NEW YORK STATE | Department of Environmental Conservation

Energy

2021 NYS GREENHOUSE GAS EMISSIONS REPORT

SECTORAL REPORT #1

Kathleen C. Hochul, Governor | Basil Seggos, Commissioner

Table of Contents

Format of This Report

This sectoral report provides a detailed explanation of methods, data, and trends for the energy sector. The accounting used in this sectoral report follows the requirements of the Climate Leadership and Community Protection Act (CLCPA) and is in alignment with the 6 NYCRR Part 496 regulation, "Statewide GHG Emission Limits." This includes the use of a 20-Year Global Warming Potential metric provided in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC 2013). The organization of this report and specific methodologies are based on guidelines from the IPCC Taskforce on National Greenhouse Gas Inventories (or "IPCC guidelines") as applied in the U.S. national greenhouse gas emissions report (IPCC 2006 and 2019, EPA 2021a). The accompanying *Summary Report* provides a comparison with other accounting methods, including by economic sector or using conventional accounting formats. DEC also intends to provide emission values for all years via the Open Data NY platform.

Figures and Tables

Energy

This sectoral report provides information on greenhouse gas emissions associated with the energy system. Most emissions in the energy sector are from the combustion of fuels (Table SR1.1). This report also describes emissions within New York State from other uses of fossil fuels (such as for asphalt), the leakage of emissions in the oil and gas system (or fugitive emissions), and the use of greenhouse gases in electricity transmission. The CLCPA also requires that this report include emissions that occur outside of the state that are associated with imported electricity and imported fossil fuels. These emissions are not typically included in governmental greenhouse gas emission reports or the IPCC guidelines. Finally, one additional source of emissions is provided as an informational item. Per IPCC guidelines, the portion of transportation fuels used for international transport, or bunker fuels, has been excluded from emission totals ("Excluded Transportation", Table SR1.1).

The energy system is the primary source of greenhouse gas emissions in New York (Table SR1.1). In 2019, total energy emissions were 289.58mmt CO_2e or 76% of statewide gross emissions and over 80% of net emissions, when measured using CLCPA accounting. This represents a 15% reduction in gross emissions since 1990. The majority of emissions were from either fuel combustion (59% of energy and 45% of total emissions) or were associated with the importing of those fuels or electricity (36% of energy and 27% of total emissions). The trend in Energy emissions over time is the same as that seen in nationally, with an initial increase in emission from 1990 through the mid-2000's and then a decline thereafter (EPA, 2021a). Further information on the relative contribution of the different emission sources within the energy sector are described in the sections below. The accompanying *Summary Report* provides a breakdown of these sources by economic sector as was used for the New York State Climate Action Council Draft Scoping Plan.

Table SR1.1 Energy Emissions, 1990-2019 (mmt CO_2e GWP20)

Emission Category	1990	2005	2015	2016	2017	2018	2019
Fuel Combustion	216.73	227.80	183.78	172.98	165.36	174.84	171.45
Other Fossil Fuel Use	1.56	2.26	1.46	1.33	1.29	1.19	0.93
Fugitive Emissions	17.41	20.68	15.83	15.11	14.64	14.19	14.22
Electricity Transmission	4.02	1.61	0.17	0.15	0.14	0.13	0.13
Out of State Energy Emissions*	100.33	132.20	119.77	114.09	102.83	107.50	102.85
Gross Total	340.05	384.56	321.01	303.66	284.25	297.84	289.58
% of Statewide Gross Total	*84.5%*	*83.9%*	*78.7%*	*77.5%*	*76.2%*	*76.8%*	*76.3%*
Net Total	333.23	375.82	309.92	293.38	274.15	287.17	278.76
% of Statewide Net Total	*92.4%*	*90.1%*	*84.5%*	*83.4%*	*82.4%*	*82.8%*	*82.3%*
Excluded Transportation Emissions	15.37	13.89	21.25	21.08	21.02	20.13	19.31

*Not an IPCC Category; Note: Totals may not sum due to independent rounding.

The primary greenhouse gas emitted by the energy sector is carbon dioxide (CO_2) for 75% of energy emissions (Table SR1.2). Under the IPCC guidelines for national governments, the CO_2 produced by burning biogenic or plant-based fuels is reported but treated separately from other anthropogenic

emissions. The same practice is applied in this report.[1] In this report, biogenic sources of CO_2 are included in gross emission totals but omitted in net totals. A small fraction of the fuels used in New York are currently biogenic, so biogenic fuel emissions are much lower than fossil fuel emissions.

The second most common greenhouse gas is methane (CH_4; 25% of energy emissions), primarily from leakage or intentional venting in the oil and gas system in New York and through the fuel system. Notably, 78% of energy sector methane is associated with out-of-state sources. Nitrous oxide (N_2O) is also a byproduct of fuel combustion, but at a lower emission rate than the gases above. Finally, the major source of sulfur hexafluoride (SF_6) globally is as an insulating gas in electricity transmission and distribution equipment, but it's leakage rate in New York declined significantly since the 1990's.

Table SR1.2 2019 Energy Emissions by Gas (mmt CO_2e GWP20)

Emission Category	CO_2	Biogenic CO_2	CH_4	N_2O	SF_6
Fuel Combustion	157.85	10.82	2.02	0.76	na
Other Fossil Fuel Use	0.93	na	na	na	na
Fugitive Emissions	0.17	na	14.05	+	na
Electricity Transmission	na	na	na	na	0.13
Out of State Energy Emissions*	46.31	+	56.39	0.16	na
Gross Total	**205.25**	**10.82**	**72.46**	**0.92**	**0.13**

* Not an IPCC Category; "+" less than 0.01mmt; "na" not applicable; Note: Totals may not sum due to independent rounding.

