Chapter 2
Inventory and Projections of GHG Emissions

Introduction

This chapter summarizes Iowa's greenhouse gas (GHG) emissions and sinks (carbon storage) from 1990 to 2025. The Center for Climate Strategies (CCS) prepared a draft of Iowa's GHG emissions inventory and reference case projections for the Iowa Department of Natural Resources (Iowa DNR) as part of the Iowa Climate Change Advisory Council (ICCAC) process. The draft inventory and reference case projections, completed in April 2008, provided the ICCAC with an initial, comprehensive understanding of current and possible future GHG emissions. The draft report was provided to the ICCAC and its Subcommittees (SCs) to assist them in understanding past, current, and possible future GHG emissions in Iowa, and thereby inform the policy option development process. The ICCAC and SCs have reviewed, discussed, and evaluated the draft inventory and methodologies, as well as alternative data and approaches for improving the draft GHG inventory and forecast. The inventory and forecast have since been revised to address the comments provided by the ICCAC.

The information in this chapter reflects the information presented in the final *Iowa Greenhouse Gas Inventory and Reference Case Projections* report (hereafter referred to as the Inventory and Projections report).[1] The final report, incorporating comments provided by the Subcommittees that were approved by the ICCAC at their September 2008 meeting and incorporated into the final report during October, is available at: http://www.iaclimatechange.us/Inventory_Forecast_Report.cfm . At the 7th ICCAC meeting in November 2008 the Council received the final I-F Report and agreed to file and forward it to the Governor and Legislature.

Historical GHG emission estimates (1990 through 2005)[2] were developed using a set of generally accepted principles and guidelines for state GHG emission inventories, relying to the extent possible on Iowa-specific data and inputs. The reference case projections (2006–2025) are based on a compilation of various existing projections of electricity generation, fuel use, and other GHG-emitting activities, along with a set of simple, transparent assumptions described in the final Inventory and Projections report.

The Inventory and Projections report covers the six types of gases included in the U.S. GHG inventory: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Emissions of these GHGs are presented using a common metric, CO_2 equivalence (CO_2e), which indicates the relative

[1] Center for Climate Strategies. *Final Iowa Greenhouse Gas Inventory and Reference Case Projections: 1990–2025*. Prepared for the Iowa Climate Change Advisory Council. October 2008.

[2] The last year of available historical data for each sector varies between 2000 and 2005.

contribution of each gas, per unit mass, to global average radiative forcing on a global warming potential-weighted basis.[3]

It is important to note that the emission estimates reflect the GHG emissions associated with the electricity sources used to meet Iowa's demands, corresponding to a consumption-based approach to emissions accounting. Another way to look at electricity emissions is to consider the GHG emissions produced by electricity generation facilities in the state—a production-based method. The study covers both methods of accounting for emissions, but for consistency, all total results are reported as consumption-based.

Iowa GHG Emissions: Sources and Trends

Table 2-1 provides a summary of GHG emissions estimated for Iowa by sector for 1990, 2000, 2005, 2010, 2020, and 2025. As shown in this table, Iowa is estimated to be a net source of GHG emissions (positive, or gross, emissions). Iowa's forests serve as sinks of GHG emissions (removal of emissions, or negative emissions). Iowa's net emissions are derived by subtracting the CO_2 equivalent emissions in sinks from the gross GHG emission totals. The following sections discuss GHG emission sources and sinks, trends, projections, and uncertainties.

Historical Emissions

Overview

In 2005, on a gross emissions consumption basis (i.e., excluding carbon sinks), activities in Iowa accounted for approximately 120 million metric tons (MMt) of CO_2e emissions, an amount equal to 1.7% of total U.S. gross GHG emissions. On a net emissions basis (i.e., including carbon sinks), activities in Iowa accounted for approximately 92 MMtCO_2e of emissions in 2005, an amount equal to 1.4% of total U.S. net GHG emissions.[4] Iowa's GHG emissions are rising faster than those of the nation as a whole. From 1990 to 2005, Iowa's gross GHG emissions increased by 23%, while national gross emissions rose by 16%.[5] Table 2-1, below, presents Iowa's historical and reference case GHG emissions by sector for

[3] Changes in the atmospheric concentrations of GHGs can alter the balance of energy transfers between the atmosphere, space, land, and the oceans. A gauge of these changes is called radiative forcing, which is a simple measure of changes in the energy available to the Earth–atmosphere system. Holding everything else constant, increases in GHG concentrations in the atmosphere will produce positive radiative forcing (i.e., a net increase in the absorption of energy by the Earth). See: Boucher, O., et al. "Radiative Forcing of Climate Change." Chapter 6 in *Climate Change 2001: The Scientific Basis*. Contribution of Working Group 1 of the Intergovernmental Panel on Climate Change Cambridge University Press. Cambridge, United Kingdom. Available at: http://www.grida.no/climate/ipcc_tar/wg1/212.htm.

[4] The national emissions used for these comparisons are based on 2005 emissions from U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006*, April 15, 2008, EPA430-R-08-005. Available at: http://www.epa.gov/climatechange/emissions/usinventoryreport.html.

