

## Appendix E. Fossil Fuel Industries

### Overview

The inventory for this subsector of the Energy Supply sector includes methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), and carbon dioxide (CO<sub>2</sub>) emissions associated with the production, processing, transmission, and distribution of fossil fuels in Florida.<sup>1</sup> There is no coal mining in Florida. In 2005, emissions from this subsector accounted for an estimated 1.55 million metric tons (MMt) of CO<sub>2</sub> equivalent (CO<sub>2</sub>e) of total gross greenhouse gas (GHG) emissions in Florida, and are estimated to increase to about 2.09 MMtCO<sub>2</sub>e by 2025.

### Emissions and Reference Case Projections

#### *Oil and Gas Production*

In 2005, Florida crude oil production totaled 7,000 barrels (bbls) per day, accounting for only 0.1% of US production.<sup>2</sup> Proved crude oil reserves are 58 million bbls, which is similarly about 0.2% of US totals.<sup>3</sup> The first year that the Energy Information Administration of the United States (US) Department of Energy reported production data for Florida (1981) was the peak year of oil production in the state (95,000 bbls per day). Production dropped dramatically in the 1980s and has steadily declined during the last two decades.<sup>4</sup> Florida has no operating petroleum refineries.

The majority of Florida's natural gas is imported from neighboring states, but the state has limited internal production. All of the natural gas produced in Florida is associated gas. Associated gas is produced as a by-product in oil wells, as opposed to non-associated gas, which is produced in natural gas and condensate wells. In 2005, Florida consumed about 778 billion cubic feet (Bcf) of natural gas while it produced only about 2.1 Bcf.<sup>5</sup>

#### *Oil and Gas Industry Emissions*

Emissions can occur at several stages of production, processing, transmission, and distribution of oil and gas. Based on the information provided in the Emission Inventory Improvement Program (EIIP) guidance<sup>6</sup> for estimating emissions for this sector, transmission pipelines are large diameter, high-pressure lines that transport gas from production fields, processing plants, storage facilities, and other sources of supply over long distances to local distribution companies or to large volume customers. Sources of CH<sub>4</sub> emissions from transmission pipelines include leaks, compressor fugitives, vents, and pneumatic devices. Distribution pipelines are extensive

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<sup>1</sup> Note that emissions from natural gas consumed as lease fuel (used in well, field, and lease operations) and plant fuel (used in natural gas processing plants) are included in Appendix B in the industrial fuel combustion category.

<sup>2</sup> US Department of Energy (DOE), Energy Information Administration, "Crude Oil Production," accessed from [http://tonto.eia.doe.gov/dnav/pet/pet\\_crd\\_crpdn\\_adc\\_mbbldp\\_a.htm](http://tonto.eia.doe.gov/dnav/pet/pet_crd_crpdn_adc_mbbldp_a.htm), January 2008.

<sup>3</sup> US DOE, Energy Information Administration, "Crude Oil Proved Reserves, Reserves Changes, and Production," accessed from [http://tonto.eia.doe.gov/dnav/pet/pet\\_crd\\_pres\\_dcu\\_SFL\\_a.htm](http://tonto.eia.doe.gov/dnav/pet/pet_crd_pres_dcu_SFL_a.htm), January 2008.

<sup>4</sup> "Petroleum Navigator", US DOE Energy Information Administration website, January 2008, accessed from <http://tonto.eia.doe.gov/dnav/pet/hist/mcrfpfl2a.htm>.

<sup>5</sup> "State Energy Profiles: Florida", US DOE Energy Information Administration website, January 2008, accessed from [http://tonto.eia.doe.gov/state/state\\_energy\\_profiles.cfm?sid=FL](http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=FL).

<sup>6</sup> Emission Inventory Improvement Program, Volume VIII: Chapter 5. "Methods for Estimating Methane Emissions from Natural Gas and Oil Systems," August 2004.

networks of generally small diameter, low-pressure pipelines that distribute gas within cities or towns. Sources of CH<sub>4</sub> emissions from distribution pipelines are leaks, meters, regulators, and mishaps. Carbon dioxide, CH<sub>4</sub>, and N<sub>2</sub>O emissions occur as the result of the combustion of natural gas by internal combustion engines used to operate compressor stations.