Fuel Combustion

This IPCC category represents emissions associated with the burning of fossil and biogenic fuels. Fuel combustion is the largest source of greenhouse gas emissions in the state. This includes fuels combusted for electricity, transportation, and heating in residential, commercial, and industrial buildings in New York (Table SR1.3). Petroleum refining, which existed in the state until 1991, represented a source of fuel combustion emissions in the 1990 baseline year, but it is not an emission source currently.

NYSERDA (2021a) is a technical supplement that is citied throughout this report and provides additional information on data and methods used in this section. Unless otherwise noted, the Energy Information Administration State Energy Data System (EIA SEDS) was used as the primary data source for the fuel combustion analysis and this section of the report is organized to align with that dataset. The EIA SEDS is the authoritative source of information on the nationwide transmission of fuels, and it aligns with the EPA's national greenhouse gas emissions report (EPA 2021a). However, there are minor differences in how emission sources are organized in the IPCC guidelines. For example, industrial fuel combustion includes emission sources from industries that the IPCC guidelines split across multiple subcategories.

The most significant trend in fuel combustion emissions since 1990 was a 65% reduction from the electricity sector (Table SR1.3). However, another major source of emissions is the transportation sector, in which emissions grew 16% from 1990 to 2019 and represented 45% of fuel combustion emissions in

[1] Per 6 NYCRR Part 496

2019. The second largest source of emissions is the use of fuels in residential buildings, such as for heating and cooking, followed by commercial fuel use and electricity generation.

Table SR1.3 Fuel Combustion Emissions, 1990-2019 (mmt CO2e GWP20)

Emission Category	1990	2005	2015	2016	2017	2018	2019
Electric Power	63.63	56.22	29.90	28.58	22.94	25.17	22.12
Residential	39.18	46.44	40.54	34.90	35.42	41.31	40.72
Commercial	27.24	29.93	22.66	21.53	21.86	23.01	22.70
Industrial	20.75	13.71	9.42	9.27	8.90	9.17	9.18
Transportation	65.91	81.51	81.26	78.70	76.24	76.18	76.73
Petroleum Refining	0.01	no	no	no	no	no	no
Gross Total	**216.73**	**227.80**	**183.78**	**172.98**	**165.36**	**174.84**	**171.45**

"no" not occurring; Note: Totals may not sum due to independent rounding.

The majority of fuel combustion emissions in 2019 were from the burning of petroleum fuels, which is unsurprising as these are the main fuels used in transportation (Table SR1.4, SR1.9). However, emissions from the combustion of petroleum fuels had declined 28% since 1990, while emissions from natural gas increased nearly 50%. Emissions from the combustion of coal declined 96%.

Table SR1.4 Fuel Combustion Emissions by Fuel Category, 1990-2019 (mmt CO2e GWP20)

Fuel Category	1990	2005	2015	2016	2017	2018	2019
Petroleum Fuels	127.44	135.13	97.91	92.20	88.85	91.68	91.54
Natural Gas	47.59	58.98	74.27	71.06	67.88	74.09	70.87
Coal	33.60	23.95	3.54	2.54	1.56	1.37	1.30
Wood	8.09	9.75	8.06	7.19	7.06	7.70	7.73
Gross Total	**216.73**	**227.80**	**183.78**	**172.98**	**165.36**	**174.84**	**171.45**

Note: Totals may not sum due to independent rounding.

Electricity Generation

This category addresses emissions from facilities whose primary activity is to generate electricity that will be transmitted via the electricity grid. Per IPCC guidelines, this category does not include electricity generated for local use, or distributed sources of generation such as industrial facilities or combined heat and power (CHP) facilities (a form of industrial fuel combustion). Although some excess portion of electricity may be shared with the electricity grid, that is not the main function of these emission sources. Instead, all emissions associated with on-site combustion of fuels is covered in the Residential, Commercial, and Industrial Fuel Combustion section below. Additionally, this section focuses on emission sources located within New York. Emissions resulting from Imported Electricity are described in a separate section below.

The mix of fuels used to generate electricity in New York has changed over time. For the 1990-2019 timeseries, these fuels included coal, distillate fuel oil, natural gas, petroleum coke, residual fuel oil, and wood. Additional information on the sources of fuels used in New York can be found in the annual

NYSERDA “Patterns and Trends” report and NYISO “Gold Book" and “Power Grid” reports (e.g., NYSERDA 2021c, NYISO 2021a and b).

Methodology

Emissions from fuel combustion are generally estimated by applying standard emission factors to the volume or energy content (BTUs) of fuels used in each sector. An alternative approach would be to summarize data that may be reported by facilities as part of state or federal air pollution regulations, however these data sources do not cover all sources or gases for the full 1990-2019 timeseries. For this report, annual BTUs of fuel consumed were taken from the EIA SEDs dataset and emission factors for CO_2, CH_4, and N_2O were from the EPA (NYSERDA 2021a, EPA 2021a Table A-32).

Results

The most significant emission reduction in this report was the decrease in fuel combustion emissions in the electricity sector, by 65% (Table SR1.3). This is related to the transition away from fuels with higher combustion emissions to those with lower combustion emissions; as natural gas usage has increased, the use of coal and petroleum fuels such as residual fuel oil has declined (Table SR1.5). As described in NYSERDA (2021a), the emissions from the extraction, processing, transmission, and distribution of these fuels have not followed the same pattern. Note, according to the SEDS dataset, petroleum coke was not a source of fuel prior to 1996 or after 2011.

