Central New York Greenhouse Gas Inventory

Tier II Regional Greenhouse Gas Inventory & Allocation Methodology

Requested by

Central New York Regional Planning and Development Board

Prepared by

ICF International

December 20, 2012

Table of Contents

Preface 1
Abbreviations and Acronyms 2
1. Background 4
1.1. Key Steps and Issues in Establishing an Inventory 4
1.2. Organization of the Inventory Report 5
1.3. Organization of the Inventory Spreadsheet 6
2. Summary of Results 7
3. Stationary Energy Consumption 9
3.1. Electricity Generation– Scope 1 10
3.2. Electricity Consumption – Scope 2 11
3.3. Fuels – Scope 1 13
3.4. Energy Supply 19
4. Mobile Energy Consumption 21
4.1. On-road 21
4.2. Off-road 23
4.3. Marine 25
4.4. Rail 26
4.5. Air 28
5. Waste 29
5.1. Solid Waste 29
5.1.1. Scope 1 29
5.1.2. Scope 3 30
5.2. Wastewater 34
6. Industrial Processes 37
7. Agriculture 39
8. Land Use, Land-Use Change and Forestry 41
9. Municipal-Level Allocation 44
9.1. Municipal-Level Allocation 44
9.2. Challenges 44
9.3. Methods by Sector 45
9.3.1. Stationary Energy Consumption 45
9.3.2. Transportation 46
9.3.3. Waste Management 48
9.3.4. Industrial Processes 48

9.3.5. Agriculture 48
9.4. Results 49
10. Emissions Forecast to 2030 57
10.1. County-Level Forecast 57
10.2. Challenges 57
10.3. Methods by Sector 58
10.3.1. Stationary Energy Consumption 58
10.3.2. Transportation 58
10.3.3. Waste Management 59
10.3.4. Industrial Processes 60
10.3.5. Agriculture 60

List of Figures

Figure 1 – Total 2010 Emissions by County and by Source 8
Figure 2 – 2010 Per Capita Emissions by County in Central New York ($MTCO_2e$/person) 8
Figure 3 – 2010 Per Capita Electricity Consumption by Sector (MWh/person) 13
Figure 4 – 2010 Stationary Fuel Energy Use (MMBTU) and Emissions ($MTCO_2e$) by Fuel Type 19
Figure 5 – 2010 Energy Supply Emissions ($MTCO_2e$) 21
Figure 6 – 2010 On-Road Energy Use by Fuel Type (MMBTU) 23
Figure 7 – 2010 Off-Road Emissions ($MTCO_2e$) 24
Figure 8 – 2010 Marine Emissions by County and Type ($MTCO_2e$) 26
Figure 9 – 2010 Rail Emissions by County ($MTCO_2e$) 28
Figure 10 – 2010 Emissions from Landfills in Central New York ($MTCO_2e$) – Scope 1 Solid Waste Emissions 30
Figure 11 – 2010 Waste Generation (tons) and Emissions ($MTCO_2e$) – Scope 3 Solid Waste 34
Figure 12 – 2010 Wastewater Treatment Emissions by County and Gas ($MTCO_2e$) 37
Figure 13 – 2010 Industrial Process Emissions by Process and County ($MTCO_2e$) 39
Figure 14 – 2010 Agricultural Emissions by County and Source ($MTCO_2e$) 41
Figure 15 – 2005-2010 Net Change in Forested Acres and 2010 Net Change in Forest Carbon from LULUCF ($MTCO_2e$) 43

List of Tables

Table 1 – Total 2010 Emissions, by County and Gas (MT CO_2e) 7
Table 2 – Total 2010 Central New York Emissions, by Source (MMT CO_2e) 9
Table 3 – 2010 Electricity Generation GHG Emissions ($MTCO_2e$) 10
Table 4 – 2010 Electricity Generation by Fuel (MWh) 11
Table 5 – 2010 Electricity Generation and Emissions by Fuel 11
Table 6 – 2010 Electricity Consumption Emissions ($MTCO_2e$) 12
Table 7 – 2010 Electricity Consumption by Sector and County (MWh) 13
Table 8 – 2010 Stationary Fuel Consumption GHG Emissions (MT CO_2e) 18
Table 9 – 2010 Stationary Fuel Consumption by Sector and Fuel Type (MMBTU) 18
Table 10 – 2010 Stationary Fuel Emissions by Sector and Fuel Type ($MTCO_2e$) 19
Table 11 –2010 Emissions from Energy Supply Activities ($MTCO_2e$) 20

Table 12 – On-road Energy Consumption Data Summary 22
Table 13 – 2010 On-Road GHG Emissions ($MTCO_2e$) 23
Table 14 – 2010 Off-road Emissions by County ($MTCO_2e$) 24
Table 15 – 2010 (using 2007 proxy) Off-road Emissions by Equipment type ($MTCO_2e$) 25
Table 16 – 2010 Marine Emissions by County ($MTCO_2e$) 26
Table 17 – 2010 Rail Emissions ($MTCO_2e$) 27
Table 18 – 2010 Air Emissions by County ($MTCO_2e$) 29
Table 19 – 2010 Emissions from Landfills in Central New York ($MTCO_2e$) – Scope 1 Solid Waste Emissions 30
Table 20 – 2010 Scope 3 Solid Waste Emissions ($MTCO_2e$) 33
Table 21 – 2010 Waste Generated by County (tons) 33
Table 22 – 2010 Wastewater Treatment Emissions 37
Table 23 – 2010 Industrial Process GHG Emissions by Industrial Activity (MT CO_2e) 38
Table 24 – 2010 Agriculture Emissions by Source ($MTCO_2e$) 41
Table 25 – 2010 Net Change in Forest Carbon Stocks ($MTCO_2e$) 43
Table 26 – Percentage of Emissions Not Allocated, by Sector 45
Table 27 – Cayuga County Municipalities; Total Allocated Emissions by Municipality and Sector ($MTCO_2e$) 50
Table 28 – Cortland County Municipalities; Total Allocated Emissions by Municipality and Sector ($MTCO_2e$) ... 51
Table 29 – Madison County Municipalities; Total Allocated Emissions by Municipality and Sector ($MTCO_2e$) ... 52
Table 30 – Onondaga County Municipalities; Total Allocated Emissions by Municipality and Sector ($MTCO_2e$) 53
Table 31 – Oswego County Municipalities; Total Allocated Emissions by Municipality and Sector ($MTCO_2e$) 55
Table 32 – 2010 Baseline and 2030 Projected Emissions ($MTCO_2e$), and Percent Change 57
Table 33 – Off-Road Equipment Category and Estimated Growth Factor 59

Preface

The purpose of this report is to transmit the Final Tier II Greenhouse Gas (GHG) Inventory for Central New York and to provide an overview of the methodology used for each of the completed sources. The report begins with a general background to the inventory, a discussion of key steps in establishing and defining a GHG inventory, and description of how the inventory is organized. For each source that follows, the inventory presents a description of each source, a discussion of the data and methods used, and a brief review of the results.

In order to align the methods used here with those used by other regions in New York State, the State convened the NYGHG Working Group to develop a standard New York GHG Protocol (NYGHG Protocol). This inventory was developed based on the latest methods determined by the NYGHG Working Group, as well as the latest data provided to that group. Protocols were not finalized for all sources. The data and calculations presented here are contained in a separate Regional GHG Inventory Excel workbook and supplementary files.

Abbreviations and Acronyms

ACS	American Community Survey
ANDOC	Anaerobically degradable carbon
BOD_5	5-day biological oxygen demand
COLE	Carbon OnLine Estimator
eGRID	Emissions & Generation Resource Integrated Database
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FOD	First-order decay
GHG	Greenhouse gas
GHGRP	Greenhouse gas Reporting Program
C&D	Construction and demolition
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
FIDO	Forest Inventory Data Online
GRP	Gross Regional Product
HDD	Heating degree days
HFCs	Hydrofluorocarbons
HPMS	Highway Performance Monitoring System
HU	Housing units
IPCC	Intergovernmental Panel on Climate Change
LFG	Landfill gas
LFGTE	Landfill gas to energy
LUAF	Lost and unaccounted for
LULUCF	Land-use, land-use change, and forestry
Mcf	Thousand cubic feet
MF	Multi-family
MMBTU	Million British thermal units
MSW	Municipal solid waste
$MTCO_2e$	Metric tons carbon dioxide equivalent
MWh	Megawatt-hour

N_2O	Nitrous oxide
NAICS	North American Industry Classification System
NASS	National Agricultural Statistics Service
NYS DEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
NYSERDA	New York State Energy Research and Development Authority
NYUP	NPCC Upstate New York (eGRID subregion)
ODS	Ozone-depleting substances
PFCs	Perfluorocarbons
SF_6	Sulfur hexafluoride
SFA	Single-family attached
SFD	Single-family detached
SIC	Standard Industrial Classification
SIT	State Inventory Tool
T&D	Transmission and distribution
TAM	Typical animal mass
Tg	Teragrams
USDA	United States Department of Agriculture
VMT	Vehicle miles traveled
VS	Volatile solids
WWTPs	Wastewater treatment plants

1. Background

The New York Cleaner, Greener Communities Program empowers regions to create more sustainable communities by funding smart development practices. One of the key outcomes of the Plan is a regional baseline of GHG emissions and energy use. NYSERDA has provided a high-level Tier I analysis of GHG emissions and energy use by region that focuses on fuel combustion emission sources. The Tier I inventory was developed using statewide greenhouse gas emissions data and readily available regional data. This report represents a more detailed Tier II analysis that addresses sources not covered in the Tier I inventory and replaces statewide data with more detailed local data wherever possible.

The purpose of this inventory is to help the region better characterize its baseline GHG emissions and energy consumption. Identifying and quantifying key emission sources can help identify and inform strategies for reducing emissions and provide a baseline against which progress can be measured in the future. Finally, the municipal level allocation provides useful energy, GHG, demographic, and economic data for each of the region's counties, cities, towns, and villages. The municipal allocation, however, is not intended to replace detailed studies conducted by several of the region's municipalities, as it was not feasible to take an equally detailed look at each of the region's 148 municipalities.

To standardize organization and methodologies in the regional inventories being completed by each of New York's ten regions, NYSERDA has sponsored the NYGHG Protocol Working Group. ICF staff participated in this group throughout the duration of the protocol development process to discuss data sources, methodologies, and organizational structure for the regional GHG inventory. This process resulted in a common inventory protocol used by each region in the state. This Working Group also served as the organizing entity for several common data requests to New York State agencies and major electricity and natural gas utilities. Due to differences in data availability between the regions, the protocol did not provide guidance for every methodological decision. Consequently, this inventory was developed based on the available data and methods from the regional perspective.

1.1. Key Steps and Issues in Establishing an Inventory

A GHG inventory identifies activities that are responsible for GHG emissions, quantifies the level of each activity, and then calculates the associated emissions. Each of these steps—defining the activities, measuring the level of the activity, and determining the consequent emissions—must be carefully defined in order to result in a credible, transparent, and easily reproducible inventory. As discussed above, this inventory is based on the NYGHG Working Group protocol wherever possible.

The process of designing an inventory entails a number of decisions and procedural steps:

- **Inventory geography and boundaries**: The geography for this inventory is that of the five counties of the Central New York region: Cayuga, Cortland, Madison, Onondaga, and Oswego Counties. This inventory includes emissions from electricity imported into the region and from emissions from waste that is exported from the region. Product life-cycle emissions (e.g., emissions associated with the production and distribution from imported goods and services) are not included.
- **Sources:** The activities selected for the regional inventory are based on those defined by the U.S. Environmental Protection Agency (EPA) and the Intergovernmental Panel on Climate Change (IPCC). These categories are:
    - **Stationary Energy Consumption**—fuel and electricity use in homes, businesses, and other non-mobile settings for purposes such as space and water heating, lighting, appliances and electronics, and industrial activities;

- **Mobile Energy Consumption**—use of energy in transportation, including on-road transportation, passenger and freight rail, aviation, marine transportation, and off-road vehicles;
- **Agriculture**—non-energy emissions from agriculture, including both crops and livestock (e.g., methane emissions associated with livestock and nitrous oxide emissions associated with fertilizer application);
- **Waste Management**—non-energy emissions related to managing solid waste, including trash and wastewater (e.g., methane emissions associated with the anaerobic decay of waste disposed of in landfills);
- **Industrial Processes**—non-energy emissions associated with industrial activity (e.g., carbon dioxide emissions associated with cement production or emissions associated with coolants for air conditioners) and fugitive emissions from fuel systems (leakages in the production, distribution, and transmission of fossil fuels), and;
- **Land Use, Land Use Change, and Forestry**—emissions from changes in the amount of carbon stored in soil and plants due to land use and forestry practices (e.g., from clearing forest land for residential, commercial, or agricultural use).