With nearly 28,000 miles of gas pipelines, there are inevitable uncertainties associated with estimates of Florida's GHG emissions from this sector. This is compounded by the fact that there are no regulatory requirements to track GHG emissions.

However, the EPA's State Greenhouse Gas Inventory Tool (SIT) facilitates the development of a rough estimate of state-level GHG emissions. Emission estimates are calculated by multiplying emissions-related activity levels (e.g., miles of pipeline, number of compressor stations) by aggregate industry-average emission factors. Key information sources for the activity data are the US Department of Energy's Energy Information Administration (EIA),<sup>7</sup> the US Department of Transportation's Office of Pipeline Safety (OPS),<sup>8</sup> and the Florida Department of Environmental Protection (Florida DEP).<sup>9</sup> Florida Public Service Commission (PSC) staff provided additional information, including direction as to the preferred data source in cases where more than one set of activity estimates was available. Methane emissions were estimated using the SIT, with reference to methods/data sources outlined in the EIIP guidance document for natural gas and oil systems.<sup>10</sup> Emissions of CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O associated with pipeline natural gas combustion were estimated using SIT emission factors<sup>11</sup> and Florida 1990-2005 natural gas data from EIA for the "consumed as pipeline fuel" category.<sup>12</sup>

Unfortunately, OPS has not collected data from pipeline operators using a consistent set of reporting requirements over the 1990-2005 analysis period. In particular, OPS has only required operators to report state-level data for their transmission pipelines since 2001 and state-level data for their distribution pipelines since 2004. Before these dates, a large number of Florida pipeline records report data as multi-state totals. The Florida PSC was able to provide replacement data for natural gas distribution pipeline mileage and service counts that did not face the same issues. To estimate a complete time-series of natural gas gathering/transmission pipeline mileage, CCS compiled surrogate data to back-cast the 2001 gathering/transmission pipeline mileage for each year back to 1990.<sup>13</sup>

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<sup>7</sup> "Natural Gas Navigator," US DOE Energy Information Administration website, January 2008, accessed from <http://www.eia.doe.gov>.

<sup>8</sup> US Department of Transportation, Office of Pipeline Safety, "Distribution and Transmission Annuals Data: 1990 to 2005," accessed from <http://ops.dot.gov/stats/DT98.htm>, January 2008.

<sup>9</sup> "Access Database: Oil and Gas," David Taylor, Florida Department of Environmental Protection, Bureau of Mining & Minerals Regulation, Oil and Gas Section, January 29, 2008.

<sup>10</sup> Emission Inventory Improvement Program, Volume VIII: Chapter. 5. "Methods for Estimating Methane Emissions from Natural Gas and Oil Systems", August 2004.

<sup>11</sup> GHG emissions were calculated using SIT, with reference to *EIIP, Volume VIII*: Chapter 1 "Methods for Estimating Carbon Dioxide Emissions from Combustion of Fossil Fuels," August 2004, and Chapter 2 "Methods for Estimating Methane and Nitrous Oxide Emissions from Stationary Combustion," August 2004.

<sup>12</sup> US DOE, Energy Information Administration, *State Energy Consumption, Price, and Expenditure Estimates (SEDS)*, (<http://www.eia.doe.gov/emeu/states/seds.html>).

<sup>13</sup> Note that CCS estimated an additional 72 transmission pipeline miles in 2001 to account for a couple of operators that appeared to be missing from the OPS database (City of Lakeland and Florida Power and Light Company).

The Florida PSC also provided information that there were no natural gas storage compressor stations throughout the historical analysis period. Furthermore, Florida PSC provided the current number of compressor stations on interstate transmission pipelines in Florida (16). CCS used this value to represent the number of natural gas transmission compressor stations in the final year of the historical analysis period (2005). To estimate the number of stations throughout the 1990-2005 analysis period, CCS compiled surrogate data to back-cast this station count for each year back to 1990. Table E1 provides an overview of data sources and approaches used to develop historic oil and gas sector emission estimates for Florida, including a description of the surrogate data that were used to back-cast natural gas pipeline mileage and service count estimates for the analysis period.