Table SR1.5 Electricity Emissions by Fuel Type, 1990-2019 (mmt CO_2e GWP20)

Emission Category	1990	2005	2015	2016	2017	2018	2019
Coal	25.04	20.60	2.12	1.51	0.61	0.68	0.46
Distillate Fuel	0.47	0.69	0.36	0.15	0.11	0.34	0.16
Natural Gas	12.59	16.52	25.80	25.82	21.09	22.72	20.73
Petroleum Coke	no	1.33	no	no	no	no	no
Residual Fuel	25.45	16.59	0.92	0.30	0.30	0.76	0.17
Wood	0.07	0.49	0.70	0.80	0.83	0.67	0.60
Gross Total	**63.63**	**56.22**	**29.90**	**28.58**	**22.94**	**25.17**	**22.12**

“+” less than 0.01mmt; “no” not applicable; Note: Totals may not sum due to independent rounding.

Residential, Commercial, and Industrial Fuel Combustion

This sectoral category includes emissions from the combustion of fuels in residential, commercial, and industrial buildings such as for space heating, cooking, and industrial processes. Based on the EIA SEDS data, the types of fuels used from 1990 to 2019 in residential and commercial buildings in New York included coal, distillate fuel oil, kerosene, liquefied petroleum gas (LPG), natural gas, residual fuel oil, and wood. Industrial fuels included coal, distillate fuel oil, kerosene, LPG, natural gas, petroleum coke, residual fuel oil, special naphthas, and wood. Additional information on the sources of fuels used in New York can be found in the annual NYSERDA “Patterns and Trends” report (e.g., NYSERDA 2021c).

Methodology

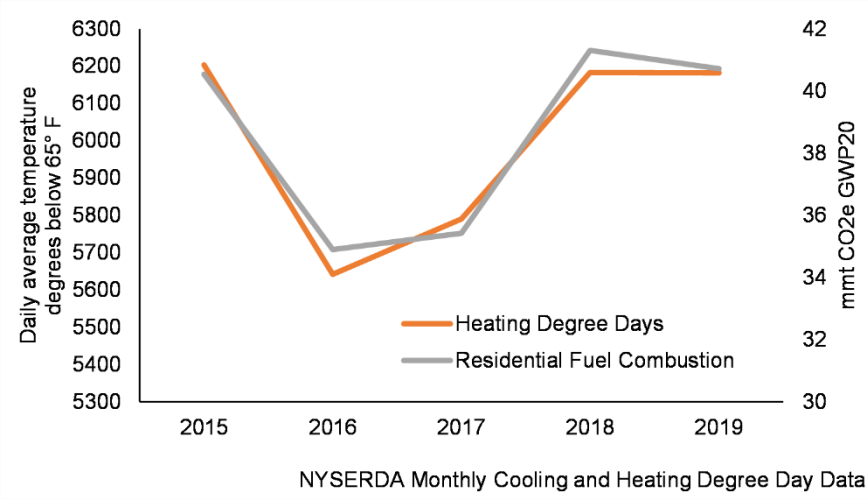
The method used to estimate emissions from fuel combustion in buildings is the same as that used for electricity generation. Annual BTUs of fuel consumed were gathered from the EIA SEDs dataset and emission factors for CO_2, CH_4, and N_2O were from the EPA (NYSERDA 2021a). Distillate fuel oil emission factors were applied to kerosene and natural gas emission factors were applied to LPG. One notable

aspect of this analysis is that when using the EIA SEDS dataset, states must also consider the volume of fuels that were not combusted but used for other purposes, as described in the Other Uses of Fossil Fuels section below.

Results

It is important to review long term trends when considering changes in fuel combustion emissions associated with space heating because interannual changes are heavily influenced by seasonal weather patterns in addition to economic trends and technological change. In particular, residential fuel combustion in a given year is affected by the severity of weather in the cold seasons. Figure SR1.1 compares residential fuel combustion emissions to the number of heating degree days in New York State, or the total number of degrees that the daily average temperature fell below 65° F in that year.[2]

Figure SR1.1 Heating Degree Days and Fuel Combustion



When comparing 1990 emission levels to emissions in recent years (or 2015-2019), fuel combustion emissions in the Residential Commercial and Industrial (RCI) sources were 17-25% lower overall (Table SR1.6). However, the largest portion of emissions is from residential fuel combustion, which was up to 5% higher in recent years compared to 1990. Commercial fuel combustion levels were 16% below 1990 and industrial fuel combustion levels were 56% below 1990 levels, likely in part to the decline in manufacturing over this time period.

Table SR1.6 RCI Fuel Combustion Emissions, 1990-2019 (mmt CO_2e GWP20)

Emission Category	1990	2005	2015	2016	2017	2018	2019
Residential	39.18	46.44	40.54	34.90	35.42	41.31	40.72
Commercial	27.24	29.93	22.66	21.53	21.86	23.01	22.70
Industrial	20.75	13.71	9.42	9.27	8.90	9.17	9.18
Gross Total	**87.18**	**90.08**	**72.63**	**65.70**	**66.18**	**73.48**	**72.60**

Note: Totals may not sum due to independent rounding.

[2] Available at https://www.nyserda.ny.gov/about/publications/ea-reports-and-studies/weather-data/monthly-cooling-and-heating-degree-day-data

As in the case of the electricity sector, there has been a transition in the RCI energy sectors away from fuels with higher combustion emissions (Table SR1.7). While combustion emissions from natural gas increased 40%, emissions of all other fuels decreased 54%.