- **Greenhouse gases included**: This inventory evaluates the impact of the three gases which together comprise 98 percent of national emissions: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), as well as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) emissions from the substitution of ozone depleting substances.[1] Together, these greenhouse gases accounted for 99.6 percent of national greenhouse gas emissions in 2010.[2]
- **Quantification approach:** This inventory uses a blend of top-down data (e.g., state fuel consumption estimates) and bottom-up data (customer utility data). This mix was dictated by data availability, existing protocols, and resource limitations.
- **Base year**: The base year for this analysis is 2010. The year 2010 was selected by the Working Group because it is the most current year for many of the data sets used in this report.

All emissions are reported in metric tons of carbon dioxide equivalent ($MTCO_2e$) or million metric tons of carbon dioxide equivalent ($MMTCO_2e$). A metric ton is 1,000 kilograms, or 2,206 pounds – about 10 percent larger than the 2,000 pound ton commonly used in the United States.

1.2. Organization of the Inventory Report

The inventory is organized by source and by Scope. Scope refers to the degree of control that the regional community has over the emission source. Although the Scope framework was first developed for corporate-level GHG inventories, a similar principal can be applied to communities. The basic definitions of the Scopes from a community perspective are as follows:

- **Scope 1**: All direct emissions from sources within the geopolitical boundary of the community.

[1] Different greenhouse gases have different capacities to trap heat in the atmosphere. In order to compare and sum the impacts of different gases, the United Nations' Intergovernmental Panel on Climate Change (IPCC) developed the Global Warming Potential (GWP) concept, where the GWP of each greenhouse gas is compared to that of CO_2, whose GWP is defined as 1. The GWP of methane (CH_4) is 21, and nitrous oxide (N_2O) is 310. GWPs for some gases are much higher—the GWP for SF_6, for example is 23,900. For more information, see U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2010*, April 2012.

[2] U.S. EPA. 2012. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2010.

- **Scope 2**: Energy-related indirect emissions that occur outside the community boundary as a consequence of consumption/use of grid-supplied electricity, heating and/or cooling within the community boundary.
- **Scope 3**: All other indirect emissions that occur outside the boundary as a result of activities within the community's geopolitical boundary, as well as trans-boundary emissions due to exchange/use/consumption of goods and services.

In the case of the NYSERDA regional GHG inventories, the Working Group's definition of Scopes 2 and 3 has been modified slightly. For the purposes of this inventory, Scope 2 includes energy-related indirect emissions regardless of whether they occur inside or outside of the region. For example, emissions from electricity generation that occurs within the region are included in Scope 1, but emissions related to the consumption of electricity by the community are included in Scope 2. This reflects the reality that electricity generated in the region may be consumed inside or outside of the region, while electricity consumed in the region may be generated inside or outside of the region. Only the Scope 2 emissions are included in the total, while Scope 1 emissions are provided as an informational item. Similarly, in this inventory, Scope 3 includes all other indirect emissions regardless of whether they occur inside or outside of the region. The sole Scope 3 source currently in the inventory is methane emissions associated with the deposition of municipal solid waste (MSW) in landfills. Many communities in the region transfer MSW to landfills outside of the region. These emissions are estimated here even though they occur outside of the region, because they result from activities within the region. This source is discussed in greater detail in Section 5 below.

The report below is organized by source and Scope, and the emission totals for each source are listed by county below. Section 9 includes emission totals for each sector at the municipal level. The municipal-level estimates are either generated bottom-up or represent an allocation of county-level emissions. The methodology used to estimate emissions for methodologies varies by sector and is discussed in Section 9.3.

1.3. Organization of the Inventory Spreadsheet

The data and calculations discussed in this report have been developed in the Excel workbook accompanying this delivery, "Central New York GHG Inventory 12-7-12.xlsx." The file is organized as follows:

- An Overview sheet with links to each worksheet
- Sheets containing summary tables and figures for the region, including all of the tables and figures presented in this report. These are based on the NYSERDA-provided reporting template.
- A worksheet containing summary tables for the region, including all of the tables and figures presented in this report (this will be updated once final based on key charts and graphs requested by CNY).
- A series of color-coded sheets covering the inventory calculations. Each lists the source, Scope, and data sources used. The sheets are categorized by inventory sector:
    - Red-tabbed sheets cover stationary energy;
    - Green-tabbed sheets cover mobile energy;
    - Brown-tabbed sheets cover solid waste and wastewater;
    - The yellow tab covers industrial processes;
    - The blue tab covers agriculture; and
    - The purple tab covers land-use, land-use change, and forestry (LULUCF).
- Lastly, the "Factors" tab at the end provides the emission, conversion, and other factors used throughout the file.

Municipal-level emissions are calculated in the file "Central New York GHG Inventory_Municipal Allocation 12-7-12.xlsx." In some cases, supplementary workbooks are used to conduct supporting calculations. These

include modules of the U.S. EPA's State Inventory Tool and the California Air Resources Board's Landfill Emissions Tool.

2. Summary of Results

Central New York's 2010 baseline gross greenhouse gas emissions were approximately 9.9 $MMTCO_2e$. Onondaga County had the largest share of emissions, with 55 percent, while Cortland County had the lowest share of emissions, with 8 percent. Onondaga is also the most populated county in the region (59 percent of 2010 population), while Cortland is the least populated (6 percent). The primary driver of emissions in the region is population and the report discusses these drivers in the source-specific results in cases where there are drivers other than population.

Cayuga County had the highest per capita emissions in the region (approximately 18 $MTCO_2e$/person), driven by its low population and relatively high agricultural emissions. Oswego County had the lowest per capita emissions, at 11 $MTCO_2e$ per person. Per capita emissions are shown by county in Figure 2. The Central New York region as a whole has lower per capita emissions than the United States, primarily a result of the region's electricity grid mix. The Central New York electricity emissions reflect a grid mix with high proportions of nuclear, hydropower, and natural gas (with lower carbon intensities) compared to the nationwide average grid mix featuring higher proportions of coal and natural gas (with higher carbon intensities).

Energy consumption for transportation was the largest source of emissions in the region, comprising 43 percent of total emissions. Building energy consumption, consisting of electricity consumption plus stationary fuel consumption, was the largest source of emissions, accounting for 41 percent of total regional emissions (14 percent and 27 percent, respectively). When including energy supply emissions (representing 4 percent of total emissions), approximately 87 percent of the regions emissions resulted from energy consumption. In 2010, fuel consumption for energy uses cost the region an estimated $2.45 billion, which amounts to approximately 8 percent of the region's Gross Regional Product (GRP). The region's emissions are summarized in Table 1 and Table 2, with a comparison of County emissions in Figure 1.

This inventory also includes changes in forest carbon stocks. This is not a required source in the New York state protocol, but is included as an additional source in the Central New York inventory because of the large presence of forested land in the region. As discussed in Section 8, there is a high degree of uncertainty associated with these estimates. Therefore, the overall inventory results focus on gross emissions, rather than net emissions. Gross emissions do not include changes in forest carbon stocks.

Table 1 – Total 2010 Emissions, by County and Gas (MT CO_2e)

County	CO_2	CH_4	N_2O	Other	Gross Emissions	Net Change in Forest C	Net Emissions
Cayuga	1,023,632	232,686	130,564	32,453	**1,419,335**	(1,950,565)	(531,230)
Cortland	580,306	112,824	34,130	19,273	**746,534**	(1,888,264)	(1,141,730)
Madison	729,884	142,504	58,358	28,767	**959,514**	1,306,939	2,266,453
Onondaga	4,840,079	326,206	120,330	185,467	**5,472,081**	371,225	5,843,307
Oswego	1,168,171	67,381	27,227	47,469	**1,310,248**	(781,498)	528,750
Central New York Total	**8,342,073**	**881,602**	**370,610**	**313,428**	**9,907,712**	**(2,942,162)**	**6,965,550**

Figure 1 – Total 2010 Emissions by County and by Source

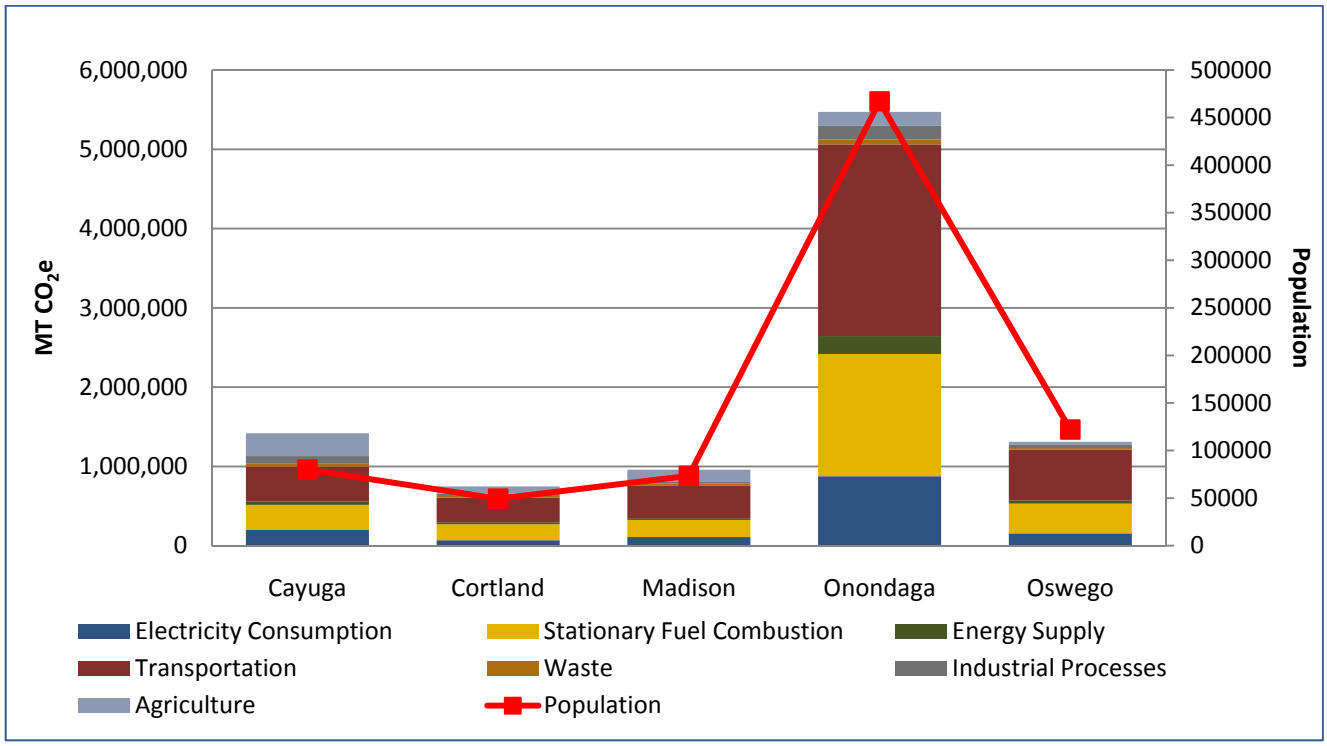


Figure 2 – 2010 Per Capita Emissions by County in Central New York ($MTCO_2e$/person)