#### *Coal Production Emissions*

No coal production emissions are estimated for Florida because there are no operating coal mines in Florida.<sup>14</sup>

#### *Emission Forecasts*

Table E1 provides an overview of data sources and approaches used to develop projected oil and gas production sector emission estimates for Florida. The approach to forecasting sector emissions/activity consisted of compiling and comparing two alternative sets of annualized growth rates for each emissions activity – one using *Annual Energy Outlook 2007* forecast data for each 5-year time-frame over the 2005-2025 analysis period, and the other using the historical 1990-2005 activity data for each of 3 periods (i.e., 1990 to 2005, 1995 to 2005, and 2000 to 2005). Because available AEO forecast information is for a broad region that may not reflect Florida-specific trends (e.g., AEO forecasts of natural gas production are for the Gulf Coast Region, which includes the major oil and gas producing Eastern portion of Texas and Louisiana in addition to Florida), the AEO forecast growth rates were only used when they were in-line with the Florida historical growth rates. Therefore, the majority of oil and gas production sector projections are based on state-level historical activity/emissions trends. In cases where of each the three historical periods indicated continual growth or decline, the period with the smallest annual rate of growth/decline was used in the projection. This conservative assumption was adopted because of the uncertainty associated with utilizing historical trends to estimate future emission activity levels.

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<sup>14</sup> US DOE, Energy Information Administration, “Coal Production and Number of Mines by State and Mine Type,” accessed from <http://www.eia.doe.gov/cneaf/coal/page/acr/table1.html>, January 2008.

**Table E1. Approach to Estimating Historical and Projected Emissions from Oil and Gas Systems**

Activity	Approach to Estimating Historical Emissions		Surrogate Data Used to Backcast Activity to 1990	Forecasting Approach Projection Assumption
	Required SIT Data	Data Source		
Natural Gas Production	Number of gas/ associated wells	Florida DEP database <sup>9</sup>		Application of smallest annualized decrease in number of wells in state (-3.57%) from each of 3 historical periods analyzed (1990-2005).
Natural Gas Processing	Number of gas processing plants	<i>Oil and Gas Journal</i> <sup>15</sup>		No change based on constant number of plants for the last 11 years.
	Flaring of Entrained Gas	EIA <sup>16</sup>		No change (no venting/flaring reported for state in last 11 years).
Natural Gas Transmission	Miles of gathering pipeline	Communication with Florida DEP staff <sup>17</sup>	FL natural gas production as reported by EIA <sup>18</sup>	Application of smallest annualized increase in state gathering/transmission emissions (1.93%) from each of 3 historical periods analyzed (1995-2005).
	Miles of transmission pipeline	Office of Pipeline Safety <sup>19</sup>	Average of volume of natural gas transported into FL and transported out of FL, as reported by EIA <sup>20</sup>	
	Number of gas transmission compressor stations	Communication with Florida PSC staff <sup>21</sup>		
	Number of gas storage compressor stations			

<sup>15</sup> PennWell Corporation, “Worldwide Gas Processing,” *Oil and Gas Journal* (1990-2005 June/July issues).

<sup>16</sup> US DOE, Energy Information Administration, “Florida Natural Gas Vented and Flared,” accessed from <http://tonto.eia.doe.gov/dnav/ng/hist/n9040fl2A.htm>, January 2008.

<sup>17</sup> Personal communication, “S. Florida Flowline Miles,” from David Taylor, Florida Department of Environmental Protection, Bureau of Mining & Minerals Regulation, Oil and Gas Section, to Andy Bollman, CCS, February 20, 2008.

<sup>18</sup> US DOE, Energy Information Administration, “Florida Dry Natural Gas Production,” accessed from [http://tonto.eia.doe.gov/dnav/ng/hist/na1160\\_sfl\\_2a.htm](http://tonto.eia.doe.gov/dnav/ng/hist/na1160_sfl_2a.htm), January 2008.