[5] During this period, population grew by 6% in Iowa and by 19% nationally. However, Iowa's economy grew at a faster rate on a per capita basis (up 51% vs. 33% nationally).

Table 2-1. Iowa historical and reference case GHG emissions, by sector*

Million Metric Tons CO_2e	1990	2000	2005	2010	2020	2025
Energy (Consumption Based)	**67.0**	**82.1**	**84.6**	**90.5**	**103.3**	**111.0**
Electricity Use (Consumption)	**27.4**	**35.8**	**37.6**	**38.0**	**43.1**	**47.5**
Electricity Production (in-state)	26.7	36.7	36.3	41.8	41.8	41.8
Coal	*26.5*	*36.3*	*34.9*	*40.4*	*40.4*	*40.4*
Natural Gas	*0.17*	*0.24*	*1.15*	*1.15*	*1.15*	*1.15*
Oil	*0.05*	*0.10*	*0.15*	*0.15*	*0.15*	*0.15*
MSW/Landfill Gas	*0.01*	*0.02*	*0.06*	*0.06*	*0.06*	*0.06*
Imported (Exported) Electricity	0.68	-0.87	1.33	-3.74	1.38	5.78
Residential/Commercial/Industrial (RCI) Fuel Use	**21.3**	**25.3**	**24.1**	**27.0**	**29.7**	**30.2**
Coal	5.53	6.42	6.22	6.45	6.82	6.83
Natural Gas	10.9	11.6	11.0	13.9	15.8	16.3
Petroleum	4.70	7.25	6.78	6.51	6.93	6.86
Wood (CH_4 and N_2O)	0.13	0.08	0.08	0.17	0.19	0.20
Transportation	**16.9**	**19.1**	**20.7**	**22.8**	**27.2**	**29.4**
On-road Gasoline	11.4	12.8	13.0	13.9	16.2	17.2
On-road Diesel	3.96	4.66	5.69	6.76	8.80	9.94
Rail	0.31	0.26	0.56	0.56	0.56	0.56
Marine Vessels, Natural Gas, LPG, Other	0.81	1.07	1.04	1.07	1.22	1.29
Jet Fuel and Aviation Gasoline	0.39	0.34	0.45	0.48	0.45	0.42
Fossil Fuel Industry	**1.49**	**1.81**	**2.25**	**2.61**	**3.32**	**3.78**
Natural Gas Industry	1.48	1.81	2.25	2.61	3.32	3.78
Coal Mining	0.01	0.00	0.00	0.00	0.00	0.00
Industrial Processes	**2.74**	**3.82**	**4.59**	**5.35**	**7.04**	**8.14**
Cement Manufacture (CO_2)	1.18	1.28	1.28	1.35	1.48	1.56
Lime Manufacture (CO_2)	0.06	0.06	0.09	0.11	0.14	0.17
Limestone and Dolomite Use (CO_2)	0.20	0.21	0.18	0.17	0.15	0.15
Soda Ash (CO_2)	0.03	0.03	0.03	0.02	0.02	0.02
Iron & Steel (CO_2)	0.03	0.10	0.12	0.16	0.27	0.36
Ammonia and Urea (CO_2)	0.64	0.56	0.49	0.47	0.44	0.43
Nitric Acid Production (N_2O)	0.30	0.57	1.01	1.05	1.14	1.19
ODS Substitutes (HFC, PFC)	0.00	0.83	1.23	1.87	3.25	4.15
Electric Power T&D (SF_6)	0.29	0.17	0.15	0.14	0.13	0.13
Waste Management	**2.18**	**2.27**	**2.40**	**2.57**	**2.95**	**3.16**
Waste Combustion	0.07	0.07	0.06	0.06	0.05	0.05
Landfills	1.65	1.68	1.82	1.97	2.30	2.48
Wastewater Management	0.46	0.53	0.52	0.54	0.60	0.62
Agriculture	**25.4**	**26.0**	**27.9**	**26.0**	**25.8**	**25.6**
Enteric Fermentation	5.04	4.39	4.26	3.81	3.27	2.98
Manure Management	4.49	6.02	6.64	6.55	6.86	7.01
Agricultural Soils	15.7	15.5	16.8	15.5	15.4	15.3
Agricultural Burning	0.13	0.16	0.19	0.2	0.24	0.26
Gross Emissions (Consumption Basis)	**97.3**	**114.2**	**119.5**	**124.4**	**139.1**	**147.9**

Million Metric Tons CO_2e	1990	2000	2005	2010	2020	2025
Increase relative to 1990		*17%*	*23%*	*28%*	*43%*	*52%*
Emissions Sinks	**-21.8**	**-19.9**	**-27.3**	**-27.3**	**-27.3**	**-27.3**
Forestry and Land Use	**-10.5**	**-8.53**	**-15.9**	**-15.9**	**-15.9**	**-15.9**
Forested Landscape	-7.88	-7.88	-15.3	-15.3	-15.3	-15.3
Urban Forestry and Land Use	-2.59	-0.65	-0.63	-0.63	-0.63	-0.63
Agricultural Soils (Cultivation Practices)	**-11.4**	**-11.4**	**-11.4**	**-11.4**	**-11.4**	**-11.4**
Net Emissions (Consumption Basis) (including forestry and land use sinks)	**75.4**	**94.3**	**92.2**	**97.1**	**111.8**	**120.6**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; CH_4 = methane; N_2O = nitrous oxide; MSW = municipal solid waste; LPG = liquefied petroleum gas; ODS = ozone-depleting substance; HFC = hydrofluorocarbon; PFC = perfluorocarbon; SF_6 = sulfur hexafluoride; T&D = transmission and distribution.