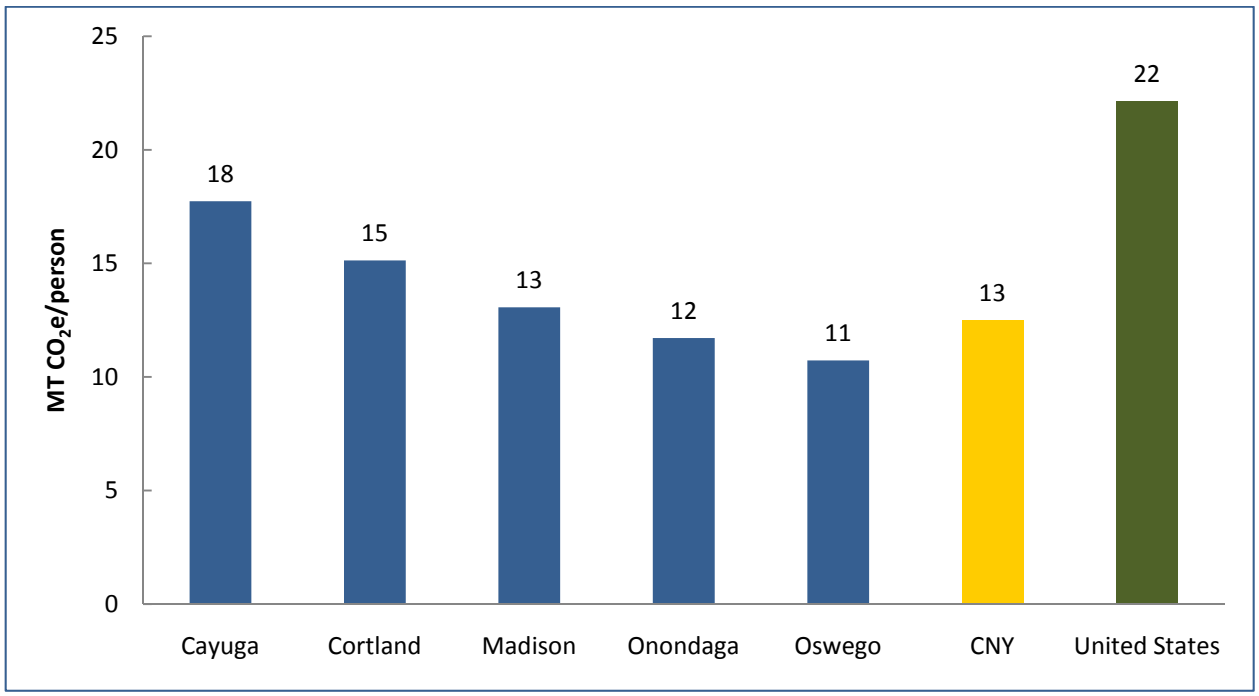


Table 2 – Total 2010 Central New York Emissions, by Source (MMT CO_2e)

	Scope	2010 Regional Emissions ($MMTCO_2e$)	*Percent of Gross Emissions*
Electricity Generation*	1	**2.2**	
Electricity	2	**1.4**	**14%**
Residential Consumption	2	0.5	5%
Commercial Consumption	2	0.4	4%
Industrial Consumption	2	0.5	5%
Stationary Energy Consumption		**2.7**	**27%**
Residential	1	1.2	12%
Commercial	1	0.8	8%
Industrial	1	0.6	6%
Energy Supply	1 & 2	**0.4**	**4%**
Mobile Energy Consumption		**4.2**	**43%**
On-road	1	3.7	37%
Off-road	1	0.4	4%
Marine	1	0.1	1%
Rail	1	0.1	1%
Air*	1	0.2	
Waste			
Solid Waste—Landfills*	*1*	0.1	
Solid Waste--Waste Generation	3	0.1	1%
Wastewater Treatment	1	0.1	1%
Industrial Processes	1	**0.4**	**4%**
Agriculture	1	**0.7**	**7%**
LULUCF*		**(2.9)**	
Gross Emissions		**9.9**	**100%**

*Not included in gross emissions total

3. Stationary Energy Consumption

Stationary energy consumption includes direct emissions from the combustion of natural gas, coal, kerosene, distillate, motor gasoline and other fuels, as well as indirect emissions from electricity consumption. Direct emissions from residential, commercial, industrial, and electricity generating activities in the region are included in Scope 1. Indirect emissions from the consumption of electricity are included in Scope 2. To avoid double-counting, Scope 1 emissions from electricity generation are not included in the regional total, but are reported for informational purposes.

3.1. Electricity Generation– Scope 1

Data & Methods

The primary data source for electricity generation is the U.S. Energy Information Administration's Form 923[3] facility production data for 2010. This dataset reports total fuel consumption (in physical units and BTUs) and total net generation in MWh. This data can be gathered through EIA's web data query portal. The Central New York region has 12 non-renewable electric generating facilities, the largest of which (in terms of electricity output) are Nine Mile Point Nuclear Station, the James A. Fitzpatrick nuclear plant, and Sithe Independence Station, a natural gas-fired plant, all in Oswego County.

Emissions from electricity generation are estimated by multiplying total fuel consumption for each plant by the CO_2, CH_4, and N_2O emission factors for each fuel type to calculate the total emission by gas. These emission factors are from EPA's Greenhouse Gas Reporting program, and are the emission factors recommended by the NYGHG Working Group. These emissions are summed up by gas and county to provide summary table of total electricity generation emission for the region.

Results

Over 25 million MWh of electricity were generated in Central New York in 2010. Eighty-two percent of energy use came from the region's two nuclear power plants, both located in Oswego County. Over two-thirds (69 percent) of electricity generation emission came from natural gas-fired plants. Emissions by county are presented in Table 3. The region's fossil fuel-based electricity generation is located in Cayuga, Onondaga, and Oswego Counties. Generation by resource is also presented below. Nuclear power is responsible for the majority of the region's generation, followed by natural gas, and to a lesser extent, hydropower, municipal solid waste (MSW), wind, coal, and petroleum. Natural gas and coal, however, are responsible for the majority of the region's emissions.

Table 3 – 2010 Electricity Generation GHG Emissions ($MTCO_2e$)

County	CO_2	CH_4	N_2O	Total	Percent of Total
Cayuga	283	0	0	283	0%
Cortland	0	0	0	0	0%
Madison	0	0	0	0	0%
Onondaga	672,708	6,851	3,425	682,984	32%
Oswego	1,473,303	1,904	1,090	1,476,297	68%
Central New York Total	2,146,293	8,756	4,515	2,159,564	100%

Note: Totals may not sum due to independent rounding.

[3]U.S. Energy Information Administration (EIA), 2012, Form EIA-923 detailed data merged with 860 form data, http://www.eia.gov/electricity/data/eia923/

Table 4 – 2010 Electricity Generation by Fuel (MWh)

County	Coal	Natural Gas	Fuel Oil	Biomass (LFG, MSW)	Nuclear	Hydro	Wind	Total
Cayuga	0	340	0	0	0	3,782	0	**4,122**
Cortland	0	0	0	0	0	0	0	**0**
Madison	0	0	0	8,207	0	10,557	128,446	**147,210**
Onondaga	101,262	165,722	854	190,067	0	0	0	**457,905**
Oswego	0	3,437,935	59,077	9,264	20,600,536	285,643	0	**24,392,456**
Central New York Total	**101,262**	**3,603,997**	**59,931**	**207,538**	**20,600,536**	**299,982**	**128,446**	**25,001,693**
Percent of Total	*0%*	*14%*	*0%*	*1%*	*82%*	*1%*	*1%*	*100%*

Note: Totals may not sum due to independent rounding.

Table 5 – 2010 Electricity Generation and Emissions by Fuel

Fuel Type	Electricity Generated (MWh)	Percent of Electricity Generated	Emissions ($MTCO_2e$)	Percent of Emissions
Nuclear	20,600,536	82%	0	0%
Natural Gas	3,603,997	14%	1,482,491	69%
Hydro	299,982	1%	0	0%
MSW	199,331	1%	173,364	8%
Wind	128,446	1%	0	0%
Coal	101,262	0%	447,959	21%
Residual Fuel Oil	59,077	0%	54,368	3%
LFG	8,207	0%	0	0%
Distillate Fuel Oil	854	0%	1,382	0%
Total	**25,001,693**	**100%**	**2,159,564**	**100%**

Note: Totals may not sum due to independent rounding.

3.2. Electricity Consumption – Scope 2

Data & Methods

Scope 2 emissions from electricity consumption were calculated using a combination of reported consumption from utilities and, where utility data are unavailable, consumption estimates. As of December 7, 2012, electricity sales data were available from six utilities serving the Central New York region: National Grid, NYSEG, Rochester Gas and Electric, Oneida-Madison Electric Cooperative, Village of Hamilton, and Village of Solvay. All utilities except one provided electricity consumption by municipality and sector. Oneida-Madison Electric Cooperative provided total electricity usage and this consumption was divided into Residential, Commercial, and Industrial sectors using the statewide breakdown of total retail electricity sales from EIA.

The data cover 143 municipalities fully and five municipalities have no or only partial utility-reported electricity consumption. The Central New York Regional Planning and Development Board provided a list of utilities

serving each municipality, which was used to determine whether cities were "fully served" by the utilities reporting.

For locations fully served by the utilities reporting, the reported usage for that area (in MWh) serves as the full electricity consumption for that town or village. If no utility data were available for the town or city, electricity usage was estimated using the following methods for each sector:

Residential – Use the same methodology used to estimate consumption for all other residential stationary fuels (see below). These estimates are based on total housing units and housing unit size. Unlike other fuels, electricity usage was not weighted by HDD or home heating fuel use, since electricity is used extensively outside of home heating.

Commercial – Use the same methodology used to estimate consumption for all other commercial stationary fuels (see below). These estimates are based on commercial square footage (which in turn is a factor of commercial sector employment and square footage-per-employee), home heating fuel use, and HDD.

Industrial – Industrial electricity consumption is not estimated if it was not provided by the utilities.

County-level electricity consumption was then estimated by summing the consumption at the city and town level. Finally, electricity usage in MWh was converted to MMBTU and emissions using the 2009 eGRID emission factors for NYUP subregion, which houses all Central New York counties. The emission factors are 497.92 lb CO_2/MWh, 15.94 lb CH_4/GWh, and 6.77 lb N_2O/GWh.

Results

Total emissions from electricity in the region are 1,406,418 $MTCO_2e$. The primary drivers of electricity consumption are households and commercial and industrial activities. Total electricity emissions by county and total electricity consumption by sector and county are shown in Table 6 and Table 7, respectively. Total electricity consumption in the CNY region in 2010 was estimated to be just close to 6.2 million MWh. Onondaga County had the largest share of that electricity use, with 62 percent. Cayuga County has the highest electricity use per capita, due to a relatively low population across the county but significant commercial and industrial activity in Auburn. Per capita electricity use by county and sector is shown in Figure 3.

Table 6 – 2010 Electricity Consumption Emissions ($MTCO_2e$)

County	CO_2	CH_4	N_2O	Other Gases	Total	Percent of Total
Cayuga	197,511	133	832	0	198,477	14%
Cortland	69,050	46	291	0	69,388	5%
Madison	108,256	73	456	0	108,785	8%
Onondaga	870,679	585	3,670	0	874,934	62%
Oswego	154,082	104	649	0	154,835	11%
Central New York Total	**1,399,578**	**941**	**5,899**	**0**	**1,406,418**	**100%**

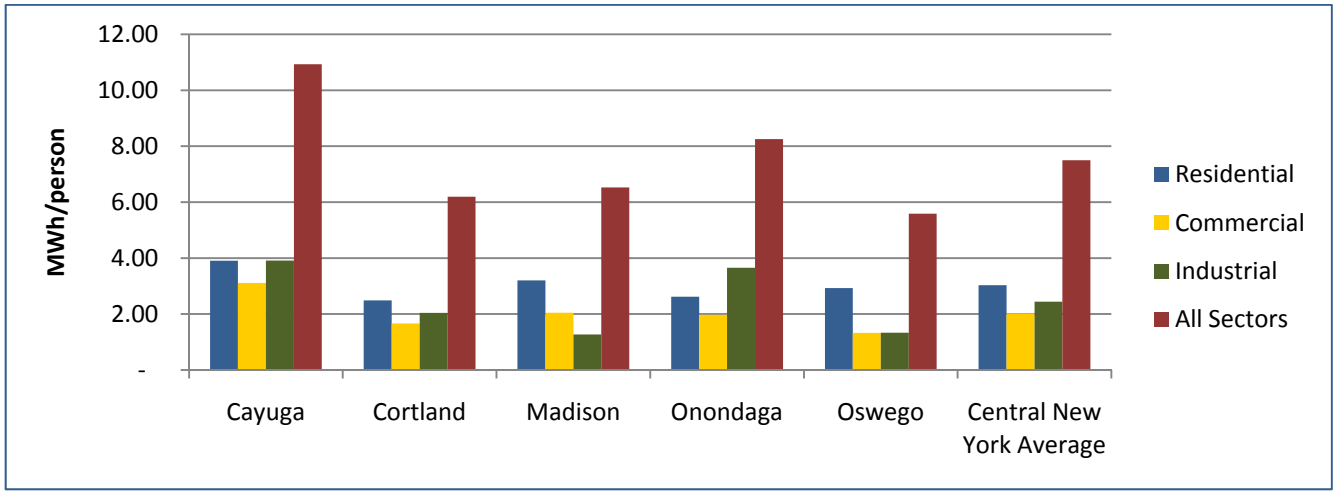
Note: Totals may not sum due to independent rounding.