<sup>19</sup> US Department of Transportation, Office of Pipeline Safety, “Distribution and Transmission Annuals Data: 1990 to 2005,” accessed from <http://ops.dot.gov/stats/DT98.htm>, January 2008.

<sup>20</sup> US DOE, Energy Information Administration, “International and Interstate Movements of Natural Gas by State,” accessed from [http://tonto.eia.doe.gov/dnav/ng/ng\\_move\\_ist\\_a2dcu\\_SFL\\_a.htm](http://tonto.eia.doe.gov/dnav/ng/ng_move_ist_a2dcu_SFL_a.htm), January 2008.

<sup>21</sup> Personal communication, “RE: Pipeline Data,” from Edward Mills, Florida Public Service Commission, to Andy Bollman, CCS, February 21, 2008.

**Table E1. Approach to Estimating Historical and Projected Emissions from Oil and Gas Systems (continued)**

Activity	Approach to Estimating Historical Emissions		Surrogate Data Used to Backcast Activity to 1990	Forecasting Approach Projection Assumption
	Required SIT Data	Data Source		
Natural Gas Distribution	Miles of distribution pipeline by pipeline material type	Florida DEP reports <sup>22</sup>		Application of <i>Annual Energy Outlook (AEO) 2007</i> Gulf Coast region natural gas consumption forecast growth rates (forecast growth rates are in-line with historical distribution emission trends). <sup>23</sup>
	Total number of services			
	Number of unprotected steel services			
	Number of protected steel services			
Natural Gas Pipeline Fuel Use (CO <sub>2</sub> , CH <sub>4</sub> , N <sub>2</sub> O)	Volume of natural gas consumed by pipelines	EIA <sup>12</sup>		Used AEO 2007 projected regional pipeline fuel consumption growth rates since they are in-line with historical FL trends.
Oil Production	Annual production	Communication with Florida DEP staff <sup>24</sup>		Application of smallest annualized decline in state oil production (-5.11%) from each of 3 historical periods analyzed (1990-2005).
Oil Transport	Annual oil transported	Unavailable (per communication with Florida DEP staff, assumed oil production = oil transported)		(same as oil production)

**Results**

Table E2 displays the estimated emissions from the fossil fuel industry in Florida for select years over the period 1990 to 2025. Emissions from this sector grew by 52% from 1990 to 2005 and are projected to increase by a further 34% between 2005 and 2025. Natural gas distribution, transmission, and pipeline fuel are the major contributors to both historic emissions and emissions growth.

<sup>22</sup> Florida Department of Environmental Protection, “Annual Leak Report for Natural Gas Systems,” various years, transmitted to CCS, February 20, 2008.

<sup>23</sup> US DOE, Energy Information Administration, “Annual Energy Outlook 2007 with Projections to 2030,” accessed from <http://www.eia.doe.gov/oiaf/archive/aeo07/index.html>, January 2008.

<sup>24</sup> Personal communication, “Production data,” from David Taylor, Florida Department of Environmental Protection, Bureau of Mining & Minerals Regulation, Oil and Gas Section, to Andy Bollman, CCS, February 8, 2008.

