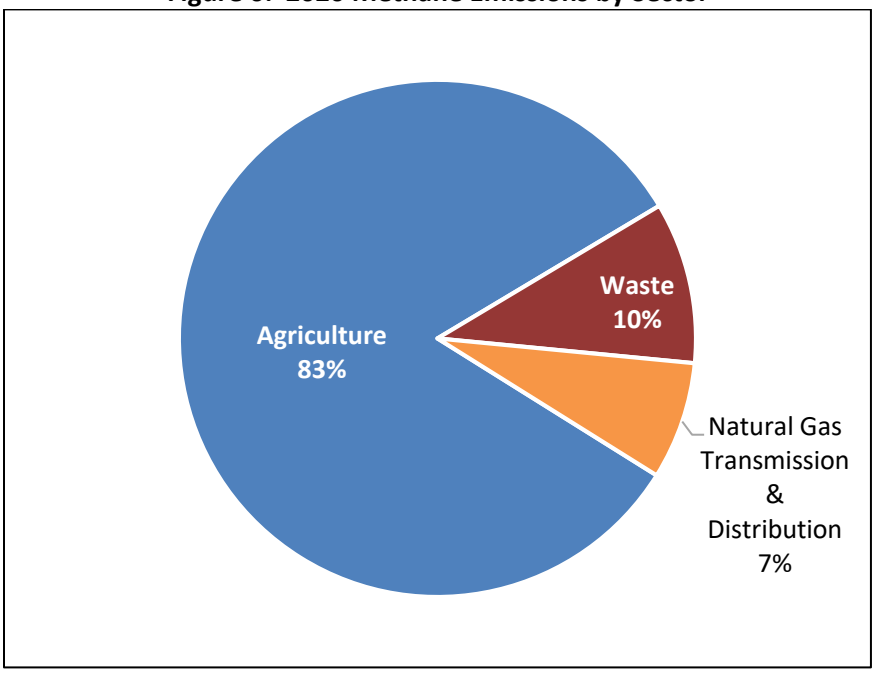


Figure 7: 2020 Nitrous Oxide Emissions by Sector

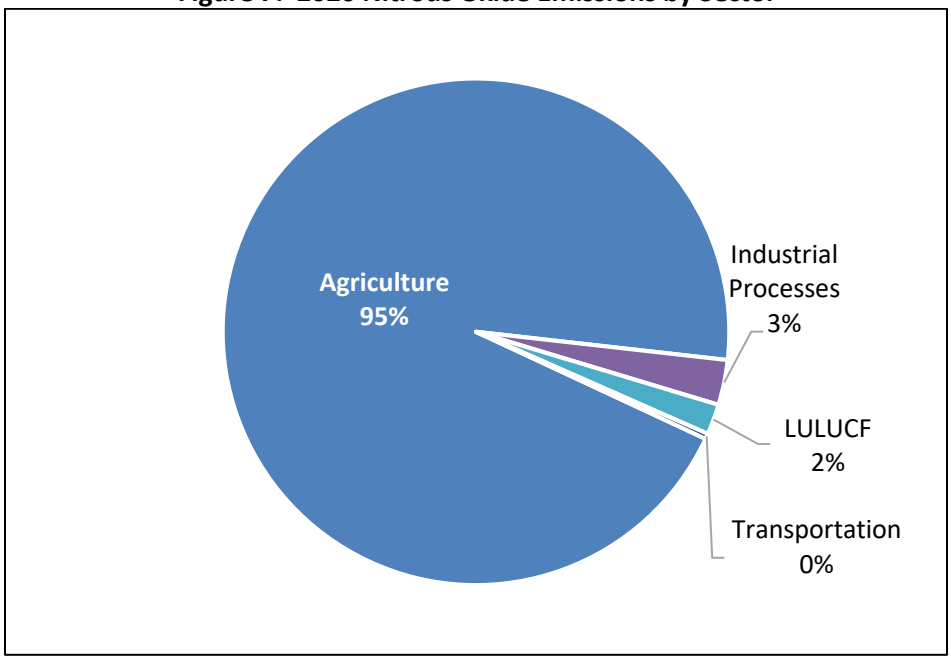
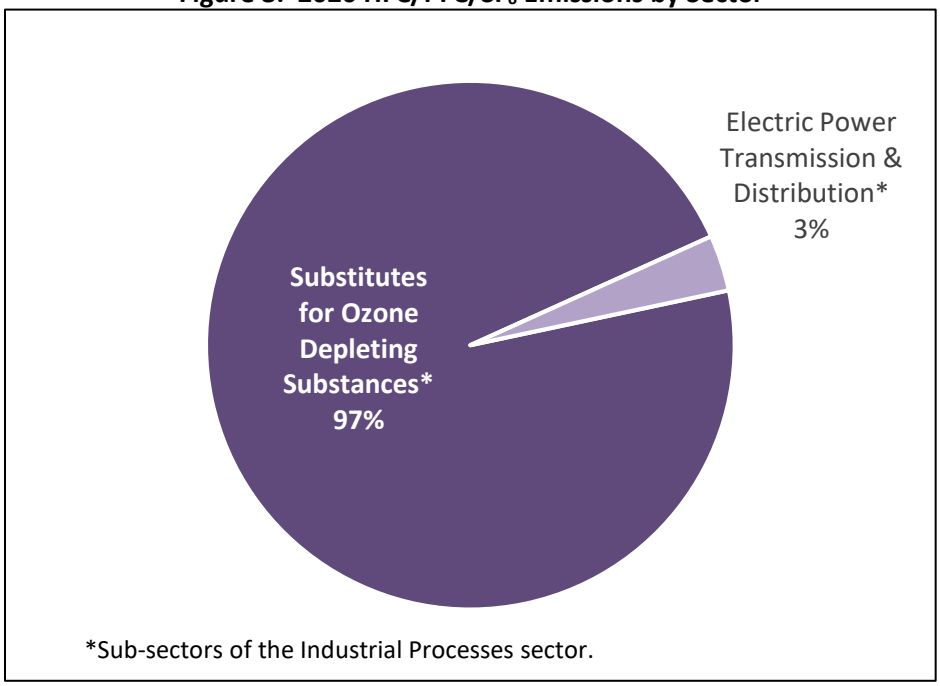


