New York State Department of Environmental Conservation

Industrial Processes and Product Use

2022 NYS GREENHOUSE GAS EMISSIONS REPORT

SECTORAL REPORT #2

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Format of This Report

This sectoral report provides a detailed explanation of methods, data, and trends for the Industrial Processes and Product Use (IPPU) 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 the IPCC Taskforce on National Greenhouse Gas Inventories approach (or "IPCC approach") 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 provides emission values for all years via the Open Data NY platform.

Tables

Industrial Processes and Product Use

This IPCC category encompasses emissions from industrial activities and includes industrial processes, such as those conducted in manufacturing facilities, as well as emissions that result when products are used, such as during the operation of equipment used in homes or businesses. Energy emissions, including the combustion of fuels at industrial facilities are summarized in *Sectoral Report #1: Energy*. The accompanying *Summary Report* also provides an alternative breakdown of industrial emissions to combine energy and process emissions.

In New York, industrial process emissions are a relatively small portion of overall statewide emissions and have declined 23% since 1990 (Table 1). This trend reflects both the nationwide reduction in manufacturing and changes in the technologies used in some industries. At the same time, emissions associated with the usage of industrial products have grown and greatly outweigh those associated with industrial processes. This trend reflects the use of hydrofluorocarbons (HFCs) as replacements for ozone depleting substances in many applications globally and in the U.S.; HFCs from industrial product use were 46.8% of national IPPU emissions in 2020 (EPA 2022b).

Table 1. Industrial Process and Product Use Emissions, 1990-2020 (mmt CO2e GWP20)

Emission Category	1990	2005	2016	2017	2018	2019	2020
Processes	2.68	2.17	1.84	1.92	2.33	2.32	2.07
Product Use	0.04	6.79	19.23	19.86	20.42	20.89	21.32
Gross Total	**2.72**	**8.97**	**21.07**	**21.78**	**22.75**	**23.21**	**23.38**
% of statewide gross total	*1%*	*2%*	*5%*	*6%*	*6%*	*6%*	*7%*
Net Total	**2.72**	**8.97**	**21.07**	**21.78**	**22.75**	**23.21**	**23.38**
% of statewide net total	*1%*	*2%*	*6%*	*7%*	*7%*	*7%*	*8%*

Industrial Processes

Industrial processes contribute anthropogenic emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and the fluorinated greenhouse gases: perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). The emissions characterized in this section occur within industries that operated in New York State from 1990 through 2020. This accounts for emissions generated during production processes, whereas fuel combustion emissions from these industries are accounted for under industrial fuel combustion in *Sectoral Report #1: Energy*.

In 2020, industrial process emissions were 2.07mmt CO_2e GWP20, or approximately 0.6% of statewide emissions (Table 2). Overall industrial process emissions declined 23% since 1990, due to a 77% reduction in the metals industry as a result of technological change and the closing of multiple facilities in New York. The other sources of industrial process emissions, including mineral industries like cement manufacturing as well as electronics industries such as semiconductor manufacturing, have increased since 1990 but remain relatively small emission sources compared to the energy sector (*Sectoral Report #1: Energy).*

Table 2. Industrial Process Emissions 1990-2020 (mmt CO2e GWP20)

Emission Category	1990	2005	2016	2017	2018	2019	2020
Metals	1.63	0.78	0.58	0.57	0.53	0.39	0.37
Minerals	1.01	1.32	1.20	1.27	1.70	1.82	1.58
Electronics	0.03	0.07	0.06	0.07	0.10	0.12	0.12
Chemicals	ne	ne	ie	ie	ie	ie	ie
Gross Total	**2.68**	**2.17**	**1.84**	**1.92**	**2.33**	**2.32**	**2.07**

“ne” not estimated

“ie” included elsewhere

Further details on each industrial sector are provided below except for the chemicals industry. For the purposes of the current report, emissions associated with the chemicals industry in NY are captured in the Energy sector. Currently, the only available information on greenhouse gas emissions from chemical industry processes that are not fuel combustion emissions are from hydrogen production.[1] However, these emissions are already captured as other fossil fuel use in the Energy sector and cannot be separated at this time. The EPA does not include hydrogen production in the national greenhouse gas inventory, possibly because hydrogen is most commonly a by-product of Energy sector processes. Additionally, the U.S. Energy Information Administration (EIA) does not disaggregate fuel volumes used for hydrogen production from other uses.