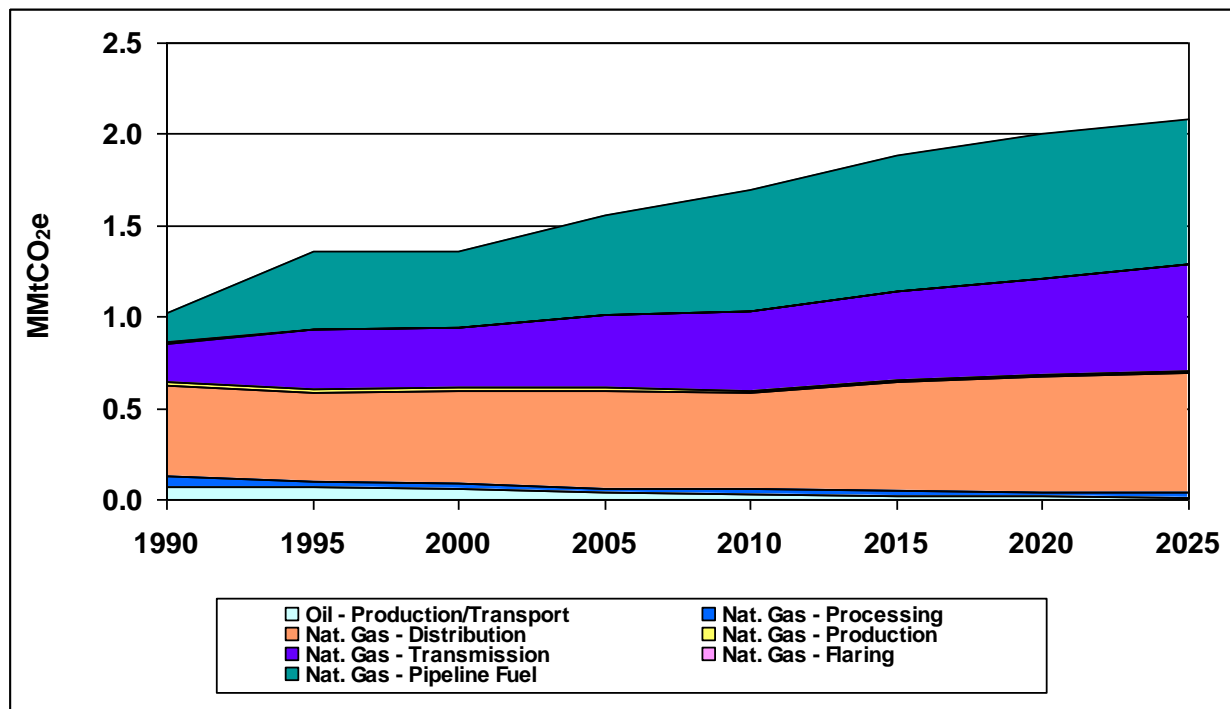
**Table E2. Historical and Projected GHG Emissions for the Fossil Fuel Industry**

(Million Metric Tons CO <sub>2</sub> e)	1990	1995	2000	2005	2010	2015	2020	2025
<b>Fossil Fuel Industry</b>	1.02	1.36	1.36	1.55	1.70	1.89	2.00	2.09
Natural Gas Industry	0.95	1.28	1.30	1.52	1.67	1.87	1.99	2.07
Production	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
Processing	0.05	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Transmission	0.21	0.33	0.33	0.40	0.44	0.48	0.53	0.58
Distribution	0.50	0.48	0.51	0.53	0.53	0.60	0.63	0.66
Flaring	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pipeline Fuel	0.16	0.43	0.42	0.55	0.66	0.75	0.79	0.80
Oil Industry	0.07	0.07	0.06	0.04	0.03	0.02	0.02	0.01
Production	0.07	0.07	0.06	0.04	0.03	0.02	0.02	0.01
Refining/Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: Calculations based on approach described in text.

Figure E1 displays process-level emission trends from natural gas and oil systems, on an MMtCO<sub>2</sub>e basis.

**Figure E1. Florida Fossil Fuel Industry Emissions, 1990 to 2025 (MMtCO<sub>2</sub>e)**



Source: Calculations based on approach described in text.

**Key Uncertainties**

Key sources of uncertainty underlying the estimates above are as follows:

- Current levels of fugitive emissions. These are based on industry-wide averages, and until estimates are available for local facilities, significant uncertainties remain.
- Due to data limitations associated with OPS reporting, natural gas gathering and transmission pipeline emissions in earlier years were estimated by assuming that changes in each emissions producing activity were related to changes in activity levels for surrogates for the emissions activity.<sup>25</sup>
- Projections of future production of fossil fuels. The assumptions used for the projections do not reflect unknown potential future changes that could affect GHG emissions, including potential changes in regulations and emissions-reducing improvements in oil and gas production, processing, and pipeline technologies.

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<sup>25</sup> For example, gathering pipeline emissions were back-cast to pre-2001 years by applying the ratio of Florida natural gas production in each pre-2001 year to Florida natural gas production in 2001.