Table SR1.7 RCI Fuel Combustion Emissions by Fuel Type, 1990-2019 (mmt CO_2e GWP20)

Emission Category	1990	2005	2015	2016	2017	2018	2019
Coal	8.56	3.35	1.42	1.03	0.96	0.69	0.84
Distillate	21.79	24.52	13.96	10.78	10.28	12.19	12.20
Natural Gas	34.73	41.73	46.49	43.67	45.34	49.85	48.69
Wood	8.02	9.25	7.35	6.38	6.23	7.03	7.13
Other	14.07	11.23	3.40	3.84	3.37	3.73	3.73
Gross Total	**87.18**	**90.08**	**72.63**	**65.70**	**66.18**	**73.48**	**72.60**

Note: Totals may not sum due to independent rounding.

Transportation

Emissions from the transportation sector are distinguished from other sources of fuel combustion emissions in that they are predominantly emitted by mobile sources (sources that can be moved). Road transportation comprises the largest subcategory of emissions and includes passenger cars and trucks, commercial light-duty trucks, motorcycles, buses, and heavy-duty trucks. Non-road transportation sources include aviation, marine, and rail as well as equipment used in agriculture, construction, landscaping, or recreation. The IPCC guidelines also include emissions associated with the operation of oil and natural gas pipelines and distribution. In this report, the leakage of emissions in this infrastructure is described below in the Fugitive Emissions section.

Transportation fuels used in New York for 1990-2019 included motor gasoline, diesel, compressed natural gas (CNG), and blended biofuels (ethanol and biodiesel). Emissions of gasoline and diesel blended with biofuels are reported together with the fossil fuel, and the biogenic CO_2 accounted for separately. One key aspect of transportation emissions accounting relates to the treatment of fuels used for international transport, or bunker fuels (Table SR1.10). The current report follows the IPCC guidance and focuses on fuels used for domestic transportation and so only considers fuels used for trips that start in New York and whose destination is within the United States.

Methodology

Non-Road Transportation: Non-road emission sources were estimated using fuel volume data from EIA SEDS and emission factors from the EPA, with minor adjustments as described in NYSERDA (2021a). A key exception is the analysis of aviation emissions which is based on a combination of SEDS fuel volumes and information from the Bureau of Transportation Statistics. This approach enables New York to include fuel volumes that the EIA SEDS dataset allocates to neighboring states as well as distinguish between domestic and international flights. As described above, emissions from international flights were excluded from emission totals, but were provided as an informational item. Additionally, it is not possible at this time to determine the portion of marine residual and distillate fuels that are not bunker fuels, i.e., not used for ocean-going trips. So, these fuels were all treated as bunker fuels and excluded from the analysis (a total of 0.73mmt CO2e). This may be reassessed in future reports if new data are made available (see Planned Improvements).

Road Transportation: Road transportation emissions include two additional layers of complexity compared to other types of fuel combustion. The first is that the actual tailpipe emissions of methane and nitrous oxide from vehicles depends on the control technology used in those vehicles, which varies widely among vehicle makes and model years. Secondly, motor vehicles move easily across state borders and may contain fuels purchased in other states. The EIA SEDS dataset provides an estimate of fuels sold in New York, but not fuels purchased elsewhere that were combusted in New York. Given these complexities, it is not appropriate to use the EIA SEDS fuel volumes alone to estimate emissions from road transportation.

The U.S. EPA requires states to use the Motor Vehicle Emissions Simulator (MOVES) model for estimating air pollution emissions from "on-road" transportation. This model is also ideal for estimating statewide greenhouse gas emissions as it estimates tailpipe emissions based on total vehicle miles travelled (VMT), rather than fuel sales. DEC's MOVES modeling inputs are provided to the EPA's National Emissions Inventory (or "NEI", EPA 2021b). EPA then publishes emission estimates based on these inputs. These published emissions were used as the emission estimates for 2011 and 2014 while the emissions for 2017 were from DEC modeling of inputs submitted to EPA. 2017 is the most recent year of MOVES modeling by DEC. Emissions from 2017 were copied for 2018 and 2019, updated DEC modeling of these emissions is planned. Emission estimates for 1990 through 2010 were conducted by the NYSDERA contractor, ERG, and are further described in NYSERDA (2021a).

Results

Transportation is the largest source of fuel combustion emissions, which increased substantially since 1990. Road transportation emissions increased nearly 7mmt CO2e since 1990 or 12% (Table SR1.8) and represented 82% of transportation fuel combustion emissions and 17% of statewide total emissions in 2019. Non-road source emissions increased 4mmt or 41% since 1990. A little over half of non-road emissions are from aviation (56% in 2019). However, this does not include the additional 14.6mmt of emissions associated with international aviation (Table SR1.10) that were excluded from this analysis.

Table SR1.8 Transportation Emissions, 1990-2019 (mmt CO_2e GWP20)

Emission Category	1990	2005	2015	2016	2017	2018	2019
Road	**55.98**	**69.80**	**67.50**	**65.13**	**62.75**	**62.75**	**62.75**
Non-Road	**9.93**	**11.71**	**13.75**	**13.57**	**13.49**	**13.43**	**13.98**
Aviation	5.90	6.69	7.45	7.70	7.82	7.60	7.82
Rail	0.12	0.85	0.79	0.66	0.37	0.50	0.58
Marine	0.45	0.61	0.73	0.84	0.84	0.75	0.81
Other Transportation	3.20	3.00	3.06	3.07	3.10	3.13	3.40
Pipeline	0.26	0.56	1.73	1.31	1.36	1.45	1.38
Gross Total	**65.91**	**81.51**	**81.26**	**78.70**	**76.24**	**76.18**	**76.73**

Note: Totals may not sum due to independent rounding.