Metals

New York has a long history of metal manufacturing that includes some of the oldest facilities in the nation. However, overall emissions are lower than in other states reflecting the relative size of the industry and economic changes in the industry. The industry includes the production of aluminum, iron and steel, ferroalloy, and secondary lead (Table 3).

[1] The U.S. GHGRP lists one chemical facility with process emissions (i.e., emissions not related to stationary combustion). The facility reported 0.022-0.034mmt of CO2 per year for “hydrogen production”, 2016-2020.

Table 3. Metal Industry Process Emissions 1990-2020 (mmt CO2e GWP20)

Gas/Source	1990	2005	2016	2017	2018	2019	2020
CO_2	**0.75**	**0.62**	**0.56**	**0.55**	**0.51**	**0.37**	**0.35**
Aluminum	0.41	0.28	0.22	0.22	0.21	0.22	0.22
Ferroalloys	0.20	0.20	0.21	0.18	0.18	na	na
Iron and Steel	0.09	0.09	0.09	0.10	0.07	0.07	0.05
Lead	0.05	0.05	0.05	0.06	0.05	0.08	0.07
CH_4	**+**	**+**	**+**	**+**	**+**	**+**	**+**
Ferroalloys	+	+	+	+	+	na	na
Iron and Steel	+	+	+	+	+	+	+
PFCs	**0.88**	**0.16**	**0.01**	**0.02**	**0.02**	**0.02**	**0.02**
Aluminum	0.88	0.16	0.01	0.02	0.02	0.02	0.02
Gross Total	**1.63**	**0.78**	**0.58**	**0.57**	**0.53**	**0.39**	**0.37**

"+" less than 0.01mmt

"na" not applicable

Aluminum

Aluminum production results in process emissions of CO_2 and PFCs. CO_2 emissions occur during the smelting process when alumina is reduced to aluminum. The electrolysis used during this reduction consumes carbon-containing anodes and cathodes and releases CO_2. Emissions of the PFCs perfluoromethane (CF_4) and perfluoroethane (C_2F_6), also occur during the smelting process as anode effects. PFC emissions can be reduced through operational controls that reduce the frequency and duration of anode effects. The EPA notes that PFC emissions have been reduced since 1990 due to both decreased aluminum production and mitigation actions taken by aluminum smelters (EPA 2022b).

Methodology

For 1990 through 2010, emissions were estimated by applying the IPCC production method-specific (e.g., prebake or Soderberg) CO_2 emission factors to an estimate of New York State aluminum production. State aluminum production was estimated by applying the ratio of national production by capacity to New York state capacity by facility, using data from the USGS National Minerals Information Center. PFC (C_2F_6, CF_4) emissions were estimated by scaling national PFC aluminum emissions using the ratio of NYS production to national production. For 2011 and later years, emission values reflect facility reporting to the U.S. EPA Greenhouse Gas Reporting Program (GHGRP) by aluminum production facilities located in New York (EPA 2022c).

Results

Emissions have declined 81% since 1990 to 0.24mmt CO_2e (Table 3). A majority of this reduction, 82%, was from the decline in PFCs emissions from changes in operational controls that are a reflection of national trends. A secondary factor was the decline in New York State aluminum production levels. This trend is largely reflective of economic factors.

Ferroalloys

Ferroalloys are iron alloys that contain significant quantities of other elements and are often used in the production of steel and other alloys. The production of ferroalloys generates emissions of CO_2 and CH_4 as metallurgical coke is oxidized during the manufacturing process. No ferroalloy manufacturers currently operate within New York State as the sole facility closed in 2018.