Table 7 – 2010 Electricity Consumption by Sector and County (MWh)

County	Residential	Commercial	Industrial	Total	Percent of Total
Cayuga	312,651	248,839	313,024	874,514	14%
Cortland	122,885	82,130	100,716	305,731	5%
Madison	235,351	150,572	93,398	479,321	8%
Onondaga	1,224,740	923,041	1,707,293	3,855,073	62%
Oswego	357,398	162,258	162,569	682,224	11%
Central New York Total	**2,253,025**	**1,566,839**	**2,376,999**	**6,196,863**	**100%**

Note: Totals may not sum due to independent rounding.

Figure 3 – 2010 Per Capita Electricity Consumption by Sector (MWh/person)



3.3.Fuels – Scope 1

Data & Methods

Scope 1 stationary fuel combustion includes use of fuels such as natural gas, coal, fuel oil, wood, others for home heating, commercial heating, and industrial energy use. Different methods are used to estimate energy use and emissions for the residential, commercial, and industrial sectors. In addition, natural gas is estimated differently than other fuels due to the availability of utility sales data. The methods for residential, commercial, and industrial natural gas and other fuels are described below.

Residential

The primary data sources for residential stationary combustion include the US Census Bureau Redistricting data for 2010, the American Community Survey (ACS) 5-year housing characteristic estimate for 2010,[4] and the Energy Information Administration's (EIA) state energy consumption data by sector for New York in 2010.[5] Statewide fuel consumption was allocated to counties using a weighted value based on the occupancy of

[4] U.S. Census Bureau. 2012. American Fact Finder.
[5] EIA. 2012. SEDS - State Energy Data System for New York. http://205.254.135.7/state/seds/seds-states.cfm?q_state_a=NY&q_state=New%20York

single-family detached (SFD), single-family attached (SFA), or multi-family (MF) dwellings; energy use per housing unit by different types of dwellings; the average Heating Degree Days (HDD) for each region in the state; and the use of household heating fuels by household count. This calculation methodology was used for all fuels reported as home heating fuels in the ACS: Electricity, Natural Gas, Coal, Propane, Fuel Oil, Wood, and Solar.

Residential stationary combustion emissions are estimated by first estimating fuel consumption, and then multiplying estimated fuel consumption by fuel-specific emission factors. To estimate consumption by fuel for each county, housing data from the American Community Survey were collected for each county in the state. Total SFD and SFA housing units were indicated in the data. Total MF housing units were assumed to equal categories for 2 or more units, plus mobile home, boat, RV, van, and other. These counts, which included both occupied and vacant housing units, were multiplied by the percentage of occupied housing units in each municipality to convert the total housing units by type to occupied units by type. The heating fuel counts were based only on occupied units.

Next, the occupied housing units were adjusted to account for the difference in energy use per housing unit by dwelling type. Per the NYGHG Working Group, a SFD uses 108 MMBTU per year, while a SFA uses 89 MMBTU per year, and a MF uses 54 MMBTU per year. The adjusted housing units for each county were calculated as:

$$Adjusted\ HU = \frac{108}{108} \times \mathrm{SFDHU} + \frac{89}{108} \times \mathrm{SFAHU} + \frac{54}{108} \times \mathrm{MFHU}$$

Where:

HU = “housing units”, the total number of housing units by county
SFDHU = “single-family detached housing units”, the number of single family detached units by county
SFAHU = “single-family attached housing units”, the number of single family attached units by county
MFHU = “multi-family housing units”, the number of multi-family units by county (defined as 2+ family houses, plus mobile home, boat, RV, van, and other)

The following process was used to estimate total fuel use by county for each fuel type:

$$Adjusted\ HU_{fuel} = HU_{fuel} \times \frac{Adjusted\ HU}{HU}$$

Where:

HU = “housing units”, the total number of housing units by county
HU_{fuel} = total number of housing units that heat with each fuel type by county

Finally, the residential consumption for each county, weighted by structure type and county- specific heating degree day (HDD), was calculated as follows for each fuel type, except coal:

$$Fuel\ Use_{County} = Total\ Fuel\ Use_{State} \times \frac{(Adjusted\ HU_{Fuel} \times HDD)_{County}}{(Adjusted\ HU_{Fuel} \times HDD)_{State}}$$

For coal, statewide residential consumption was not available through EIA despite a small number of households reporting using coal or coke as a heating fuel in the region. To calculate residential coal or coke consumption, the energy per housing unit value for fuel oil was used as a proxy to correct for the unreported data.

$$Coal\ Use_{County} = Adjusted\ HU_{coal} \times \frac{Oil\ Use_{County}}{Adjusted\ HU_{oil}}$$

Where:

HU_{oil} = total number of housing units that heat with oil statewide

HU_{coal} = total number of housing units that heat with coal statewide

The energy use estimated for each fuel was then multiplied by fuel-specific emission factors to estimate total emissions. All fuel emission factors in this inventory come from EPA's Mandatory Reporting of Greenhouse Gases, Final Rule.[6] Total emissions are calculated by gas and are rolled up into a total for each county.

Commercial

Commercial stationary combustion is also estimated using an apportionment of the state energy consumption in the commercial sector reported by the EIA. Statewide commercial fuel use is apportioned to counties by a weighted value based on commercial square footage, home heating fuels, and HDD.

First, the amount of commercial square footage by county was determined by multiplying the total number of commercial-sector jobs in each county (collected from the New York State Data Center and provided by the NYGHG Working Group) by the average square footage per worker per building type (collected from the Commercial Building Energy Consumption Survey and provided by the NYGHG Working Group). These were multiplied by the percentage of housing units by each fuel type as reported in the ACS served to estimate the amount of space heated by each fuel. Next, the calculated consumption was weighted by HDD: the consumption of each fuel in each county equaled the commercial building area using that fuel multiplied by the regional HDD. The proportion of HDD-weighted fuel consumption in each county was multiplied by the statewide fuel consumption to get county-level fuel consumption for each fuel type.

The energy use estimated for each fuel was then multiplied by fuel-specific emission factors to estimate total emissions. Emission factors for CO_2, CH_4, and N_2O for each of the fuel types were gathered from guidance based EPA's Greenhouse Gas Reporting program. Total emissions are calculated by gas and are rolled up into a total for each county.

[6] U.S. EPA. Mandatory Reporting of Greenhouse Gases, Final Rule. 40 CFR Parts 86, 87, 89, 90, 94, 98, 1033, 1039, 1042, 1045, 1048, 1051, 1054, 1065. Table C-1 and C-2

Industrial

The primary data source for industrial stationary combustion is EPA's Greenhouse Gas Reporting Program (GHGRP) data for calendar year 2010.[7] This dataset includes emission information from large facilities (defined as those that emit > 25,000 MT CO2e per year) in nine industry groups, including: power plants, landfills, metals manufacturing, mineral production, petroleum refineries, pulp and paper manufacturing, chemicals manufacturing, government and commercial facilities, and other industrial facilities. These groups cover 29 source categories of emissions. In 2012, this EPA dataset will be expanded to include 12 additional industry groups for calendar year 2011.

Total statewide industrial fuel consumption for 2010 from EIA's State Energy Data System, Table CT6 and manufacturing employment in New York State and the Central New York counties were also used to supplement the GHGRP dataset. Manufacturing employment data came from the U.S. Census Bureau's 2007 Economic Census, Employment by NAICS Code, codes 31–33.

Industrial stationary combustion emissions are estimated using a combination of reported direct emissions from the Central New York region and a method to allocate statewide industrial fuel consumption to the Central New York counties.

First, data were pulled for known industrial emission in the Central New York region from EPA's GHGRP dataset. To identify industrial facilities located in the Central New York region, facilities were filtered by state and county. Non-industrial facilities were removed using NAICS codes. Facilities with NAICS codes for Utilities (with NAICS codes beginning with 22-), Lessors of Real Estate (531120), Solid Waste Landfills (562212), Solid Waste Combustors and Incinerators (562213), and Universities (611310) were removed. The result was a list of seven facilities located in the Central New York region from the GHGRP dataset.

The same process was completed for New York State, where non-industrial facilities were removed by NAICS code. The result was a final list of 53 industrial facilities in New York State, with NAICS codes related to manufacturing (beginning with 31-, 32-, or 33-) and pipeline transportation of natural gas (486210).

Second, the industrial facilities from EPA's GHGRP dataset were cross-checked with those in the Title V air permit dataset from the New York State Department of Environmental Conservation, distributed via the NYGHG Working Group. To identify industrial facilities from the Title V dataset located in the CNY region, facilities were filtered by state and county. Non-industrial facilities were then removed from the list based on the listed Standard Industrial Classification (SIC) code, a set of classification codes related to NAICS. Only facilities with SIC codes for Manufacturing (beginning with 20- to 39-), and Gas Production and Distribution (beginning with 492-) were kept. Facilities that were already included in the EPA's GHGRP were removed. This cross-check identified five additional industrial facilities in the CNY region. Added to the seven GHGRP facilities, this resulted in a final list of 12 industrial facilities located in the Central New York region, including their emissions by fuel type.

With the list of industrial facilities and their stationary combustion emissions finalized, "remaining" industrial emissions (i.e., emissions not captured in the GHGRP, such as from smaller industrial sources) were estimated at the state level and then allocated to the Central New York counties based on industrial employment. Using 2010 industrial fuel consumption data[8] (in trillion BTU) from EIA's State Energy Data System, total New York

[7] Dataset is available at: http://epa.gov/climatechange/emissions/ghgdata/index.html

[8] 2010 New York industrial fuel consumption data from EIA's SEDS Table CT6 were used directly with one exception; the fuel type "Other Petroleum Products" was adjusted to remove Asphalt and Road Oil, which are non-energy products. Asphalt and Road Oil makes up about 62% of the Other Petroleum Products category, so 38% of the 52.9 trillion BTU (20.1 trillion BTU) was used to distribute among the Central New York counties.

State emissions, by fuel, were calculated using the default emission factors per MMBTU established by the NYGHG Working Group. The remaining emissions, statewide, were then allocated to the county level by the portion of statewide industrial manufacturing employment in that county (based on employment data by NAICS code from the 2007 Economic Census).

The following process was followed **for each fuel type**:

$$EIA\ New\ York\ Sate\ Industrial\ Stationary\ Combustion\ Emissions = \sum_{by\ fuel} (trillion\ BTU\ consumed\ \times 10^{-6}\ \times\ {}^{MTCO_2e}/_{MMBTU})$$

$$Remaining\ emissions_{State} = EIA\ New\ York\ State\ Industrial\ Stationary\ Combustion\ Emissions - GHGRP\ Reported\ New\ York\ State\ Stationary\ Combustion\ Emissions$$

$$Remaining\ emissions_{County} = Remaining\ emissions_{State} \times \frac{Industrial\ Employment_{County}}{Industrial\ Employment_{State}}$$

$$Total\ Industrial\ Stationary\ Combustion\ Emissions_{County} = Reported\ Emissions_{County} + Remaining\ Emissions_{County}$$

Natural Gas

Natural gas consumption was estimated using a combination of reported usage from utilities and, where utility data were unavailable, consumption estimates. As of December 7, 2012, natural gas sales data were available from National Grid and NYSEG. The data cover 88 municipalities fully. Sixty towns and villages have no or only partial utility-reported natural gas consumption. The National Grid and NYSEG service territory web pages were used to determine whether a municipality was "fully served" by the utilities reporting.[9]

For locations fully served by the utilities reporting, the reported usage for that area (in therms, converted to MMBTU) served as the full natural gas consumption for that town or village. If no utility data were available for the town or city, the usage estimates generated using the methods for Residential and Commercial fuels described above were used. For industrial natural gas, natural gas consumption for GHGRP facilities in each municipality was used if there was no reported consumption from the utility. If a municipality had no reported utility natural gas consumption and no natural gas consumption from GHGRP facilities, then no industrial natural gas consumption was assumed.