Given that the largest source of emissions is road transportation, it is not surprising that gasoline is also the fuel type associated with the highest level of emissions, or 69% of transportation fuel combustion emissions in 2019 (Table SR1.9). However, the growth of gasoline emissions is approximately the same as jet fuel (roughly 2mmt between 1990 and 2019, a 5% growth in gasoline, 33% growth in jet fuel), while diesel emissions grew by over 5mmt, almost 60% increase.

Table SR1.9 Transportation Emissions by Fuel Type, 1990-2019 (mmt CO_2e GWP20)

Fuel Type	1990	2005	2015	2016	2017	2018	2019
Aviation Gasoline	0.06	0.10	0.03	0.03	0.03	0.03	0.03
CNG	+	0.16	0.25	0.26	0.08	0.08	0.08
Diesel	9.21	14.41	15.05	15.21	14.85	15.17	14.65
Gasoline	50.42	59.68	56.78	54.23	52.12	51.88	52.81
Jet Fuel	5.84	6.59	7.42	7.67	7.79	7.57	7.78
Natural Gas	0.26	0.56	1.73	1.31	1.36	1.45	1.38
Residual Fuel	0.12	na	na	na	na	na	na
Gross Total	**65.91**	**81.51**	**81.26**	**78.70**	**76.24**	**76.18**	**76.73**

"+" less than 0.01mmt; "na" not applicable; Note: Totals may not sum due to independent rounding.

As described above, IPCC guidelines omit fuels used for international transport and these emissions were excluded from this analysis as well (Table SR1.10). As New York State receives a significant volume of the United States international travel and shipping, these emissions are significant.

Table SR1.10 Excluded Transportation Emissions, 1990-2019 (mmt CO_2e GWP20)

Emission Category	1990	2005	2015	2016	2017	2018	2019
Bunker (Aircraft)	11.58	8.25	13.68	14.52	15.15	14.57	14.55
Bunker (Marine Vessel)	0.60	2.63	2.91	1.97	1.32	1.33	0.71
Excluded Total	**12.18**	**10.89**	**16.58**	**16.49**	**16.46**	**15.90**	**15.26**

Note: Totals may not sum due to independent rounding.

Petroleum Refining

The EIA SEDS dataset suggests that one refinery operated in New York in 1990 and ceased operations in 1991. Emissions for this facility were calculated for 1990 and 1991 by scaling national refinery emissions for those years to New York based on the state's crude oil distillation capacity. Emissions were estimated as 0.01mmt CO_2e for both1990 and 1991.

Other Fossil Fuel Use

While the majority of emissions from fossil fuels are the result of fuel combustion or leakage, there are also emissions associated with other non-energy uses of fossil fuels. This includes emissions that might occur during the manufacturing or use of plastics, asphalt, or lubricants. Some of these uses result in longer term storage of carbon, rather than emissions. Nationwide, the EPA estimates that 38% of the carbon consumed in these uses is emitted as CO_2.[3] The IPCC guidelines include these other uses of fossil fuels in the Industrial Process and Product Use sector. This report follows the national greenhouse gas inventory, which includes these emissions in the energy sector (EPA 2021a).

[3] EPA (2021a) 3.2 Carbon Emitted from Non-Energy Uses of Fossil Fuels (CRF Source Category 1A)

Methodology

The EIA SEDS dataset provides total fuel volumes, but an additional step is needed to determine how much fuel was likely to be used in New York for different products. The U.S. national inventory was used to determine the percentage of each type of fuel that was either combusted, used for other reasons that resulted in emissions, or not associated with emissions (i.e., stored) for each year in the time series (NYSERDA 2021a). For those fuel volumes that were determined to be used for other reasons that resulted in emissions, it is assumed that 100% of the carbon content was oxidized and released as CO_2, and no CH_4 or N_2O emissions were produced.

Results

Although these non-combustion activities are not a major source of annual emissions, emissions declined 40% from 1990 to 2019, suggesting a reduction in the use of these fuels in New York State.

Table SR1.11 Emissions from Other Uses by Fuel Type, 1990-2019 (mmt CO_2e GWP20)

Fuel Type	1990	2005	2015	2016	2017	2018	2019
Lubricants	0.88	0.75	0.61	0.59	0.54	0.52	0.48
Special Naphthas	0.22	0.10	0.18	0.17	0.16	0.15	0.15
Miscellaneous Petroleum Products	0.23	0.12	0.12	0.13	0.16	0.16	0.15
Natural Gas	0.08	0.06	0.06	0.06	0.06	0.06	0.06
Coal	0.02	0.77	0.39	0.29	0.29	0.22	0.02
Other Fuels	0.13	0.47	0.09	0.09	0.07	0.08	0.08
Gross Total	**1.56**	**2.26**	**1.46**	**1.33**	**1.29**	**1.19**	**0.93**

Note: Totals may not sum due to independent rounding.