Methodology

Due to a lack of state-level ferroalloy production data prior to 2010, it is not possible to estimate emissions prior to 2009. However, the number and capacity of facilities in New York was consistent from 1990-2018. As such, the values for 1990-2009 represent the nine-year average of ferroalloy production emissions from facilities in New York, as reported to the GHGRP for 2010-2018. Values for years after 2009 reflect reporting to the GHGRP by individual ferroalloy production facilities (EPA 2021b).

Results

New York State has no currently operating ferroalloy production facilities, resulting in zero emissions for this category since 2019 (Table 3). Based on its reporting to the EPA GHGRP, the only facility operating in the period covered by this report maintained relatively stable annual emissions until its closure in 2018.

Iron and Steel

The production of iron and steel generates process-related emissions of CO_2 and CH_4. Multiple steps in the steel making process produce emissions. The majority of CO_2 emissions are generated by the use of metallurgical coke to remove oxygen from iron ore during the production of pig iron. One of the two operating facilities was shuttered in 2018.

Methodology

The eight-year (2010-2017) average of iron and steel emissions from facilities in New York, as reported to the GHGRP, was applied as a static value to 1990-2009 (EPA 2022c). The number of New York facilities was consistent between the 2010-2017 and 1990-2009 periods. For 2010 and later years, emission values represent data reported to the GHGRP by iron and steel production facilities (EPA 2022c).

Results

The closure of one of the two operating iron and steel production facilities in 2018 resulted in the largest decline in emissions over the period (Table 3). Emissions declined 34% in 2018 compared to 2017 and remained stable in 2019. Iron and Steel is possibly the only IPPU category that was affected by the 2020 COVID19 global pandemic. Emissions declined 44% 1990-2020 and 29% 2019-2020. The decrease in emissions in 2020 is reflective of national decreases due to the impacts from the COVID19 global pandemic (EPA 2022a).

Lead

In New York State, the only form of lead production since 1990 has been secondary lead production. Secondary production primarily deals with the recycling of lead acid batteries and other scrap lead products. CO_2 emissions occur during production as metallurgical coke is used in the reduction process.

Methodology

The ten-year (2010-2019) average of secondary lead production emissions from facilities in New York, as reported to the GHGRP, was applied as a static value to 1990-2009 (EPA 2022c). One facility has operated in New York for the entirety of the time period covered. For 2010 and later years, emission values represent data reported to the GHGRP by secondary lead production facilities (EPA 2022c).

Results

After relatively stable emissions from 2010-2018, emissions have since risen. Emissions from lead production increased 40% in 2020 as compared to 1990 (Table 3).

Minerals

The minerals category refers to the production of cement, and the uses of carbonates and soda ash. In each of these categories, CO_2 is released as the input mineral is heated, creating a process called calcination. Cement is the largest contributor of emissions in the Minerals subcategory in New York (Table 4).

Table 4. Mineral Industry Process CO2 Emissions, 1990-2020 (mmt CO2)

Emission Category	1990	2005	2016	2017	2018	2019	2020
Cement	0.67	0.80	0.62	0.83	1.28	1.26	1.02
Other Process Use of Carbonates	0.15	0.36	0.45	0.32	0.30	0.45	0.45
Soda Ash	0.20	0.17	0.13	0.12	0.12	0.12	0.11
Gross Total	**1.01**	**1.32**	**1.20**	**1.27**	**1.70**	**1.82**	**1.58**

Cement

Greenhouse gas emissions related to cement production can come from both clinker and cement kiln dust. Clinker is an intermediate product from which finished portland and masonry cement are made. Clinker production releases CO_2 when calcium carbonate is heated in a cement kiln to form lime (calcium oxide) and CO_2.

Methodology

For 1990 through 2009, cement emissions were calculated by applying an EPA clinker emission factor to annual state clinker production estimates, with a cement kiln dust correction factor applied to the total to account for these additional emissions. State-level clinker production data is not publicly available, but district-level data is published annually via the USGS National Minerals Information Center and incorporated into the EPA SIT (EPA 2022a). State clinker production was estimated by applying the SIT default share (50%) to the New York and Maine district totals. For 2010 and later years, emission values represent data reported to the GHGRP by cement facilities located in New York (EPA 2022c).