Efforts were also taken to ensure natural gas consumption from the utility data did not include natural gas consumption already accounted for at electricity generation facilities. Utility natural gas consumption amounts

[9] National Grid, Service Territory Map, http://www.nationalgridus.com/niagaramohawk/about_us/serviceterr_map.asp
NYSEG, Service Area, http://www.nyseg.com/MediaLibrary/2/5/Content%20Management/NYSEG/YourHome/PDFs%20and%20Docs/NYSEG%20Service%20Area%20Map.pdf

in cities and towns with natural gas-fired power plants were cross-checked with natural gas consumption at the power plants, and values that seemed to match the power plant consumption were removed from the utility data.

County-level natural gas consumption was then estimated by summing the consumption at the city and town level. Finally, natural gas usage in MMBTU was converted to emissions using the natural gas emission factors of 53.02 kg CO_2/MMBTU, 0.001 kg CH_4/MMBTU, and 0.0001 kg N_2O/MMBTU.

Results

Emissions by end use sector and by fuel for stationary fuel consumption are presented in Table 8, Table 9, and Table 10. Total emissions in 2010 from non-electricity stationary energy use were 2,652,101 $MTCO_2e$. Natural gas is the dominant fuel in the region, representing 70 percent of energy use. Natural gas is also the dominant fuels in terms of emissions, representing 74 percent of emissions from stationary combustion. Similar to electricity, emissions from other fuels by county generally track population levels. In addition, per capita emissions from stationary fuel combustion are highest in Cayuga County due to high industrial activity at the two major facilities in Auburn (Nucor Steel and Owens-Brockway Glass).

Table 8 – 2010 Stationary Fuel Consumption GHG Emissions (MT CO_2e)

County	Residential	Commercial	Industrial	Total	Percent of Total	Emissions per Capita
Cayuga	158,838	95,758	61,641	316,236	12%	4.0
Cortland	82,446	78,374	40,989	201,809	8%	4.1
Madison	115,414	76,648	23,392	215,454	8%	2.9
Onondaga	685,975	489,165	367,483	1,542,624	58%	3.3
Oswego	185,238	93,275	97,465	375,978	14%	3.1
Central New York Total	1,227,911	833,220	590,970	2,652,101	100%	3.3
Percent of Total	*46%*	*31%*	*22%*	*100%*		

Note: Totals may not sum due to independent rounding.

Table 9 – 2010 Stationary Fuel Consumption by Sector and Fuel Type (MMBTU)

Fuel Type	Residential	Commercial	Industrial	Total	Percent of Total
Natural Gas	16,211,707	12,356,854	8,184,319	36,752,879	70%
Coal	171,239	12,447	642,770	826,455	2%
Distillate Fuel Oil	2,735,148	1,864,434	416,679	5,016,261	10%
Residual Fuel Oil	0	0	99,654	99,654	0%
Propane/LPG	2,229,938	564,233	43,090	2,837,262	5%
Other Petroleum	0	0	761,291	761,291	1%
Wood	4,604,197	612,703	410,714	5,627,614	11%
Biogas	0	0	142,476	142,476	0%
Solar	120,905	0	0	120,905	0%
Total	**33,760,454**	**20,756,726**	**18,811,314**	**73,328,494**	**100%**

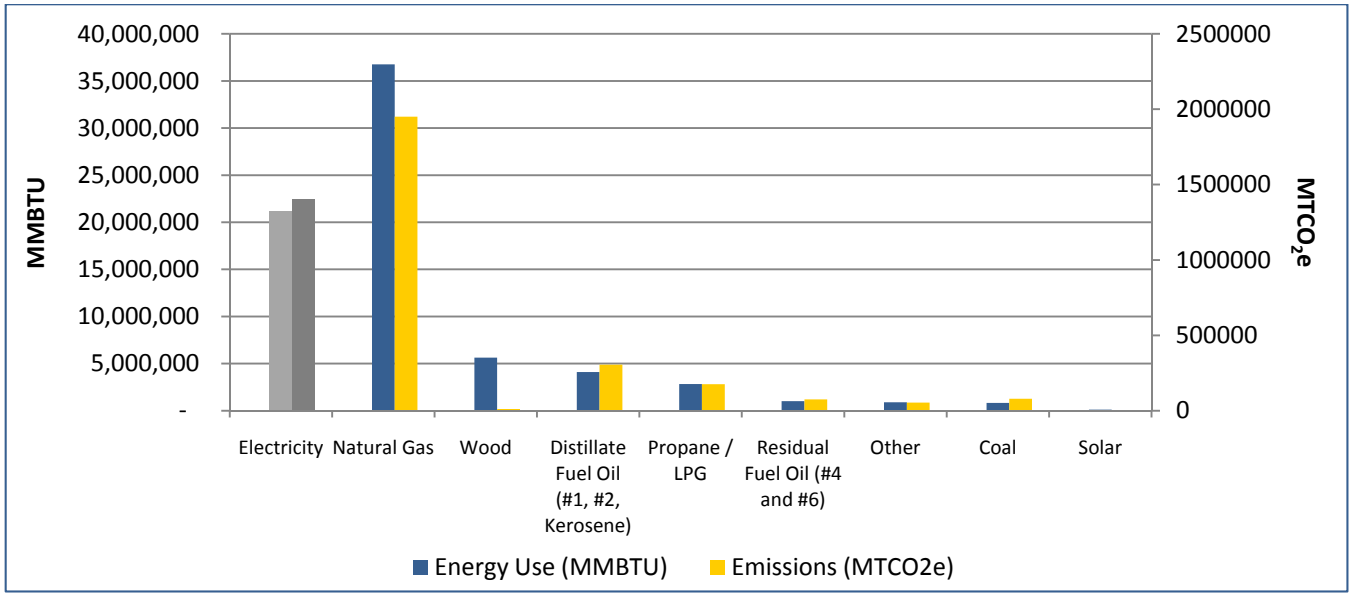
Note: Totals may not sum due to independent rounding.

Table 10 – 2010 Stationary Fuel Emissions by Sector and Fuel Type ($MTCO_2e$)

Fuel Type	Residential	Commercial	Industrial	Total	Percent of Total
Natural Gas	860,388	655,803	434,358	1,950,549	74%
Coal	17,855	1,172	60,502	79,528	3%
Distillate Fuel Oil	202,973	139,361	30,921	373,254	14%
Residual Fuel Oil			7,509	7,509	0%
Propane/LPG	137,607	35,676	2,724	176,008	7%
Other Petroleum			54,171	54,171	2%
Wood	9,089	1,209	746	11,045	0%
Biogas			37	37	0%
Solar	0			0	0%
Total	**1,739,249**	**1,188,825**	**1,130,445**	**4,058,519**	**100%**

Note: Totals may not sum due to independent rounding.

Figure 4 – 2010 Stationary Fuel Energy Use (MMBTU) and Emissions ($MTCO_2e$) by Fuel Type



3.4.Energy Supply

Emissions that result from energy supply processes are included here. These include electricity transmission and distribution (T&D) losses, natural gas T&D losses, and the use of sulfur hexafluoride (SF_6) in the utility industry. The following methods are used to calculate emissions from each.

Data & Methods

To estimate losses due to electricity T&D, total electricity consumption (MWh) was multiplied by a T&D loss factor to determine the quantity of electricity lost during T&D. This analysis used the Eastern regional loss

factor from eGRID, 5.28 percent. The total electricity lost is then multiplied by the electricity emission factors to estimate emissions from electricity T&D.

Natural gas transmission and distribution losses from pipelines are sources of CH_4 emissions. Utilities often report their average annual lost and unaccounted for (LAUF) natural gas to the New York Public Service Commission. For utilities that do not report LAUF, the statewide average of 1.8 percent as documented by National Grid in Public Service Commission reporting was used. The estimated natural gas consumption per county was multiplied by the LAUF and then converted from thousand cubic feet (mcf) to $MTCO_2e$.

Sulfur hexafluoride (SF_6) is a greenhouse gas that is used as an electrical insulator in electricity T&D equipment.[10] The SF_6 may escape from this equipment and emit into the atmosphere. To estimate these emissions, a national average implied emission factor was used. The emission factor was estimated by dividing 2010 total SF_6 emissions from electricity T&D from the U.S. Greenhouse Gas Inventory[11] by total nationwide retail electricity sales from the EIA.[12] The resultant factor of 0.0031 $MTCO_2e$/MWh was applied to total electricity consumption in the Central New York Region.

Results

Emissions from energy supply activities in the Central New York Region were estimated to be 353,098 $MTCO_2e$. The emissions from this sector are summarized in Table 11 and Figure 5. Natural gas T&D losses are the largest source of energy supply emissions, and add about 13 percent to overall natural gas consumption. Electricity T&D losses and SF_6 emissions contribute about 7 percent to overall electricity consumption emissions. Energy supply emissions are driven by electricity and natural gas consumption in each county.

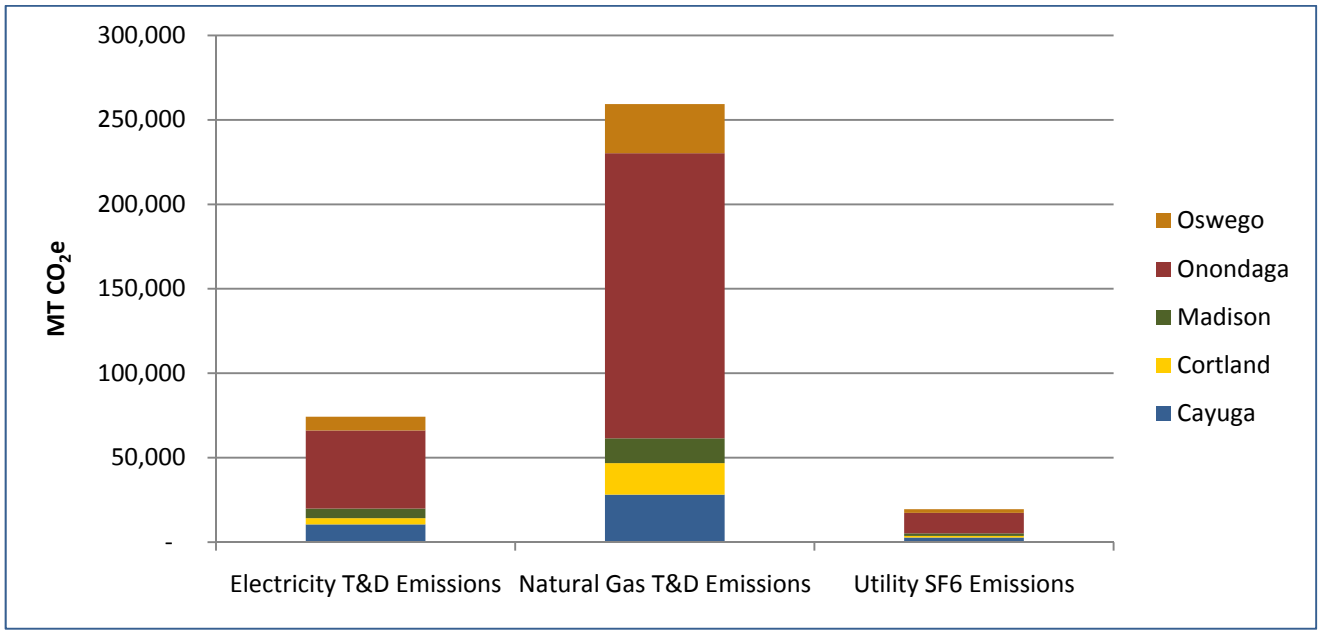
Table 11 –2010 Emissions from Energy Supply Activities ($MTCO_2e$)

County	Electricity T&D Emissions ($MTCO_2e$)	Natural Gas T&D Emissions ($MTCO_2e$)	Utility SF_6 Emissions ($MTCO_2e$)	Total	Percent of Total
Cayuga	10,480	28,112	2,749	41,340	12%
Cortland	3,664	18,661	961	23,286	7%
Madison	5,744	14,689	1,506	21,939	6%
Onondaga	46,197	168,791	12,116	227,104	64%
Oswego	8,175	29,110	2,144	39,430	11%
Central New York Total	**74,259**	**259,363**	**19,476**	**353,098**	**100%**

Note: Totals may not sum due to independent rounding.