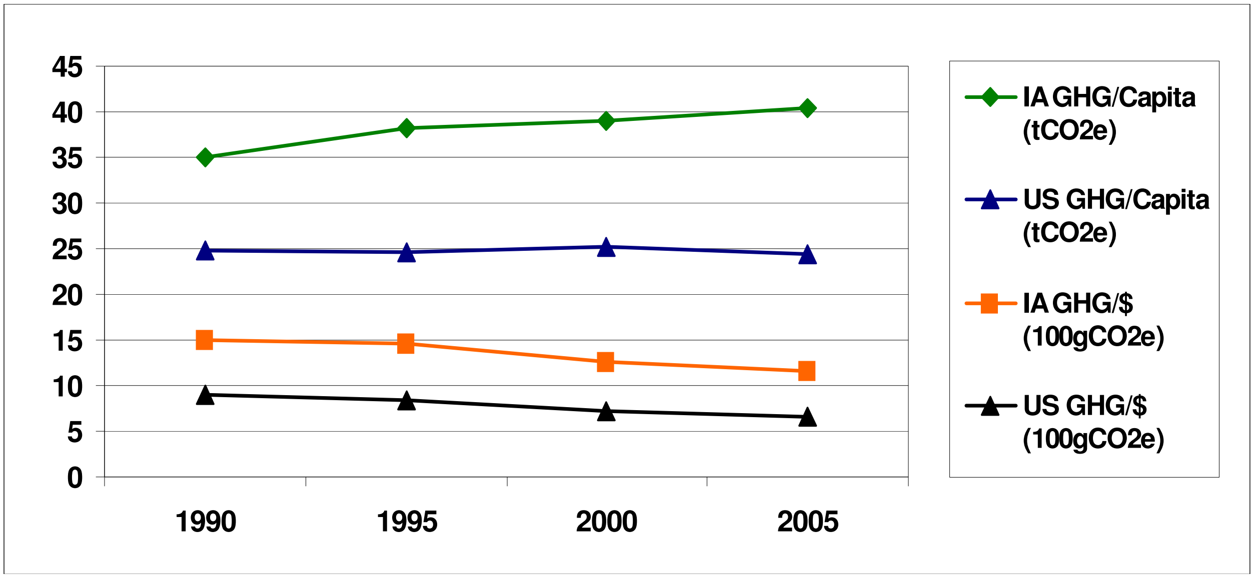
* Totals may not equal exact sum of subtotals shown in this table due to independent rounding.

In Iowa, gross CO_2e emissions on a per capita basis were about 40 metric tons (t) of gross CO_2e in 2005, higher than the national per capita emissions of about 24 tCO_2e in 2005. Figure 2-1 illustrates the state's emissions per capita and per unit of economic output. It also shows that while per-capita emissions have increased from 1990 to 2005 in Iowa, per capita emissions for the nation as a whole remained fairly flat from 1990 to 2005. The higher per capita emission rates in Iowa are due in part to emissions in the agricultural industry (agricultural industry emissions are much higher than the national average) and a lower population density (due to a larger rural area) in Iowa relative to the US as a whole.[6] In both Iowa and the nation as a whole, economic growth exceeded emissions growth throughout the 1990–2005 period. From 1990 to 2005, emissions per unit of gross product dropped by 26% nationally, and by 24% in Iowa.[7]

[6] Based on information from the US Census Bureau (http://quickfacts.census.gov/qfd/states/19000.html), Iowa has 55,869 square miles, which is 1.6% of the nation's 3,537,438 square miles. In 2005, Iowa had a population density of 53.3 persons per square mile, as compared with 84.7 persons per square mile for the US.

[7] Based on real gross domestic product (millions of chained 2000 dollars) that excludes the effects of inflation. U.S. Department of Commerce, Bureau of Economic Analysis. "Gross Domestic Product by State." Available at: http://www.bea.gov/regional/gsp/.