Results

Although this analysis suggest that emissions increased in recent years (Table 4), the pre-2010 analysis may underestimate emissions because it is based on a simplified apportionment of the USGS data. Facility data reported to EPA suggest a slight decline in emissions since 2010.

Other Process Use of Carbonates

Carbonates, such as limestone, dolomite, and soda ash, are used in a wide variety of applications. Examples of these applications include cement production, flue gas desulphurization, glass production, as a flux in metallurgy, mine dusting or acid water treatment, sugar refining, and agricultural soil management. This section refers specifically to industrial process uses of limestone and dolomite not covered in agricultural emission analysis elsewhere in this report. Carbonates in these processes are heated to the point where CO_2 is generated and emitted as a byproduct.

Methodology

The EPA SIT method was used to estimate emissions related to industrial processes for this source, using default emission factors (EPA 2022a). Following this method, New York's total annual limestone and dolomite consumption (as reported by the USGS National Minerals Information Center) was multiplied by the ratio of national consumption for industrial uses to total national consumption. The quantities were then applied to limestone and dolomite specific emission factors.

Results

Emissions in this category roughly doubled from 1990 to 2005, doubled again by 2015, and have since declined 15% (Table 4). Emissions in 2020 for this category are slightly more than three times 1990 emissions. As this analysis is based on consumption levels in New York, this directionality may reflect economic activity in the state, but the use of these commodities also reflects national trends. National trends, including emission increases 1990 to 2015 and subsequent decreases, were predominately the result of limestone usage in flue gas desulfurization systems (EPA 2022b).

Soda Ash

Soda ash (sodium carbonate) is used in, and in the production of, many consumer products such as glass, soap and detergents, paper, textiles, and food. The largest use of soda ash is in the glass manufacturing industry. CO_2 is released when soda ash is heated and consumed in industrial processes.

Methodology

Soda ash emissions were estimated by applying an IPCC emission factor (IPCC 2006) to estimated state consumption. State consumption estimates were derived by scaling national consumption from the USGS National Minerals Information Center according to population size (EPA 2022b).

Results

The analysis conducted here reflects national trends in soda ash use and state population size, which may not portray actual trends in New York soda ash use emissions. National soda ash use has declined 32% since to 1990, while estimated emissions in New York have increased 57% (Table 4).

Electronics

The electronics manufacturing industry employs numerous greenhouse gases in production processes (Table 5). These processes include plasma etching, reactor chamber cleaning, and temperature control. The electronics industry includes semiconductor, photovoltaic cells, thin-film-transistor flat panel display, and micro-electro-mechanical system manufacturing. The only electronics industry that DEC has identified as operating in New York is semiconductor manufacturing, discussed below.

Table 5. Semiconductor Industry Emissions by Gas, 1990-2020 (mmt CO2e GWP20)

Gas	1990	2005	2016	2017	2018	2019	2020
N_2O	+	+	0.02	0.02	0.02	0.02	0.02
HFCs	+	+	+	+	+	+	+
PFCs	0.03	0.05	0.04	0.05	0.07	0.08	0.09
SF_6	0.01	0.01	+	+	+	+	+
NF_3	+	+	+	+	+	+	0.01
Gross Total	**0.03**	**0.07**	**0.06**	**0.07**	**0.10**	**0.12**	**0.12**

"+" less than 0.01mmt

Semiconductor manufacturing uses and emits a variety of greenhouse gases in its production process. Greenhouse gasses emitted include nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). Manufacturers of semiconductors use fluorinated greenhouse gases in the plasma etching and plasma enhanced chemical vapor deposition processes. Some fluorinated compounds can also be transformed in the plasma processes into other compounds (e.g., CF_4 generated from C_2F_6). Abatement systems reduce emissions of these gases, but those that are not captured are released into the atmosphere. The production of semiconductors is highly complex, with different steps requiring varying amounts of these chemicals for specific purposes. Technological changes and manufacturing improvements impact the relative annual contribution of greenhouse gases over the covered time period.