[10] U.S. EPA. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2010. Section 4.23, Electrical Transmission and Distribution.
[11] U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2010. Table 4-1.
[12] EIA. Summary Electricity Statistics. Table ES-1, "Total Retail Sales." http://www.eia.gov/electricity/annual/xls/tablees1.xls

Figure 5 – 2010 Energy Supply Emissions ($MTCO_2e$)



4. Mobile Energy Consumption

4.1. On-road

On-road mobile transportation includes travel by motor vehicles on roads in Central New York. The combustion of fuel in vehicles results in emissions of CO_2, CH_4 and N_2O. The amount of CO_2 emitted by vehicles depends on the amount of fuel consumed, whereas CH_4 and N_2O emissions vary based on control technologies used by vehicles. On-road vehicles include passenger cars, other 2-axle/4-tire vehicles, single-unit trucks, buses, combination trucks, and motorcycles.

Data & Methods

There are 3 data components needed to estimate mobile energy emissions:

- Types of vehicles on the road ("Vehicle Mix")
- Distance traveled by on-road vehicles ("VMT," vehicle miles traveled)
- Fuel consumption per vehicle type ("Fuel Economy")

Vehicle Mix. Data on the on-road vehicle mix for each functional class of road (e.g., rural interstate, urban freeways and expressways) were obtained for each NYSDOT region from NYSDOT's Environmental Science Bureau dataset.[13] The breakdown of vehicle types for each functional class of road was translated to HPMS vehicle categories by the NYGHG Working Group.

Distance. Data on vehicle miles traveled (VMT) were obtained from NYSDOT modeled data for all counties. County-level VMT data were available by functional class.

[13] NYSDOT Environmental Science Bureau, 2009, Mobile 6.2 CO Emission Factors for project-Level Microscale Analysis, Appendix A. https://www.dot.ny.gov/divisions/engineering/environmental-analysis/manuals-and-guidance/epm/repository/coeftab0.pdf

Fuel Economy. State- or regional-level data on the fuel economy of the Central New York's vehicle fleet were not available. As a proxy, national average fuel economy values by vehicle class were used, based on the Federal Highway Administration's *Highway Statistics 2010* series.

Table 12 presents characteristics of the data used to estimate emissions from on-road mobile energy consumption. As shown, 2009 is the latest year currently available for all sources.

Table 12 – On-road Energy Consumption Data Summary

	Granularity	Data by functional class	Vintage of data	Other issues
VMT	Counties	Yes	2009	
Vehicle Mix	NYSDOT Regions	Yes	2009	
Fuel Economy	National	No	2009	Separate fuel economy values for gasoline and diesel vehicles are unavailable

The general methodology for estimating CO_2 emissions from mobile combustion is:

$$CO_2\ emissions = Fuel\ Consumption\ \times Emission\ Factor$$

Fuel consumption in Central New York was estimated by determining the distance traveled by different vehicle types and the amount of fuel consumed by each type of vehicle (fuel economy). First, data on total annual distance (VMT) traveled by vehicles within each county was allocated to vehicle types using the NSYDOT dataset on the breakdown of vehicles on NY roads (vehicle mix) by functional class of road. For each vehicle type and functional class, VMT data were multiplied by the average fuel economy of each vehicle type to determine total annual fuel consumption for each vehicle type. Total gasoline and diesel fuel consumption were then multiplied by the CO_2 emission factor for each fuel, which resulted in an estimate of CO_2 emissions for the region. In equation form:

$$CO_2\ emissions\ (MT) = \sum VMT_{ab} \times FC_{ab} \times EF_{ab}$$

Where:

VMT = annual vehicle miles traveled (miles/year)
FC = fuel consumption per mile traveled (gallons per mile; 1/ fuel economy)
EF = Emission factor (MT CO_2/gallon of fuel)
a = fuel type (diesel or gasoline)
b = vehicle type (passenger car, bus, combination truck, motorcycle, single-unit truck, and other 2/4 axle trucks)

Based on guidance from the NYGHG Working Group, the calculations assumed that 10 percent of gasoline sold in New York is comprised of ethanol, and as a result 10 percent of gasoline consumption within the region was assumed to be ethanol. CO_2 emissions from ethanol were assumed to be zero, as biogenic CO_2 is not included in this inventory.

Methane and nitrous oxide make up for less than 2 percent of on-road transportation emissions, and require data on the types of vehicle control technologies in use in the region's on-road vehicle fleet. Since this information was not available for the Central New York region, non-CO_2 emissions from vehicles were

estimated by multiplying CO_2 emissions by the ratio of total (CO_2 + non-CO_2) emissions from transportation per MT of CO_2 emissions (MT CO_2e/MT CO_2). This ratio, obtained from the U.S. EPA National GHG Inventory is 0.000994 MTCO_2e of CH_4 per MTCO_2 and 0.01367 MTCO_2e of N_2O per MTCO_2 of on-road transportation emissions.

Results

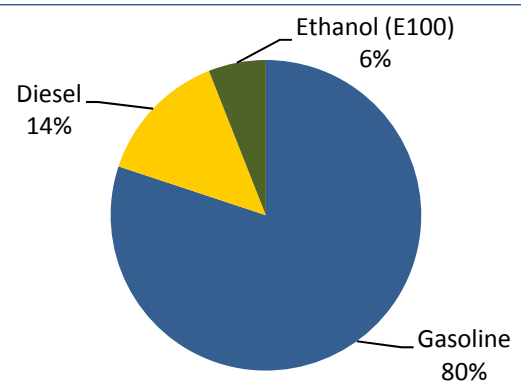
The 2010 (using 2009 as a proxy) on-road emissions in the Central New York region were 3,663,556 metric tons of carbon dioxide equivalent. Table 13 provides on-road emissions by county. Emissions are driven primarily by vehicle miles traveled, and influenced by the types of vehicles and the number of passengers per vehicle. On-road transportation emissions represent 37 percent of gross emissions in the region and 40 percent of the region's energy use. The majority of this energy consumption is gasoline, followed by diesel and ethanol, as shown in Figure 6.

Table 13 – 2010 On-Road GHG Emissions (MTCO_2e)

	CO_2	CH_4	N_2O	Other Gases	Total	Percent of Total	Emissions per Capita
Cayuga	324,119	322	4,429	0	328,870	9%	4.11
Cortland	278,193	276	3,802	0	282,271	8%	5.72
Madison	353,475	351	4,830	0	358,657	10%	4.88
Onondaga	2,142,256	2,129	29,275	0	2,173,660	59%	4.65
Oswego	512,583	509	7,005	0	520,097	14%	4.26
Central New York Total	**3,610,626**	**3,588**	**49,342**	**0**	**3,663,556**	**100%**	**4.63**

Note: Totals may not sum due to independent rounding.

Figure 6 – 2010 On-Road Energy Use by Fuel Type (percent)



4.2.Off-road

Off-road vehicles include engines used for agricultural, construction, lawn and garden, and off-road recreation purposes.

Data & Methods

Off-road vehicle use and emissions data for each of the five counties in the Central New York region in 2007 were generated using EPA's NONROAD Emissions Model outputs as provided by NYS DEC via the NYGHG

Working Group. The model input values were adjusted by NYS DEC. Among other emissions types, the NONROAD model estimates carbon dioxide emissions. To derive county-level emissions estimates, the emissions from all off road vehicles in each county were summed and converted to $MTCO_2e$ from short tons of CO_2. To avoid double counting, the emissions from vehicles in the pleasure craft classification are included in the marine emission source and are not included in the off-road emission source.

Results

Off-road vehicle activities generated an estimated 351,180 $MTCO_2e$ of emissions in 2010 (using 2007 data as a proxy). The results of the off-road emissions estimates are shown in Table 14,

Table 15, and Figure 7. The main sources of off-road emissions are construction and mining equipment, industrial equipment, and commercial equipment, the majority of which are located in Onondaga County.

Table 14 – 2010 Off-road Emissions by County ($MTCO_2e$)

County	Total Emissions ($MTCO_2e$)	Percent of Total	Emissions per Capita
Cayuga	48,721	14%	0.61
Cortland	28,356	8%	0.57
Madison	36,643	10%	0.50
Onondaga	197,233	56%	0.42
Oswego	40,227	11%	0.33
Central New York Total	**351,180**	**100%**	**0.44**

Note: Totals may not sum due to independent rounding.

Figure 7 – 2010 Off-Road Emissions ($MTCO_2e$)

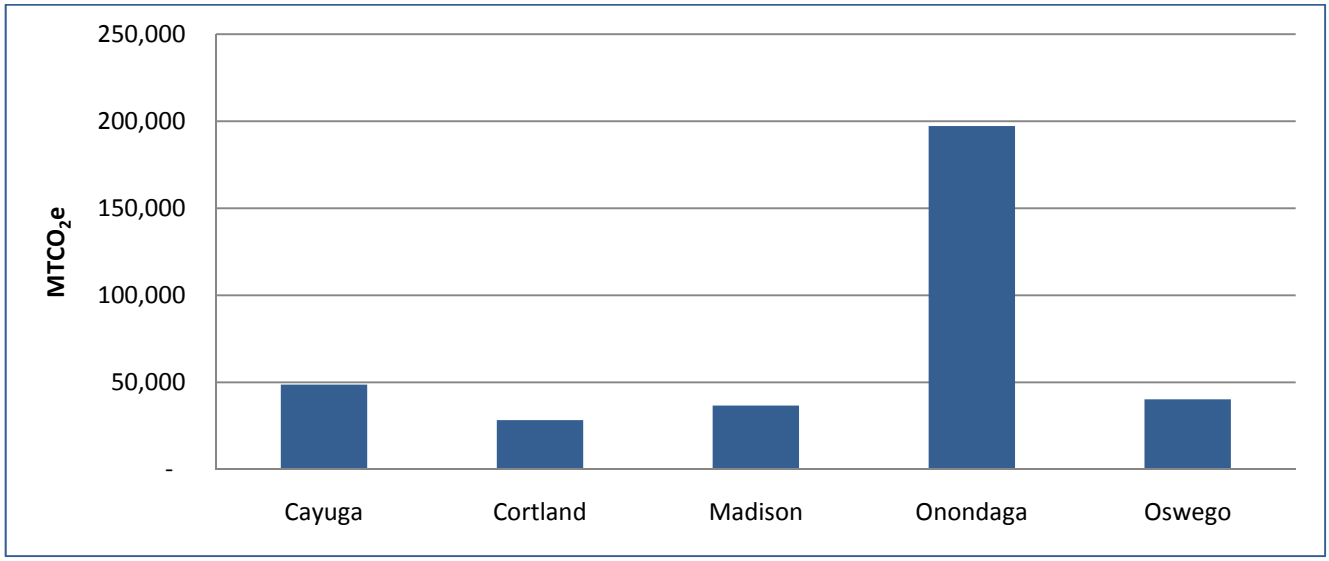


Table 15 – 2010 (using 2007 proxy) Off-road Emissions by Equipment type ($MTCO_2e$)

Equipment Type	Total Emissions ($MTCO_2e$)	Percent of Total
Recreational Equipment	35,397	10%
Construction and Mining Equipment	87,422	25%
Industrial Equipment	77,831	22%
Lawn and Garden Equipment (Res)	27,050	8%
Lawn and Garden Equipment (Com)	18,940	5%
Agricultural Equipment	56,705	16%
Commercial Equipment	42,555	12%
Logging Equipment	2,762	1%
Airport Equipment	1,879	1%
Railroad Equipment	639	0%
Total	**351,180**	**100%**

Note: Totals may not sum due to independent rounding.