Figure 2-1. Iowa and U.S. gross GHG emissions, per-capita and per-unit gross product

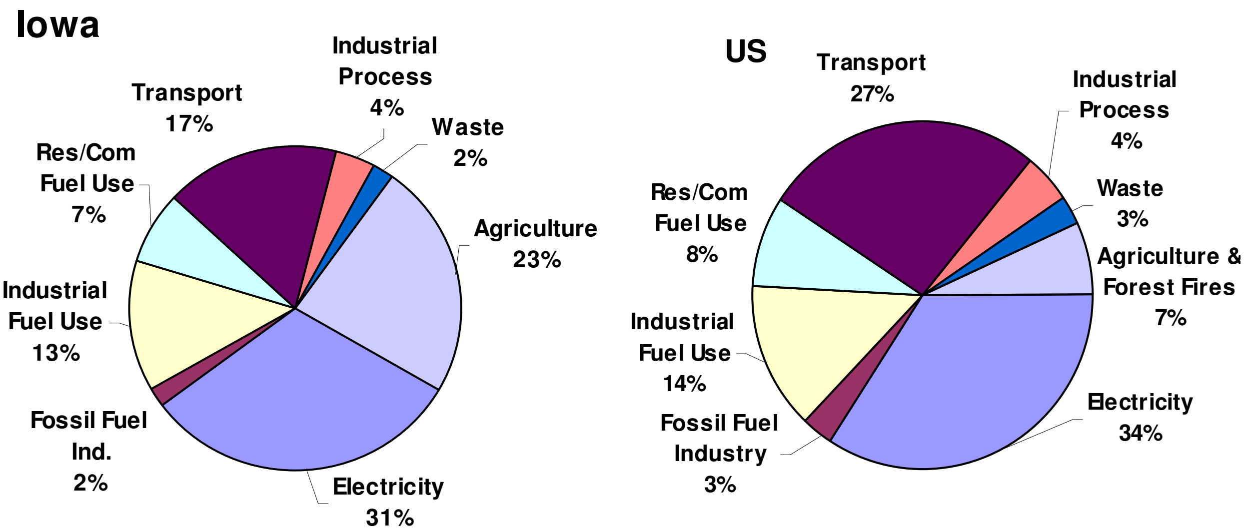


GHG = greenhouse gas; tCO_2e = metric tons of carbon dioxide equivalent.; g = grams.

Figure 2-2 compares gross GHG emissions estimated for Iowa to emissions for the U.S. for 2005. The principal sources of Iowa's GHG emissions in 2005 are electricity consumption (31% of Iowa's gross GHG emissions); agriculture (23% of Iowa's gross GHG emissions); residential, commercial, and industrial (RCI) fuel use (20% of Iowa's gross GHG emissions); and transportation (17% of Iowa's gross GHG emissions). Figure 2-2 also shows that the industrial processes sector in Iowa accounted for 4% of gross GHG emissions in 2005. These emissions are rising due to the increasing use of HFCs and PFCs as substitutes for ozone-depleting chlorofluorocarbons.[8] Other industrial process emissions include CO_2 released by cement and lime manufacturing; CO_2 released during soda ash, limestone, and dolomite use; CO_2 released during ammonia, urea, and iron and steel production; N_2O released during nitric acid production; and SF_6 released from transformers used in electricity transmission and distribution systems. Also, landfills and wastewater management facilities produce CH_4 and N_2O emissions that accounted for 2% of total gross GHG emissions in Iowa in 2005. Similarly, emissions associated with the production, processing, transmission, and distribution of fossil fuels accounted for 2% of the gross GHG emissions in 2005.

[8] Chlorofluorocarbons are also potent GHGs; however, they are not included in GHG estimates because of concerns related to implementation of the Montreal Protocol on Substances That Affect the Ozone Layer. See Appendix I in the Final Inventory and Projections report for Iowa (http://www.iaclimatechange.us/Inventory_Forecast_Report.cfm).

Figure 2-2. Gross GHG emissions by sector, 2005: Iowa and U.S.



Notes: Res/Com = Residential and commercial fuel use sectors. Emissions for the residential, commercial, and industrial fuel use sectors are associated with the direct use of fuels (natural gas, petroleum, coal, and wood) to provide space heating, water heating, process heating, cooking, and other energy end-uses. The commercial sector accounts for emissions associated with the direct use of fuels by, for example, hospitals, schools, government buildings (local, county, and state) and other commercial establishments. The industrial processes sector accounts for emissions associated with manufacturing and excludes emissions included in the industrial fuel use sector. The transportation sector accounts for emissions associated with fuel consumption by all on-road and non-highway vehicles. Non-highway vehicles include jet aircraft, gasoline-fueled piston aircraft, railway locomotives, boats, and ships. Emissions from non-highway agricultural and construction equipment are included in the industrial sector. Emissions associated with forest wildfires and rangeland burning were not calculated for Iowa due to a lack of data on acreage burned.

Electricity = Electricity generation sector emissions on a consumption basis, including emissions associated with electricity imported from outside of Iowa and excluding emissions associated with electricity exported from Iowa to other states.

Forestry emissions refer to the net CO_2 flux[9] from forested lands in Iowa, which account for about 8% of the state's land area.[10] Iowa's forests are estimated to be net sinks of CO_2 emissions in the state, reducing net GHG emissions by 16 $MMtCO_2e$ in 2005. In addition, estimates of net carbon fluxes from agricultural soil cultivation practices are estimated to be net sinks of CO_2 emissions in Iowa, reducing net GHG emissions by 11 $MMtCO_2e$ in 2005. However, the

[9] "Flux" refers to both emissions of CO_2 to the atmosphere and removal (sinks) of CO_2 from the atmosphere.