Figure 8: 2020 HFC/PFC/SF_6 Emissions by Sector



Comparison with U.S. Emissions

Comparing Iowa's GHG emissions with U.S. emissions requires the use of 2019 data because the 2020 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 2019 were 130.64 $MMtCO_2e$. This represents 1.99% of the total 2019 U.S. gross GHG emissions of 6,558.30 $MMtCO_2e$.

Figure 9: 2019 U.S. GHG Emissions by Sector

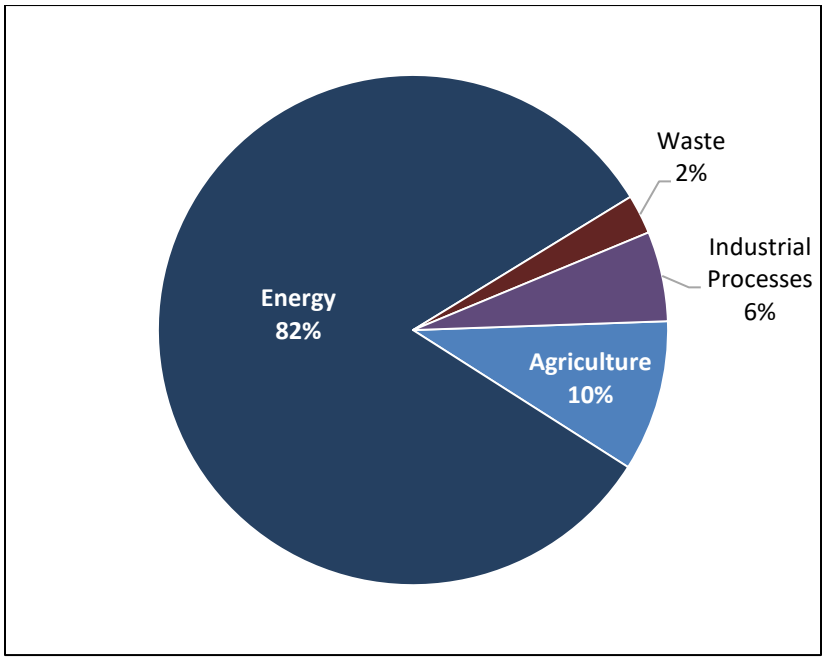
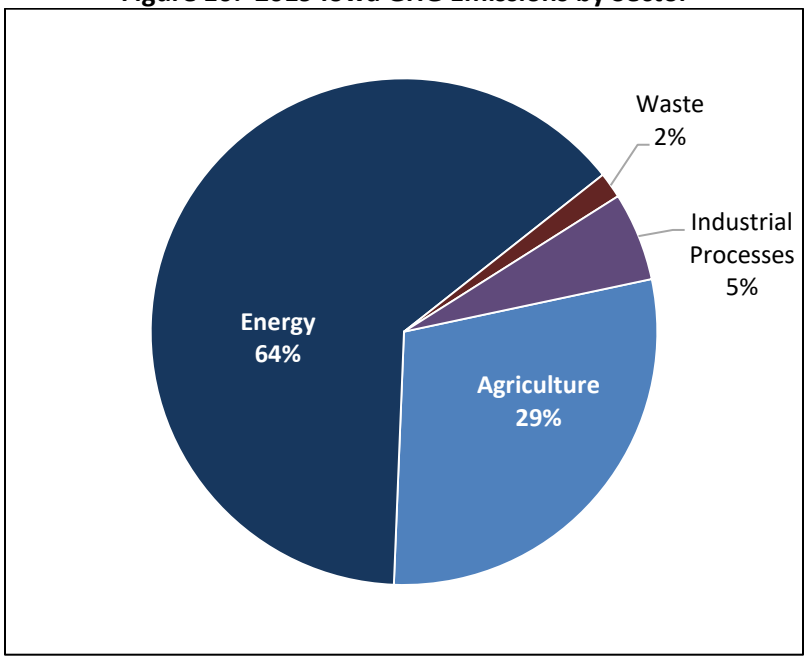