Fugitive Emissions from Fossil Fuels

This IPCC category represents emissions associated with the intentional venting or unintentional leakage of emissions from oil and natural gas infrastructure in New York. This includes many individual sources from extraction, through the transmission and distribution system, and at the “customer side” or the final delivery location. As described in the *Summary Report*, governmental greenhouse gas inventories are “bottom-up” and attempt to catalogue annual emissions from all sources across a wide geographic area. The analysis of fugitive emissions in this section and in the Imported Fossil Fuels section below also considers “top-down” information, or data collected from sensors that are not associated with any specific emission source. Top-down information can complement bottom-up inventories and provide valuable points of comparison. Notably, the primary source of information for this report is NYSERDA (2021b), which is an updated version of the NYS Oil and Gas Methane Inventory from 2019. The estimate of current CH_4 emissions increased 44% as that analysis was updated to reflect improved methodologies. This report applies a further consideration of potential fugitive emissions and higher emission rates for in-state natural gas wells, as described in NYSERDA (2021a).

Methodology

The underlying data and methodology used in this report are described in the NYS Oil and Gas Methane Inventory (NYSERDA 2021b) as supplemented by methods described in NYSERDA (2021a). These analyses will continue to be updated as new information is made available, which is likely to result in higher estimates of fugitive CH_4 (see Planned Improvements). For these analyses, NYSERDA contracted

with researchers at Abt Associates Inc. and Eastern Research Group and received technical support from DEC and other State agencies as well as from outside experts. DEC also hosted a public hearing in March 2021 to describe the analyses and take feedback on data sources and methodology. DEC continues to welcome feedback on this and any part of the current analyses.

Results

Based on the analysis provided by NYSERDA (2021a, b) emissions in the oil and gas industry within New York has declined 18% since 1990 (Table SR1.12). However, emissions from this industry remain high, and were 3.6% of total emissions in 2019 despite providing a very small portion of fuel used in the state. This analysis was also used to generate upstream and downstream emission factors by fuel type for use by State agencies, as provided in the accompanying *Summary Report*.

Table SR1.12 Oil and Gas Fugitive Emissions, 1990-2019 (mmt CO_2e GWP20)

Gas	1990	2005	2015	2016	2017	2018	2019
Carbon dioxide	0.02	0.04	0.04	0.05	0.07	0.09	0.17
Methane	17.39	20.65	15.78	15.07	14.57	14.10	14.05
Nitrous oxide	+	+	+	+	+	+	+
Gross Total	**17.41**	**20.68**	**15.83**	**15.11**	**14.64**	**14.19**	**14.22**

"+" less than 0.01mmt; Note: Totals may not sum due to independent rounding.

Electricity Transmission

This IPCC category is typically included in the Industrial Process and Product Use sector but represents an emission source associated with energy systems. Emissions of sulfur hexafluoride (SF_6) are primarily the result of leaks emitted from electric system substations and switchgear. In addition to leaks, SF_6 can also be emitted during installation, servicing, and disposal of substations and switchgear. To address the high rate of SF_6 emissions in the 1990's, EPA established the Electric Power Systems Partnership, which resulted in a significant decline in annual emission rates nationwide.[4] However, these systems are still the industry standard and new SF_6 equipment continues to be installed. SF_6 is one of the strongest known greenhouse gases and has an extremely stable molecular structure. This stability also means that SF_6 degrades slowly in the atmosphere, potentially affecting the earth's climate for thousands of years.

Methodology

Per the U.S. EPA SIT, national emissions estimates were scaled to New York State using the ratio of New York State to U.S. electricity sales (MWh) with one notable adjustment. Based on feedback from EPA, SF_6 emissions were calculated separately for Consolidated Edison Inc. (ConEd), which historically represented a large share of U.S. emissions. Electricity sales attributable to ConEd were deducted from national and state totals and SF_6 was estimated separately for ConEd. Publicly reported ConEd SF_6 emissions were used, where available. For the earlier years of 1990-1995, the 1996 ratio of ConEd to total national emissions was applied to the annual U.S. emissions estimate.

[4] https://www.epa.gov/eps-partnership/eps-partnership-accomplishments

Results

Based on this assessment, emissions of SF_6 were greatest in the early years of the time series and declined substantially. The emission rate has remained relatively flat in recent years, likely due to the servicing of existing equipment and the continuing installation of new SF_6 equipment across the state.

Table SR1.13 Electricity Transmission SF_6 Emissions, 1990-2019 (mmt CO_2e GWP20)

Emission Category	1990	2005	2015	2016	2017	2018	2019
Electricity Transmission	4.02	1.61	0.17	0.15	0.14	0.13	0.13
Gross Total	**4.02**	**1.61**	**0.17**	**0.15**	**0.14**	**0.13**	**0.13**

Out of State Energy Emissions

The CLCPA requires that this emissions report include two categories of emissions that occur outside of the State's jurisdictional boundaries and that are not typically included in governmental greenhouse gas accounting. These are emissions associated with imported electricity and with the "extraction and transmission" of imported fossil fuels (Table SR1.14). The IPCC guidelines do not include these emission categories and DEC is unaware of similar analyses in any governmental greenhouse gas report. However, the emission sources covered here may be included in reporting by the states in which they are located. National emission reports will not attribute these emissions to New York State or to facilities located in New York.

The data and methods used for these two analyses are described at a high level below and in greater detail in NYSERDA (2021a). In general, this analysis seeks to calculate the "upstream", out-of-state emissions associated with imported electricity and the fossil fuel volumes described in other sections of this report.

This report follows IPCC guidelines and excludes emissions from bunker fuels, or fuels used for international transport ("Excluded Transportation Emissions", Table SR1.14). This is explained in more detail in the Fuel Combustion section above. For this section, this means that this report excludes the upstream, out-of-state emissions for the volume of fuel that was used as a bunker fuel in New York.