[10] Total forested acreage in Iowa is 2.8 million acres. Total forested area and forest type percentages provided by P. Tauke, DNR to M. Stein, DNR on March 21, 2008. The total land area in Iowa is 35.8 million acres (http://www.50states.com/iowa.htm).

Inventory and Projections report does not consider above-ground carbon sequestration in agriculture because it is not considered to be sequestered.[11]

Reference Case Projections

Relying on a variety of sources for projections, as noted in the Inventory and Projections report, a simple reference case projection of GHG emissions through 2025 was developed. As illustrated in Figure 2-3 and shown numerically in Table 2-1, under the reference case projections, Iowa's gross GHG emissions continue to grow steadily, climbing to about 148 $MMtCO_2e$ by 2025, 52% above 1990 levels. This equates to a 1.1% annual rate of growth from 2005 to 2025. Relative to 2005, the share of emissions associated with electricity consumption and the transportation sector both increase slightly to 32% and 20%, respectively, in 2025. The share of emissions from the industrial processes and fossil fuel industry sectors is projected to increase to 6% and 3%, respectively, by 2025. The share of emissions from the RCI fuel use sector and the waste management sector is projected to remain the same at about 20% and 2%, respectively, of Iowa's gross GHG emissions in 2025. The agriculture sector is the only sector in Iowa whose emission share in 2025 is projected to decrease from its emission share in 2005 (from 23% in 2005 to 17% in 2025).

Emissions associated with electricity consumption are projected to be the largest contributor to future GHG emissions growth, followed by emissions associated with the transportation sector, as shown in Figure 2-4. Other sources of emissions growth include the RCI fuel use sector and the increasing use of HFCs and PFCs as substitutes for ozone-depleting substances in refrigeration, air conditioning, and other applications. The agriculture sector is the only sector in which emissions are projected to decrease from 2005 to 2025. Table 2-2 summarizes the growth rates that drive the growth in the Iowa reference case projections, as well as the sources of these data.