Figure 10: 2019 Iowa GHG Emissions by Sector



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 2025, 2030, and 2035 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. It would be preferable to forecast emissions using the DNR's 2020 calculated GHG inventory as the baseline, but the SIT Projection tool only allows input of emissions up to 2018 and it is not reasonable to fully update the data in the SIT Projection Tool to eliminate all such inconsistencies. A 2020 "forecast" was also produced to help gauge the reasonableness of the projections.

Table 10: Projected Gross GHG Emissions 2020 – 2035 ($MMtCO_2e$)

	Calculated	Projected			
Sector	**2020**	**2020**	**2025**	**2030**	**2035**
Agriculture	37.65	45.38	50.16	55.84	61.50
Power Plants	17.07	22.67	21.80	22.11	21.51
RCI Fossil Fuel Use	36.77	32.11	33.05	33.37	33.86
Industrial Processes	7.55	6.60	7.90	8.99	10.24
Natural Gas T & D	1.42	1.54	1.64	1.65	1.65
Transportation	18.28	21.99	20.66	19.68	19.11
Waste	2.03	3.22	3.27	3.41	3.67
Total	**120.77**	**135.00**	**138.49**	**145.05**	**151.53**

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* (STEO) on December 7, 2021, predicting that "energy-related CO2 emissions will increase about 7% from 2020 as economic activity increases and leads to rising energy use."[13] It should be noted that the STEO addresses national emissions, not Iowa-specific emissions. In addition, while vehicle miles traveled decreased by 11.5% in 2020, from 33.8 trillion miles in 2019 to 29.9 trillion miles in 2020,[14] a May 2021 article in *The Courier* reported that the state's traffic volume is currently close to pre-pandemic levels.[15]

2. Derecho
   On August 10, 2020, 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.[16] This will likely reduce the amount of carbon sequestered in by forests in 2020, and may continue to decrease in future years as damaged trees are affected by pests and disease. Due

[13] U.S. EIA, Short Term Energy Outlook, December 7, 2021.

[14] Iowa DOT, VMT BY County/System as of December 31 2020.

[15] Iowans driving more, buying new vehicles, May 3, 2021.

[16] Iowa DNR rises to meet derecho challenges, helps Iowans and their trees recover, September 10, 2020.

to uncertainty in the volume of CO_2 sequestered for the entire year since the event occurred towards the end of the growing season, DNR did not include the tree loss in the calculations for 2020, but will do so for 2021.

3. Emissions from Power Plants
   Emissions from power plants are difficult to forecast. While emissions may continue to decrease as Iowa utilities shift away from burning coal to burning natural gas and installing renewable generation, the amount and fuel source of electricity generated is influenced by many factors such as:
   - the economy,
   - weather,
   - future environmental regulations,
   - electricity demand by customers,
   - how electricity generation is dispatched by the grid operator, and
   - other market forces.

   The most recent data from EPA's Clean Air Markets Division shows that CO_2 emission from electric power generation during the first nine months of 2021 are 47.4% higher than CO_2 emissions from the first nine months of 2020. However, they are 1.4% lower than the first nine months of 2019 so we can expect 2021 emissions from electric power generation to be closer to 2019 emissions.

Uncertainty

As with many forecasts, numerous factors affect the certainty of the predictions. In addition to the factors affecting power plant emissions, GHG emission from other categories may be influenced by energy efficiency and conservation practices, driving practices, use of renewable fuels, and other variables. Discrepancies between the data used to calculate the 2020 GHG inventory and the assumptions within the SIT Projection Tool reduce confidence in the projections as the Tool is not configured to include 2019 or 2020 activity data. For example, the Tool projects that agriculture emissions will continue to increase at the rate they did from 1990 – 2017, when 2018, 2019, and 2020 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. A possible area of enhancement is improved forecasting. Additionally, EPA has planned changes to the SIT to match new disaggregated state-level inventories as a part of the national emissions inventory. This may lead to further improvements in Iowa's inventory.