Table SR1.14 Out of State Energy Emissions, 1990-2019 (mmt CO_2e GWP20)

Emission Category	1990	2005	2015	2016	2017	2018	2019
Imported Electricity	0.92	7.86	6.55	7.22	6.67	8.27	7.84
Imported Fossil Fuels	99.42	124.34	113.22	106.87	96.16	99.22	95.01
Gross Total	**100.33**	**132.20**	**119.77**	**114.09**	**102.83**	**107.50**	**102.85**
Excluded Transportation Emissions	3.19	3.00	4.67	4.60	4.56	4.23	4.05

Note: Totals may not sum due to independent rounding.

Imported Electricity

This emission category relates to the importing of electricity into New York that was generated at facilities outside of New York. The amount of power imported into New York in any given year is determined by a variety of factors that are beyond the scope of this report. Additionally, the types of technologies used to

generate electricity in other states and the emissions that result from that generation are also not subject to New York State's jurisdiction.

Methodology

The data and methodology used in this report are described in the accompanying report from NYSERDA (2021a). For this analysis, NYSERDA contracted with researchers at Eastern Research Group Inc. (ERG) and received technical support from DEC and other State agencies as well as from outside experts. DEC continues to welcome feedback on this and any part of the current analysis. This analysis included both net electricity imports from the surrounding regional electricity grids as well as imports from specific electricity generation units in New Jersey that are directly connected to New York's electricity grid.

Results

Emissions of CO_2, CH_4, and N_2O from imported electricity were very low in 1990 but have been greater than 6.5mmt per year since 2002. In other words, although emissions were higher in 2019 compared to 1990, this is not a new trend. Instead, emissions from imported electricity have stayed between 6.5 and 10.52mmt CO_2e for almost twenty years, and below 8.3mmt CO_2e for the last five years.

Imported Fossil Fuels

This category of emissions encompasses a wide variety of individual emission sources including those associated with the extraction of fuels, transport to refineries, the processing and blending of finished fuels, and then the transport of those fuels to the New York State border. This category does not include emission sources within New York State, as these are described in the other sections of this report. For comparison, the Fuel Combustion section above assessed the emissions resulting from the combustion of a certain volume of fuel. This Imported Fuels analysis estimated the emissions that occurred during extraction, production, and transmission or distribution of those fuels to New York. Just as the Fuel Combustion analysis applied a combustion emission factor to fuel volumes, this analysis calculated and then applied emission factors related to the upstream fuel cycle.

Methodology

The data and methodology used in this section of the report are described in the accompanying technical documentation from NYSERDA (2021a). For that analysis, NYSERDA contracted with ERG and received technical support from DEC and other State agencies as well as from outside experts. DEC also hosted a public hearing in March 2021 to describe the analysis and take feedback on data sources and methodology. DEC continues to welcome feedback on this and any part of the current analysis.

The methodology used in this section of the report is unique because it encompasses a large, complex set of infrastructures that are not located in New York and are not subject to New York State laws or reporting requirements. There is also no comprehensive federal data source that can provide all of the necessary information. The closest source of information are lifecycle models, which attempt to estimate emissions associated with a product across all stages, from the extraction of raw materials through the final end-use of the product. However, lifecycle models are not updated annually and they may utilize information collected across multiple years. There is also no lifecycle analysis tool that will provide information specific to New York State. Instead, the research team used a combination of lifecycle models, historical emission and fuel data, and spatial information to reconstruct the full time series. NYSERDA (2021a) also describes approaches to assess sensitivities and address specific sources of uncertainty. For this report, DEC uses emission outputs from the "high sensitivity" approach, which represented the most precautionary approach and applies the highest emission factors.

Results

Emissions of CO_2, CH_4, and N_2O from imported fossil fuels declined 4% since 1990 (Table SR1.15). The previous sections of this report described a trend away from fuels with higher combustion emissions such as coal towards those with lower combustion emissions such as natural gas. That trend in fuel use is also apparent in the emissions associated with imported fossil fuels, as upstream, out-of-state emissions associated with coal were reduced 95% while natural gas increased 29%. NYSERDA (2021a) provides additional background and supplemental information, including comparisons of aggregate emission rates associated with different fuel basins that provided fuel to New York. This analysis was also used to generate upstream emission factors by fuel type for use by State agencies, as provided in the accompanying *Summary Report*.

Table SR1.15 Imported Fossil Fuel Emissions by Fuel Type, 1990-2019 (mmt CO2e GWP20)

Fuel Type	1990	2005	2015	2016	2017	2018	2019
CNG	+	0.16	0.21	0.22	0.05	0.04	0.04
Coal	9.24	5.97	2.31	2.17	1.68	1.80	1.41
Diesel/Distillate	10.83	10.83	10.83	10.83	10.83	10.83	10.83
Gasoline	21.65	26.32	23.58	22.34	21.37	20.67	21.04
Jet Fuel	1.52	1.78	2.06	2.12	2.14	2.00	2.06
Natural Gas	43.66	66.24	72.13	68.45	59.87	62.97	59.18
Other Fuels	12.52	13.03	2.08	0.74	0.22	0.90	0.45
Gross Total	**99.42**	**124.34**	**113.22**	**106.87**	**96.16**	**99.22**	**95.01**

"+" less than 0.01mmt; Note: Totals may not sum due to independent rounding.

As discussed in the sections above, the IPCC guidelines omit fuels used for international transport, so the associated upstream, out of state emissions from those fuels has also been excluded from this analysis (Table SR1.16).