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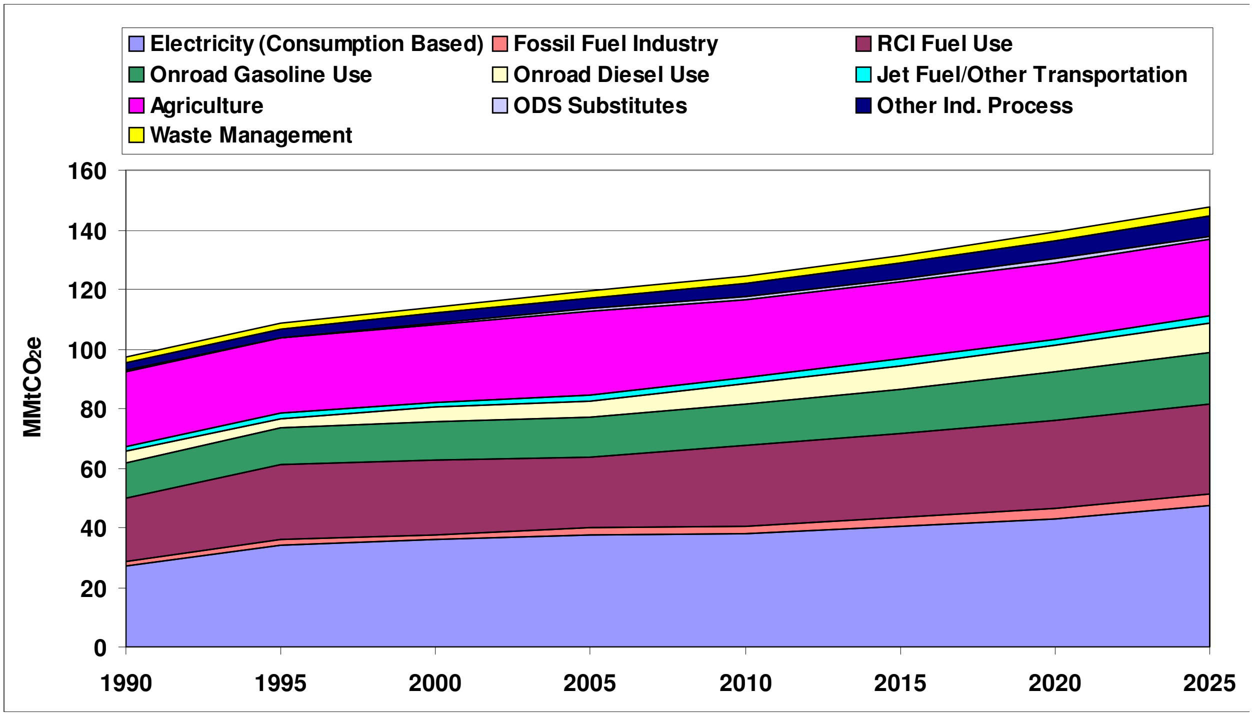
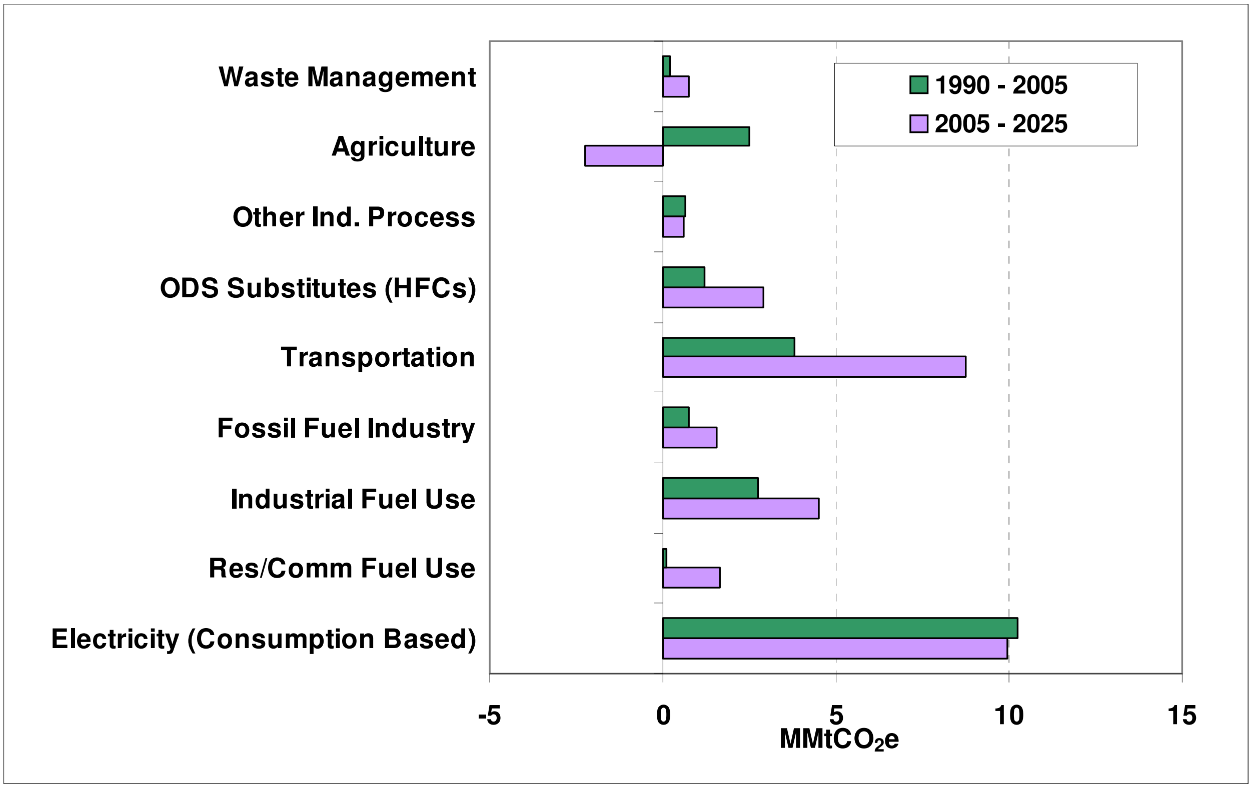
[11] Above-ground carbon re-enters the natural carbon cycle and is lost to the atmosphere through respiration or decomposition either directly or indirectly (e.g., used as energy as animal feed or by humans) over relatively short periods of time (months to years). Carbon sequestration in agriculture is below ground in the form of soil carbon (i.e., the result of the photosynthesis process), where carbon can be stored over long periods of time (potentially indefinitely). The U.S. Environmental Protection Agency (EPA) Web sites http://www.epa.gov/sequestration/ccyle.html and http://www.epa.gov/sequestration/local_scale.html have some useful information. For additional information on the potential for sequestration in agriculture, see EPA's *Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture* (http://www.epa.gov/sequestration/pdf/greenhousegas2005.pdf).

Figure 2-3. Iowa gross GHG emissions by sector, 1990–2025: historical and projected



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; RCI = direct fuel use in residential, commercial, and industrial sectors; ODS = ozone-depleting substance; Ind. = industrial.

Figure 2-4. Sector contributions to gross emissions growth in Iowa, 1990–2025: reference case projections



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; ODS = ozone-depleting substance; HFCs = hydrofluoro-carbons; Res/Comm = direct fuel use in the residential and commercial sectors (see Fig. 2-2 note for full definition.)

Table 2-2. Key annual growth rates for Iowa, historical and projected

	1990–2005	2005–2025	Sources
Population	0.42%	0.06%	Decennial Population and Population Estimates for Iowa: 1900 – 2007 - http://data.iowadatacenter.org/datatables/State/stpopest19002007.xls "Iowa Census Data Tables: Projections," State Data Center of Iowa, http://data.iowadatacenter.org/browse/projections.html
Electricity Sales -Total Sales[a] -IA Sales[b]	 2.50% 2.40%	 1.90% 1.50%	For 1990-2005, annual growth rate in total electricity sales for all sectors combined in Iowa calculated from EIA State Electricity Profiles (Table 8) http://www.eia.doe.gov/cneaf/electricity/st_profiles/iowa.html and sales by Iowa generators calculated by subtracting T&D losses from net generations collected from EIA Annual Electric Utility Data - 906/920 database. For 2005-2025, annual growth rates are based on data that Iowa utilities provided for Iowa load growth forecast for 2007 through 2025.
Vehicle Miles Traveled	2.10%	1.80%	Iowa historical VMT data (1994-2006) provided by, Iowa Department of Transportation. Future data were estimated based on historical trends.