Methodology

Emissions associated with semiconductor manufacturing for 1990 through 2010 were estimated by applying the ratio of New York to national shipments value (for semiconductors and related device manufacturing) to national semiconductor manufacturing emissions. Shipment values were retrieved from the U.S Census Bureau's quinquennial Economic Census (i.e., 1992, 1997, 2002, and 2007), with ratios held constant between censuses and the 1992 value applied to the preceding two years. For 2011 and later years, emission values represent data reported to the GHGRP by semiconductor manufacturing facilities located in New York (EPA 2022c).

Results

Based on this analysis, greenhouse gases associated with semiconductor manufacturing may have increased since 1990 (Table 5) and the facilities that report annually to EPA continue to emit these substances in stable or increasing levels. Although the relative emission level is low compared to other sources and gases covered in this report, PFCs and SF_6 are incredibly powerful and long-lived greenhouse gases. In some cases, emissions will persist in the atmosphere for hundreds of thousands of years.

Industrial Products

The IPCC's IPPU sector includes various emission sources associated with the use of manufactured or packaged goods (Table 6). The largest source of product use emissions is hydrofluorocarbons (HFCs) and other substances used as substitutes for ozone depleting substances (or "ODS substitutes"). ODS are subject to long-standing international phase-down described below. Another category is the use of nitrous oxide in the medical and food industries. Two additional IPCC IPPU categories, non-energy fuel use and electricity transmission equipment emissions have been assigned to the energy sector (*Sectoral Report #1: Energy)*. The EPA does not differentiate fuels used for energy from those used for non-energy purposes, this report follows the same convention.[2]

Table 6. Industrial Product Emissions, 1990-2019 (mmt CO2e GWP20)

Emission Category	1990	2005	2016	2017	2018	2019	2020
Ozone-Depleting Substance Substitutes	0.04	6.79	19.23	19.86	20.42	20.89	21.31
N_2O Products	+	+	+	+	+	+	+
Non-Energy Fuel Use	ie	ie	ie	ie	ie	ie	Ie
Electricity Transmission	ie	ie	ie	ie	ie	ie	ie
Gross Total	**0.04**	**6.79**	**19.23**	**19.86**	**20.42**	**20.89**	**21.31**

"+" less than 0.01mmt

"ie" included elsewhere

N_2O Product Use

Nitrous oxide (N_2O) is used in a variety of applications, including some covered in other areas of this report, such as in semiconductor manufacturing. This category covers emissions associated with the use of N_2O outside of manufacturing processes. These uses cannot be measured directly at the state-level but are based on the analysis provided by the EPA in the national

[2] EPA (2021) page 4-7

greenhouse gas inventory (EPA 2022b). As EPA describes it, the N_2O produced in the U.S. is primarily used in medical or dental anesthetics (89.5% of national usage in 2019), followed by propellants used in food applications such as pressure-packaged whipped cream (6.5%). The remaining uses for N_2O are either covered in other sections of the national inventory or are non-emissive.

Methods

To estimate emissions at the state-level, annual U.S. emissions for 1990-2020 were collected from the national emission data (EPA's submission to the UNFCCC) and scaled to New York based on population size. The EPA's national greenhouse gas inventory report describes the analysis conducted. This analysis focused on N_2O emissions from medical/dental uses and food propellants, which are assumed to be emitted at 100% when the product is used based on the IPCC approach (IPCC 2006). For 1990-2003, the EPA used a combination of industry data and expert interviews. From 2004-2020, the EPA used the 2003 estimated value. EPA (2022a) also describes planned improvement for their analysis.

Results

The EPA (2022a) analysis found that N_2O product use emissions remained flat at less than 1000 metric tons CO_2e per year from 1990-2003 because substitutes have been introduced to meet increasing demand. There are no new data for this emission source.