4.3.Marine

The marine transportation sector includes engines used for pleasure craft (recreational) purposes and commercial marine vessels.

Data & Methods

Non-commercial marine off-road vehicle use and emissions data for each of the five counties in the CNY region in 2007 was obtained from the NONROAD emissions model outputs used to calculate off-road emissions (see section 4.2). The emissions from all off-road vehicles within the pleasure craft classification in each county were summed, and converted to metric tons from short tons.

Commercial marine emissions for each county were calculated based on carbon monoxide (CO) emissions for the sector reported in the 2008 National Emissions Inventory.[14] The National Emissions Inventory contains CO emissions, by county, for the "Mobile – Commercial Marine Vessels" sector. A ratio of CO_2 to CO emissions was used to estimate CO_2 emissions from commercial marine vessels. The ratio was based on CO_2 and CO emission factors for low-sulfur fuel oil no. 6. The CO_2/CO emission factor ratio (25,000 lb $CO_2/10^3$ gal over 5 lb $CO/10^3$ gal)[15] was then multiplied by total CO emissions for each county to get CO_2 emissions for commercial marine vessels.

Results

Marine emissions were estimated to be approximately 118,827 $MTCO_2e$ in 2010 (using 2007 data as a proxy). Cayuga and Oswego Counties, which border Lake Ontario, house the majority of the region's marine activity, both recreational and commercial. See Table 16 and Figure 8.

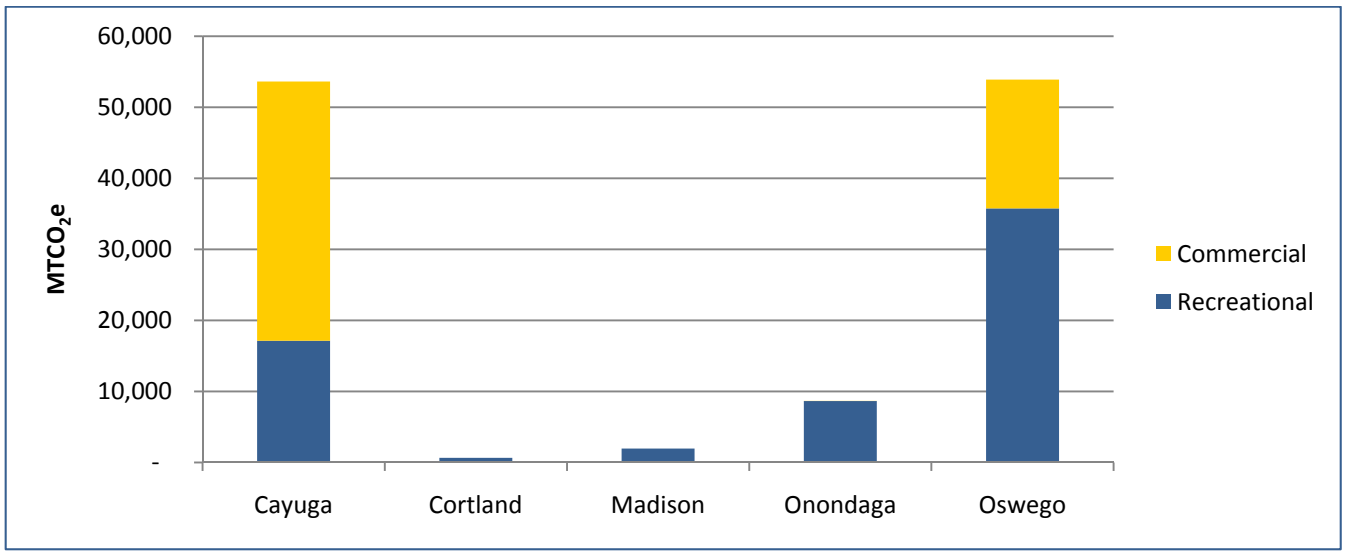
[14] U.S. EPA, 2009, 2008 National Emissions Inventory. http://www.epa.gov/ttnchie1/net/2008inventory.html
[15] CO_2 and CO emission factors came from EPA's AP 42 emissions factor report, fifth edition, Volume I, Chapter 1, Section 1.3. http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s03.pdf

Table 16 – 2010 Marine Emissions by County ($MTCO_2e$)

County	Total Emissions ($MTCO_2e$)	Percent of Total
Cayuga	53,639	45%
Cortland	656	1%
Madison	1,969	2%
Onondaga	8,668	7%
Oswego	53,895	45%
Central New York Total	118,827	**100%**

Note: Totals may not sum due to independent rounding.

Figure 8 – 2010 Marine Emissions by County and Type ($MTCO_2e$)



4.4.Rail

Emissions from railroad locomotives result from the use of diesel fuel.

Data & Methods

Due to the limited amount of data available in this sector, the NYGHG Working Group elected to use data from the 2002 New York State Locomotive Survey[16] as a proxy for 2010 emissions. The survey collected information on 2002 locomotive fuel use for four categories of locomotives: Class I, Class II/III, commuter/passenger, and switchyard. Class I railroads are large, long-distance line haul railroads and Class II and III railroads consist primarily of regional and local line haul and switching railroads. Yard locomotives move railcars within a particular railway yard.

[16] NYSERDA Clean Diesel Technology: Non-Road Field Demonstration Program. Development of the 2002 Locomotive Survey for New York State, http://www.nyserda.ny.gov/Publications/Research-and-Development/~/media/Files/Publications/Research/Environmental/locomotive%20survey%20report%20wit%20appendices.ashx

The survey reported county-level fuel consumption for Class I and system-wide fuel consumption estimates for Class II/III locomotives. The survey also reported county-level fuel consumption estimates from passenger/commuter lines that operate diesel locomotive cars. Fuel consumption estimates for a switchyard in Cortland County were reported; some Class I rail companies in New York State operate switchyards and the fuel consumption from other potential switchyards in the Central New York Region could not be separated out from line haul fuel consumption.

The county-level Class I, commuter/passenger, and switchyard fuel consumption estimates were multiplied by the diesel fuel CO_2 emission factor to calculate CO_2 emissions and converted to metric tons. The fuel consumption estimates were converted by the diesel density factor and multiplied by the emission factors, global warming potentials, and unit conversion factors to calculate CH_4 and N_2O emissions.[17] The inventory does not report emissions from the Class II/III rail type because the fuel consumption estimates are not reported by county.

Results

Emissions were estimated to be approximately 85,049 $MTCO_2e$ in 2010 (using 2002 data as a proxy). Onondaga County has the largest share of these emissions, followed by Oswego County. These emissions are summarized in Table 17 and Figure 9.

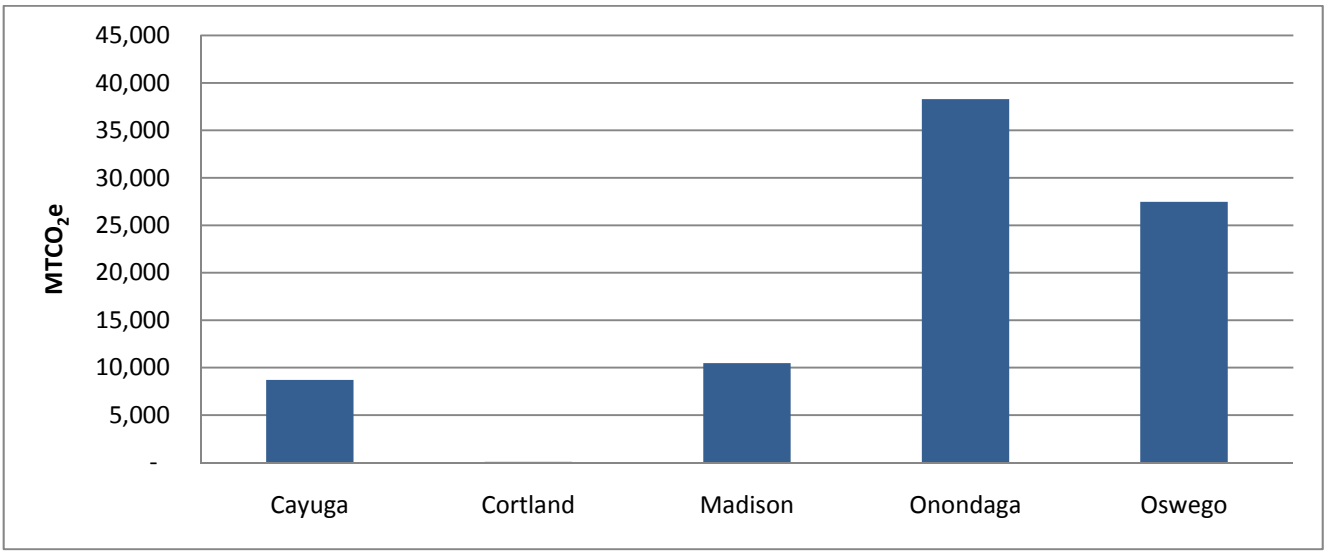
Table 17 – 2010 Rail Emissions ($MTCO_2e$)

	CO_2	CH_4	N_2O	Total $MTCO_2e$	Percent of Total
Cayuga	8,692	14	5	8,710	10%
Cortland	85	0	0	86	0%
Madison	10,457	17	5	10,480	12%
Onondaga	38,215	63	20	38,297	45%
Oswego	27,416	45	14	27,476	32%
Central New York Total	**84,865**	**139**	**45**	**85,049**	**100%**

Note: Totals may not sum due to independent rounding.

[17] Default factors from EPA's 2012 State Inventory Tool (SIT), Mobile Combustion Module. The SIT's default diesel density factors are from EIA Annual Energy Review 2007. The SIT's default diesel emission factors are from IPCC 1996 Guidelines for National Greenhouse Gas Inventories.

Figure 9 – 2010 Rail Emissions by County ($MTCO_2e$)



4.5.Air

Airplanes that fly in and out of airports in the Central New York region are sources of emissions. The airports in the region are Syracuse Hancock International Airport (airport code SYR) in Onondaga County, Hamilton Municipal Airport (VGC) in Madison County, and Fulton/Oswego Airport (NY2) in Oswego County.

Data & Methods

Emissions from air travel are estimated using a flight statistics dataset from the U.S. Department of Transportation's Bureau of Transportation Statistics.[18] Data fields used are the number of performed flights and the distance traveled in 2010 by airport.

The data were filtered to include only domestic flights from and to the three airports in Central New York (flights to Canada and The Bahamas were excluded). Total miles traveled in 2010 were calculated for each route by multiplying the number of performed flights with the distance per trip. The total miles of flights from and to each of the three airports were calculated. Then, flight miles were halved in the emissions calculations because emissions from half the trip are attributed to the origin airport and half are attributed to the destination airport. This ensures that two regions following the same methodology would not double-count emissions.

Regional flight emissions were calculated using the following equation:

$$Regional\ flight\ emissions = \frac{Regional\ departing\ flight\ miles + Regional\ arriving\ flight\ miles}{National\ flight\ miles} \times National\ flight\ emissions\ \times 0.5$$

National flight emissions data (114.0 Tg CO_2e) were from the U.S. EPA National GHG Inventory for 2010.[19]

[18] U.S. Department of Transportation. 2012. U.S. Air Carriers Traffic and Capacity Data: T-100 Segment (All Carriers). Bureau of Transportation Statistics. Available at http://www.transtats.bts.gov/DL_SelectFields.asp?Table_ID=293&DB_Short_Name=Air%20Carriers.

Results

Emissions from air travel were estimated to be approximately 167,537 $MTCO_2e$ in 2010. The emissions are summarized in Table 18. Nearly all of these emissions are from Syracuse Hancock International Airport. These emissions are considered an optional, Scope 3 source under the NYGHG Working Group guidance, and are not included in the gross emissions totals for the region. The emissions are presented for informational purposes.

Table 18 – 2010 Air Emissions by County ($MTCO_2e$)

County	Total Air Emissions ($MTCO_2e$)	Percent of Total
Cayuga	0	0%
Cortland	0	0%
Madison	3	0%
Onondaga	167,531	100%
Oswego	2	0%
Central New York Total	**167,537**	**100%**

Note: Totals may not sum due to independent rounding.