[a] Represents annual growth in total sales of electricity by generators inside or outside of Iowa to RCI sectors located within Iowa.
[b] Represents annual growth in total sales of electricity by generators in Iowa to RCI sectors located within Iowa.

A Closer Look at the Four Major Sources: Electricity Consumption; Agriculture; Residential, Commercial, Industrial (RCI) Fuel Consumption; and Transportation

Electricity Consumption Sector

As shown in Figure 2-2, electricity use in 2005 accounted for 31% of Iowa's gross GHG emissions (about 38 $MMtCO_2e$), which was slightly lower the national share of emissions from electricity generation (34%). On a per-capita basis, Iowa's GHG emissions from electricity consumption are higher than the national average (in 2005, 12.7 tCO_2e per capita in Iowa, versus 8.1 tCO_2e per capita nationally). Electricity generated by plants located in Iowa comes primarily from coal (71% in 2005), while virtually all of the rest comes from nuclear (17% in 2005), wind and hydroelectric (6% in 2005), and natural gas (5% in 2005).

In 2005, emissions associated with Iowa's electricity consumption (38 $MMtCO_2e$) were about 1.3 $MMtCO_2e$ higher than those associated with electricity production (36.3 $MMtCO_2e$). The higher level for consumption-based emissions reflects GHG emissions associated with net imports of electricity from other states to meet Iowa's electricity demand.[12] In some historical and forecast years, Iowa is an electricity importing state. In other years, Iowa is an electricity exporting state—when its total gross generation by the in-state power plants exceeds the annual demand for electricity in the state. The reference case projection assumes that production-based emissions (associated with electricity generated in-state) will increase by about 5 $MMtCO_2e$ between 2005 and 2025, and consumption-based emissions (associated with electricity consumed in-state) will increase by about 10 $MMtCO_2e$.

While estimates are provided for emissions from both electricity production and consumption, unless otherwise indicated, tables, figures, and totals in this report reflect electricity consumption emissions. The consumption-based approach can better reflect the emissions (and emission reductions) associated with activities occurring in the state, particularly with respect to electricity use (and efficiency improvements), and is particularly useful for decision making. Under this approach, emissions associated with electricity exported to other states would need to be covered in those states' inventories in order to avoid double counting or exclusions. The reference case forecast for Iowa assumes significant wind generation resources are added and also excludes to base-load coal plants that are currently at various stages of the permitting and approval process. The CCS methodology allows new fossil-based generation to be included in the reference case only when the plants have received all necessary permits which has not occurred for the two coal plants proposed in Iowa.

Agricultural Sector

The agricultural sector accounts for 23% of the gross GHG emissions in Iowa in 2005. This is significantly higher than the national average for agricultural emissions in that year (7%). However, this is not at all surprising considering the importance of the agricultural sector to the economy in Iowa.

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[12] Estimating the emissions associated with electricity use requires an understanding of the electricity sources (both in-state and out-of-state) used by utilities to meet consumer demand. The current estimate reflects some very simple assumptions, as described in Appendix A of the Inventory and Projections report.

These emissions primarily come from agricultural soils, manure management, and enteric fermentation. Agricultural soils can produce GHG emissions from nitrogen fertilizers and manure as well as from decomposition of crop residues. Manure management can result in CH_4 emissions as a result of manure breaking down. Enteric fermentation is the result of normal digestive processes of livestock; it creates CH_4 emissions. All of these processes can result in emissions of N_2O. Emissions from the agricultural sector are projected to decrease by 8% between 2005 and 2025. This decrease is expected to come primarily from the agricultural soils-livestock and enteric fermentation categories.

Residential, Commercial, and Industrial Fuel Use Sectors

In 2005, combustion of oil, natural gas, coal, and wood in the RCI sectors contributed about 20% (about 24 $MMtCO_2e$) of Iowa's gross GHG emissions, slightly lower than the RCI sector contribution for the nation (22%). Activities in the RCI[13] sectors produce GHG emissions when fuels are combusted to provide space heating, process heating, and energy for other applications.

The residential sector's share of total RCI emissions from direct fuel use was 20% (4.8 $MMtCO_2e$) in 2005, the commercial sector accounted for 15% (3.6 $MMtCO_2e$), and the industrial sector's share of total RCI emissions from direct fuel use was 65% (15.7 $MMtCO_2e$). Overall, emissions for the RCI sectors (excluding those associated with electricity consumption) are expected to increase by 25% between 2005 and 2025. Emissions from the commercial sector are projected to increase by 48% from 2005 to 2025. The industrial sector is predicted to have a 29% increase. In contrast, emissions from the residential sector are expected to decrease slightly (1%) between 2005 and 2025.