Hydrofluorocarbons / Substitutes for Ozone Depleting Substances

The largest category of emissions in the IPPU sector in New York are ODS substitutes. Unlike other IPCC categories, the emission sources covered in this section are not related to any specific type of activity or product. Instead, these emissions reflect the use of certain gases across many parts of the economy including refrigeration, heating and air-conditioning (or HVAC), insulation foam, consumer products, and fire retardants.

Starting around the baseline year of 1990 and just prior to the formation of the UNFCCC and the IPCC, the Montreal Protocol was adopted to address chemicals responsible for degrading the ozone layer. This global phasedown in ODS led to a corresponding increase in the emissions from new substitute compounds. The most common ODS substitutes are HFCs or blends that contain HFCs. PFCs and SF_6 have also been used in ODS substitutes but at a much lower level.

Importantly, most ODS are also greenhouse gases, and some are more harmful to the climate than the substances that have replaced them. This report does not provide information on ODS because ODS are not included in the IPCC approach for national reporting on greenhouse gases. This may be the same reason ODS were not explicitly included in the definition of greenhouse gas in the CLCPA. The IPCC accounting does not include greenhouse gases that were already subject to the Montreal Protocol prior to the development of the UNFCCC international climate agreements. However, ODS are still in use today, even if the global phasedown under the Montreal Protocol has been largely successful. Future reports may provide an estimate of ODS emissions once there is sufficient information to estimate emissions at the state level.

Methods

The standard approach for estimating ODS substitute emissions is to develop a vintaging model that considers the stock of equipment and other products along with the turnover time for these products, the substances contained in the products, and the time period over which those substances are lost to the environment. In some cases, these substances are intentionally emitted, such as when they are used as an aerosol propellant (e.g., personal defense sprays or medical inhalers). In other cases, the substances are leaked during the operation of certain equipment, such as supermarket refrigeration systems, or lost when equipment is improperly disposed of, such as home appliances like refrigerators or air conditioning units. The model used for this report is described in detail in NYSERDA (2021), which includes an additional description and explanation of trends in these emissions.

Results

The majority of emissions today are from HFCs used as refrigerants in food refrigeration and HVAC equipment (Table 7). The growth in HFCs in these applications reflects the use of HFCs as ODS substitutes as well as the increasing adoption of air conditioning and other appliances. HFCs were also increasingly used in recent years as ODS substitutes in foam insulation. The growth of HFCs in aerosols was relatively small due to the adoption of not-in-kind replacements, such as pump dispensers.

Table 7. ODS Substitute Emissions, 1990-2020 (mmt CO2e GWP20)

Emission Category	1990	2005	2016	2017	2018	2019	2020
Refrigerants	+	3.50	11.70	12.59	13.47	14.24	14.97
Foam Blowing Agents	no	0.72	2.38	2.44	2.43	2.43	2.42
Aerosols	0.04	2.15	4.59	4.27	3.93	3.63	3.34
Solvents and Fire Suppression	no	0.42	0.56	0.56	0.59	0.59	0.59
Gross Total	**0.04**	**6.79**	**19.23**	**19.86**	**20.42**	**20.89**	**21.31**

"+" less than 0.01mmt

Refrigerant emissions can be divided into multiple end-uses (Table 8) based on the type of equipment and user. The largest source of emissions in 2020 was commercial refrigeration, which is mainly comprised of equipment used in supermarkets and other food stores. The second largest source of emissions is air-conditioning (or HVAC) in motor vehicles. Finally, the remaining large sources of HFCs are from the use of refrigerants for space cooling, specifically air-conditioning equipment used in residential and commercial buildings.