Table SR1.16 Excluded Emissions by Fuel Type, 1990-2019 (mmt CO_2e GWP20)
Informational Purposes Only

Emission Category	1990	2005	2015	2016	2017	2018	2019
Diesel/Distillate	0.03	0.03	0.12	0.09	0.09	0.09	0.09
Jet Fuel	3.01	2.23	3.80	4.01	4.17	3.85	3.84
Residual Fuel	0.14	0.74	0.75	0.49	0.30	0.29	0.12
Gross Total	**3.19**	**3.00**	**4.67**	**4.60**	**4.56**	**4.23**	**4.05**

"+" less than 0.01mmt; Note: Totals may not sum due to independent rounding.

Planned Improvements

Fuel Combustion

The apportionment of SEDS fuel data to excluded bunker fuels is an area for future improvement. Fuel combustion emissions were estimated using SEDS data, but these data do not provide the share of fuels for international (bunker) trip use. Two areas of specific interest for improvement are marine

diesel/distillate and airline jet fuel. Due to lack of information, marine diesel/distillate use is currently assigned entirely to bunker fuels. Information will be sought to determine the share of this fuel use being used domestically and include these emissions in the State gross total. Additional approaches to the apportionment of aviation jet fuel use will be evaluated. One of these approaches is the use Bureau of Transportation Statistics T-100 segment data to estimate emissions and fuel use.

Fugitive Emissions from Fossil Fuels

DEC and partners will continue to research and evaluate methods for reconciling bottom-up and top-down estimates of fugitive emissions. Some of the areas of potential future analysis are summarized in NYSERDA (2021b), including further evaluations of top-down measurements taken in New York State, as they become available, and expanding the scope of potential emission sources in commercial and industrial buildings. Further refinements to the analyses conducted in NYSERDA (2021a) may also result in improvements to the estimate of in-state fugitive emissions (Out of State Emissions, below).

Electricity Transmission

Current methodology relies on apportioning national electricity transmission SF_6 emissions to New York State. DEC may seek additional data on SF_6 use in electricity transmission equipment in New York State. Improved data will help refine emissions estimates for this category, as well as be more reactive to actions or policies designed to mitigate emissions.

Out of State Emissions

DEC will continue to refine the methodologies used to estimate upstream energy emissions, particularly from imported fossil fuels. This report represents the best available data and methods that could be used to produce an annualized inventory of sources relevant to New York State for the 1990-2019 time period. However, the measurement of emissions from the fuel system is an active area of research and any new and relevant information will be incorporated whenever possible. DEC welcomes feedback on alternative data and methods that may improve the accuracy of this assessment and the ability to identify and characterize emission sources outside of New York.

Abbreviations

btu	British thermal unit
CH_4	Methane
CHP	Combined heat and power
CLCPA	NYS Climate Leadership and Community Protection Act
CNG	Compressed natural gas
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
DEC	NYS Department of Environmental Conservation
EIA	Energy Information Administration, U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
GHG	Greenhouse gas
GWP	Global Warming Potential
GWP100	100-Year Global Warming Potential
GWP20	20-Year Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
LPG	Liquefied petroleum gas(es)
mmt	Million metric tons
MOVES	Motor Vehicle Emission Simulator model
N_2O	Nitrous oxide
NA	Not applicable
NEI	National Emissions Inventory
NYCRR	New York Codes, Rules and Regulations
NYISO	New York Independent System Operator
NYS	New York State
NYSERDA	NYS Energy Research and Development Authority
RCI	Residential, Commercial, Industrial
SEDS	EIA State Energy Data System
SF_6	Sulfur hexafluoride
SIT	EPA State Inventory Tool

References

EPA. 2020. State Greenhouse Gas Inventory and Projection Tool. September 2020. Washington, D.C.: U.S. Environmental Protection Agency. https://www.epa.gov/statelocalenergy/download-state-inventory-and-projection-tool

EPA. 2021a. *Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2019.* EPA 430-R-21-005. Washington, D.C.: U.S. Environmental Protection Agency.

EPA. 2021b. *2017 National Emissions Inventory: January 2021 Updated Release, Technical Support Document*. EPA-454/R-21-001. Research Triangle Park, NC: U.S. Environmental Protection Agency.

IPCC. 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. [H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.)] Hayma, Japan: The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change.

IPCC. 2013. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. [Stocker, T.F., D. Qin, G.-K., Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

IPPC. 2019. *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.* [Calvo Buendia, E., Tanabe, K., Kranjc, A., Baasansuren, J., Fukuda, M., Ngarize, S., Osako, A., Pyrozhenko, Y., Shermanau, P. and Federici, S. (eds.)]. Hayama, Kanagawa, Japan: The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change.

NYISO. 2021a. *2021 Load & Capacity Data Report ("Gold Book")*. April 2021. New York Independent Service Operator.

NYISO. 2021b. *Power Trends 2021*. *The New York ISO Annual Grid and Markets Report*. New York Independent Service Operator.

NYSERDA. 2021a. *Technical Documentation: Estimating Energy Sector Greenhouse Gas Emissions Under New York State's Climate Leadership and Community Protection Act*. Prepared by Eastern Research Group Inc, Lexington, MA, USA.

NYSERDA. 2021b. *New York State Oil and Gas Methane Emissions Inventory: 2018-2020 Update*. Update to NYSERDA Report Number 19-36. Prepared by Abt Associates, Rockville, MD, USA. https://www.nyserda.ny.gov/About/Publications/EA-Reports-and-Studies/Greenhouse-Gas-Emissions

NYSERDA. 2021c. *Patterns and Trends – New York State Energy Profiles: 2003-2017*. Albany, NY, USA: New York State Energy Research and Development Authority.