Transportation Sector

As shown in Figure 2-2, the transportation sector accounted for about 17% of Iowa's gross GHG emissions in 2005 (about 21 $MMtCO_2e$), which was significantly lower than the national average share of emissions from transportation fuel consumption (27%). The GHG emissions associated with Iowa's transportation sector increased by 3.8 $MMtCO_2e$ between 1990 and 2005.

From 1990 through 2005, Iowa's GHG emissions from transportation fuel use have risen steadily at an average rate of about 1.4% annually. In 2005, onroad gasoline vehicles accounted for about 63% of transportation GHG emissions. Onroad diesel vehicles accounted for another 28% of emissions. Air and marine travel, rail, and other sources (natural gas- and liquefied petroleum gas- (LPG-) fueled-vehicles used in transport applications) accounted for the remaining 9% of transportation emissions. GHG emissions from onroad gasoline use increased 14% between 1990 and 2005. Meanwhile, GHG emissions from onroad diesel use rose 44% during that period, suggesting rapid growth in freight movement within or across the State.

Emissions from on-road gasoline vehicles are projected to increase by 1.4% annually from 2005 to 2025, and emissions from on-road diesel vehicles are projected to increase by 2.8% annually from 2005 to 2025. Total transportation emissions are expected to reach 29 $MMtCO_2e$ by 2025, at a 1.6% annual rate of growth from 2005.

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[13] The industrial sector also includes emissions associated with agricultural energy use.

ICCAC Revisions

The ICCAC made the following revisions to the inventory and reference case projections, which explain the differences between the final Inventory and Projections report and the draft initial assessment completed during April 2008:[14]

Energy Supply:

- The inventory now includes MidAmerican Energy Company's 25% ownership of the 1,700 megawatt (MW) Quad Cities Station nuclear plant in Illinois. This equates to about 3,350 gigawatt-hours (GWh) at 90% capacity. In both the inventory and reference case projections, this generation has been treated as an in-state resource because of its ownership status.
- A revised load growth forecast for Iowa provided by the Iowa utilities has been used.
- The AEO 2007 growth forecast data for MAPP region generation in the draft I&F was updated with data from AEO 2008.
- In the initial analysis, Energy Information Administration (EIA) forecast data of the Mid-Continent Area Power Pool (MAPP) region was used to project the electricity generation growth by fuel type in Iowa. In this report, added/retired electricity generation capacities provided by the Iowa utilities was used to project the electricity generation by fuel type in Iowa for the forecast years.
- Added the 790 MW Walter Scott, Jr. supercritical coal plant that came online in 2007;
- Added the 1284.3 MW new wind capacities of MidAmerican between 2005-2009;
- Included the minority, Iowa share of the uprate for the Duane Arnold Energy Center that is scheduled to be completed in 2009, resulting in approximately a 10 MW capacity increase;
- Added the 200 MW Alliant Franklin County (Whispering Willow) wind farm (will be on the line by 2010);
- Added the 2010 Corn Belt 71 MW wind capacity; and
- Included 100 MW of new wind capacity each year from 2014 to 2020, in response to the Clean and Renewable Energy (CRE) SC's request to extrapolate the 2008-2013 wind installation (average of 100 MW per year) to the future.

In addition to the reference case, two sensitivity cases were analyzed for electricity supply. Sensitivity Analysis Case 1 added the following new capacities, in addition to those new capacities added in the reference case:

- The 649 MW Marshalltown coal plant;
- The 10% biomass co-firing requirement;
- The retirement of the Lansing units;
- Fuel switching in the Dubuque Generating Station Units from coal to natural gas; and
- Alliant 200 MW new wind capacity by 2013.

Sensitivity Analysis Case 2 added the following new capacity, in addition to those new capacities added in the reference case and those added in Sensitivity Analysis Case 1:

- The 750 MW Elk Run plant.

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[14] In addition, a minor change was made to the transportation sector reference case projection emissions. This was done to correct the growth rate for marine gasoline fuel consumption to reflect the historical marine gas consumption trend, leading to a decrease of 0.03 $MMtCO_2e$ in the marine emissions.

Agriculture:

- The estimation of soil carbon flux due to cultivation practices has been revised using a year 2000 estimate of the soil carbon sequestration in Iowa. This comes from a publication by William Stigliani, which references a 2001 study of soil carbon in Iowa. This replaced the United States Department of Agriculture (USDA) 1997 soil carbon estimates used for the initial analysis.

Key Uncertainties

Some data gaps exist in this inventory, and particularly in the reference case projections. Key tasks for future refinement of this inventory and forecast include review and revision of key drivers, such as the electricity demand, agricultural activities, RCI fuel use, and transportation growth rates that will be major determinants of Iowa's future GHG emissions (see Table 2-2 and Figure 2-4). These growth rates are driven by uncertain economic, demographic and land use trends (including growth patterns and transportation system impacts), all of which deserve closer review and discussion.