Table 8. Refrigerant Emissions by End Use, 1990-2020 (mmt CO2e GWP20)
*Other includes dehumidifiers and clothes dryers

Category/End-Use	**1990**	**2005**	**2016**	**2017**	**2018**	**2019**	**2020**
Refrigeration	**0.01**	**1.21**	**4.93**	**5.30**	**5.65**	**5.98**	**6.33**
Commercial	0.01	1.03	4.34	4.69	5.04	5.37	5.71
Residential	no	0.05	0.41	0.42	0.42	0.42	0.42
Transportation	no	0.13	0.18	0.19	0.19	0.19	0.19
HVAC	**no**	**2.28**	**6.71**	**7.24**	**7.75**	**8.17**	**8.55**
Commercial	no	0.02	1.68	1.97	2.25	2.55	2.84
Residential	no	0.03	1.40	1.64	1.88	2.10	2.32
Transportation	no	2.23	3.63	3.63	3.62	3.52	3.39
Other*	**no**	**no**	**0.03**	**0.03**	**0.04**	**0.05**	**0.06**
Residential	no	no	0.03	0.03	0.04	0.05	0.06
Commercial	no	no	+	+	+	+	+
Industrial Processes	**no**	**0.01**	**0.03**	**0.03**	**0.03**	**0.04**	**0.04**
Gross Total	**0.01**	**3.50**	**11.70**	**12.59**	**13.47**	**14.24**	**14.97**

"no" not occurring

"+" less than 0.01mmt

The substances used in this IPCC category represent individual HFC gases, blends of HFCs, and blends that include other non-HFC substances (Table 9). In recent years, there has been a transition to compounds with lower overall GWPs, which should reduce total emission levels. However, this trend will continue to be offset by the growth in the end-use applications described above including air conditioning and heat pumps.

Table 9. Emissions by ODS Substitute (mmt CO2e GWP20)
Note: Pure HFCs do not include emissions from blends.

ASHRAE #	GWP20	2020 Emission
R-125	6090	
R-134a	3710	4.42
R-143a	6940	
R-152a	506	
R-227ea	5360	
R-236fa	6940	+
R-245fa	2920	
R-32	2430	0.02
R-365mfc	2660	
R-404A	6437	3.49
R-407A	4406	0.22
R-407C	4011	0.12
R-410A	4260	4.99
R-4310mee	4310	
R-466A	1891	
R-507	6515	1.69
R-507A	6515	

"+" less than 0.01mmt.

Planned Improvements

DEC will continue to make improvements wherever possible to the analyses provided in this report. A few specific areas are considered to be priorities, or equivalent to IPCC "key categories", that can have a significant influence on this emissions inventory.

Industrial Processes

DEC will continue to seek historical data to fill gaps and to improve the accuracy of this report. The methodologies used in this report are based on those provided in the EPA SIT (EPA 2022a), facility reporting to the EPA (EPA 2022c), or a combination of both. These methods follow IPCC approach in that they use a bottom-up method to estimate all emissions whenever possible, rather than rely on facility reporting that may not cover all emissions. However, it is ideal to align both types of estimation so that emissions from such facilities are effectively monitored and controlled.

Ozone Depleting Substances

Ozone depleting substances such as CFCs and HCFCs are not included in the scope of emissions that are the focus of this report and are being phased down under international agreements. However, they are greenhouse gases and they may still be emitted in sufficient quantities in New York to warrant additional policy. DEC plans to further investigate ODS emissions as an informational item, when appropriate state-level data are available.

Abbreviations

AC	Air conditioner
CFC	Chlorofluorocarbon
CF_4	Perfluoromethane
C_2F_6	Perfluoroethane
CH_4	Methane
CLCPA	NYS Climate Leadership and Community Protection Act
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
GHGRP	EPA Greenhouse Gas Reporting Program
GWP	Global Warming Potential
GWP100	100-Year Global Warming Potential
GWP20	20-Year Global Warming Potential
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HVAC	Heating, ventilation, and air conditioning
HVAC-R	Heating, ventilation, air conditioning, and refrigeration
IE	Included elsewhere
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
MMT	Million metric tons
N2O	Nitrous oxide
NE	Not estimated
NF_3	Nitrogen trifluoride
NO	Not occurring
NYCRR	New York Codes, Rules and Regulations
ODS	Ozone depleting substances
PFC	Perfluorocarbon
SF_6	Sulfur hexafluoride
SIT	EPA State Inventory Tool
UNFCCC	United Nations Framework Convention on Climate Change
USGS	United States Geological Survey

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