5. Waste

The waste management sector encompasses solid waste and wastewater. The organic material in solid waste and wastewater degrade during the decomposition and treatment processes, and as a result, emit greenhouse gases.

5.1. Solid Waste

The decomposition of organic matter in solid waste produces methane. For this inventory, both Scope 1 and Scope 3 emissions for solid waste were calculated. Scope 1 represents emissions from landfills located within the region, regardless of where the waste originated. Scope 3 represents emissions from waste generated by the region, regardless of where the waste is ultimately transported. To avoid double-counting, only Scope 3 emissions are included in the total. Scope 1 emissions from solid waste are reported here for informational purposes.

5.1.1. Scope 1

Solid waste Scope 1 accounts for emissions from landfills located within Central New York counties. Municipal solid waste landfill facilities in the region include City of Auburn Landfill, Cortland County Landfill, Madison County Sanitary Landfill, and Oswego County Bristol Hill Landfill.

Scope 1 does not include emissions from waste combustion facilities to avoid double-counting. Combustion facilities within the region, Onondaga County Resource Recovery Facility and Oswego County Energy Recovery Facility, are also used to generate electricity and are included under the electricity generation sector.

[19] U.S. EPA. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2010*, Table 3-12, http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2012-Chapter-3-Energy.pdf

Data & Methods

Data on emissions from landfills came from EPA's Greenhouse Gas Reporting Program data for calendar year 2010. This dataset includes emission information from large facilities (defined as those that emit >25,000 $MTCO_2e$ per year) in nine industry groups, including landfills.

Methane emissions from landfill processes in the Central New York region were reported as solid waste Scope 1 emissions.

Results

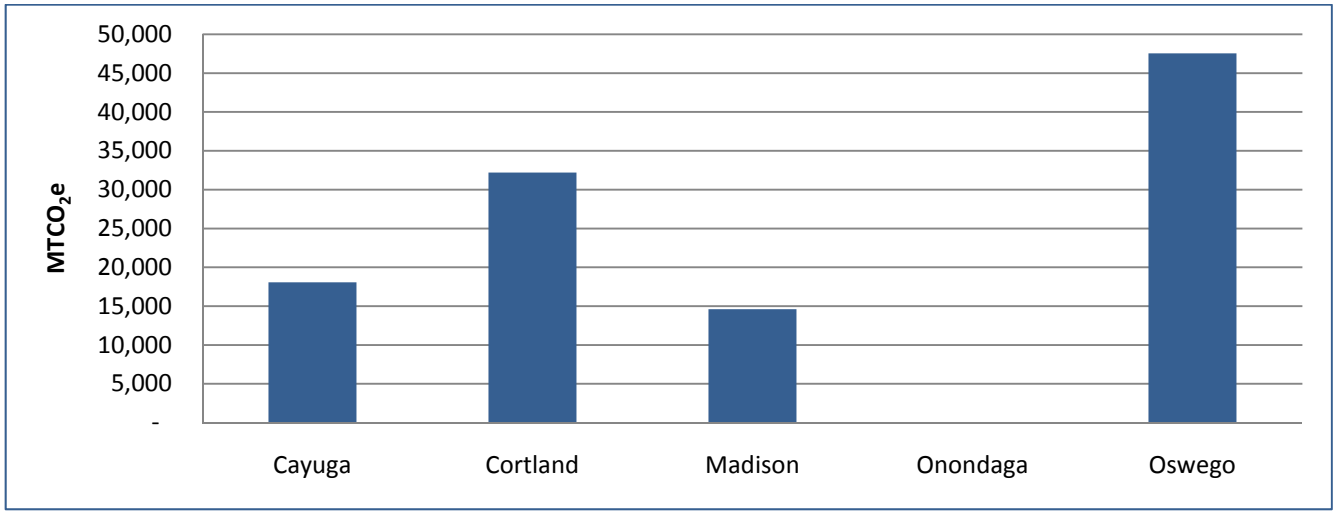
Results indicate that landfills in the region emitted 112,450 $MTCO_2e$ in 2010. The majority of these emissions came from Oswego County Bristol Hill landfill (42%), followed by the Cortland County landfill (29%). Results are shown in Table 19 and Figure 10.

Table 19 – 2010 Emissions from Landfills in Central New York ($MTCO_2e$) – Scope 1 Solid Waste Emissions

County	Landfill	Emissions ($MTCO_2e$)	Percent of Total
Cayuga	City of Auburn Landfill	18,077	16%
Cortland	Cortland County Landfill	32,197	29%
Madison	Madison County Sanitary Landfill	14,617	13%
Onondaga	-	-	0%
Oswego	Oswego County Bristol Hill Landfill	47,559	42%
Central New York Total		**112,450**	**100%**

Note: Totals may not sum due to independent rounding.

Figure 10 – 2010 Emissions from Landfills in Central New York ($MTCO_2e$) – Scope 1 Solid Waste Emissions



5.1.2. Scope 3

Scope 3 solid waste emissions account for emissions from waste generated within the Central New York counties, regardless of where the waste is sent.

Data & Methods

The general approached used to estimate emissions from waste generated within Central New York counties was to use the California Air Resources Board's Landfill Emissions Tool Version 1.3 to estimate the amount of emissions that waste generated in 2010 will produce over its decay lifetime. The tool implements the mathematically exact first-order decay (FOD) model of the 2006 IPCC guidelines. The methodology of the FOD model is available in the Local Government Operations Protocol.[20] The tool was loaded with inputs based on the characteristics of landfills that receive waste from the Central New York Counties.

Data input from the FOD model was collected from several sources. The primary source was NYS DEC 2010 Annual Landfill Facility Reports[21] provided via the NYGHG Working Group. These reports contained data for each landfill on the amount and type of waste received from each county, LFG collection acreage, total landfill acreage, and percent alternative daily cover (ADC). Data were also collected from the Onondaga County Resource Recovery Agency's 2010 Annual Report on Recyclables Recovered.[22] This report was used to estimate waste generated in 2010 from Onondaga County because data on waste generated from Onondaga County in the NYS DEC landfill reports seemed too low to be accurate. The NYS DEC 2008 solid waste plan, *Beyond Waste: A Sustainable Material Management Strategy* was used to gather information on the composition of waste discarded in New York, categorized by rural, suburban, and urban settings.

To enter data into the tool, first the number of years for which waste generated in 2010 will be releasing methane was calculated. The half-life of landfilled waste was calculated through the following equation: k = ln(2)/half-life in years. K is determined based on the amount of annual rainfall in the county, and an average rainfall of 20-40 inches per year was assumed for all counties in the Central New York region. Given the rainfall assumption, k= 0.038. The half-life was multiplied by four half-lives to determine T, the number of years for which waste deposited during the inventory year will be releasing methane. For the Central New York region, T = 73. The amount of solid waste generated in the inventory year was entered into the tool "Landfill Model Inputs tab" T years prior to the inventory year.

Various data points were calculated and input into the FOD tool to estimate emissions by county. These inputs were:

- Waste landfilled in 2010 by county – this was calculated based on the amount of MSW and C&D generated by county and waste disposal practices
    - MSW and C&D generated in 2010 by county amounts were pulled from the NYS DEC landfill reports for Cayuga, Cortland, and Madison Counties. For Onondaga County, the waste generated was pulled from the Onondaga County Annual Report on Recyclables Recovered. For Oswego County, the amount of waste generated was estimated using the average disposal per capita in the other counties in Central New York because data on waste generated from Onondaga County in the NYS DEC landfill reports seemed too low to be accurate.
    - The proportion of waste generated in each county that is sent to landfills is calculated using the amount of waste received by landfills from each county and the amount of waste combusted at waste-to-energy facilities in the region. The proportion of total waste that is

[20] Local Government Operations Protocol. Version 1.1, 2010, http://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf
[21] Received via email from Jim Yienger on July 26, 2012 7:30 AM. Data spreadsheets compiled by Shelby Egan.
[22] Onondaga County Resource Recovery Agency's 2010 Annual Report on Recyclables Recovered. https://ocrra.org/app/webroot/img/gallery/File/downloads/Reports/Recycling/Recycling_2010.pdf

sent to landfills is applied to the total waste generated in 2010 to determine the amount sent to landfills.

- Percentage of waste that contain anaerobically degradable carbon (ANDOC) – For MSW, this value was calculated using the composition of waste discarded in 2008 from the NYS DEC's *Beyond Waste* plan. New York State-specific solid waste discard composition data were used to find the fraction of waste types which contain ANDOC. The inventory assumes the waste composition from suburban settings for Onondaga County and from rural communities for other counties in the region. The suburban or rural assignments were based on NYS DEC's definition of rural communities as those with a population density of less than 325 people per square mile and suburban communities as those with a population density between 325 and 5,000 people per square mile. Population density data for each county came from the NYS Data Center.[23] The inventory assumes the waste composition for the construction and demolition (C&D) waste emission analysis is 100 percent C&D.
- Amount of alternative daily cover (ADC) – For each county, this value was calculated by first calculating the weighted ADC percentage for each county and then multiplying it by MSW landfilled. The weighted percentage of ADC for county was calculated by weighting the percentage of ADC for each landfill receiving MSW from the county by the amount of MSW received from that county. The inventory assumes no ADC for C&D waste.
- k-value – The k-value was set to 0.038 for all counties. This is based on the assumption that the average annual rainfall for the Central New York Counties is 20-40 inches per year.
- Geographic location – "US-Other" was selected from the drop=down menu for the State/Country.
- Waste-in-place – The NY State-specific waste in place fractions were entered into the "Landfill Specific ANDOC Values" tab of the tool.

The sum of the tool's emission results over T years represents the total amount of methane expected to be released by inventory year waste generated and deposited in a landfill without a landfill gas (LFG) collection system. The methane emissions for MSW waste then were adjusted for a LFG collection system. The EPA default LFG collection efficiency of 75 percent was assumed.[24] This default value was multiplied by the weighted percent of land with a LFG collection system per county to find the LFG collection rate for that county. The weighted LFG capture coverage ranges from 18 to 100 percent (i.e. some counties sent a weighted average of waste to landfills where LFG was captured on 18 percent of the landfill, some to landfills with 100 percent LFG collection coverage). The sum of methane emissions was multiplied by 100 percent minus the LFG collection rate to determine methane emissions from MSW generated and deposited in landfills with LFG collection systems. The inventory assumes no LFG collection for C&D waste. Carbon dioxide emission outputs from the solid waste tool are considered biogenic and are not included in the inventory emissions.

Results

Results indicate that total emissions from waste generation in the region in 2010 were 102,812 $MTCO_2e$. Municipal solid waste generation contributed 85 percent of those emissions (87,310 $MTCO_2e$) and C&D contributed 15 percent (15,502 $MTCO_2e$). Overall, 580,252 tons of solid waste were generated in the region in 2010. Table 20, Table 21 and Figure 11 summarize the results.

[23] NYS Data Center. Table 1: Total Population, Housing Units, Land Area, and Population Density, 2010, http://esd.ny.gov/NYSDataCenter/Data/Census2010/PL2010Tab1NY.pdf

[24] EPA, 2008. AP 42, Fifth Edition, Volume I, Chapter 2: Solid Waste Disposal. http://www.epa.gov/ttn/chief/ap42/ch02/final/c02s04.pdf

Onondaga County generated the largest portion of that waste, which is driven primarily by population, but generated a much smaller portion of emissions. This is because 95 percent of waste from Onondaga County is sent to combustion facilities rather than landfills. A similar pattern occurs in Oswego County, where 91 percent of waste is combusted. All waste generated in Cayuga, Cortland, and Madison Counties was landfilled in 2010. As a result, those counties have higher per capita waste emissions than Onondaga and Oswego. Cortland County has the highest per capita waste emissions, as their waste is sent primarily to Cortland County Landfill, which does not have an LFG capture system.

Table 20 – 2010 Scope 3 Solid Waste Emissions ($MTCO_2e$)

County	MSW CH_4 Emissions ($MTCO_2e$)	C&D CH_4 Emissions ($MTCO_2e$)	Total CH_4 Emissions ($MTCO_2e$)	Percent of Total	Emissions per Capita
Cayuga	27,709	2,286	29,994	29%	0.37
Cortland	28,334	753	29,087	28%	0.59
Madison	20,413	1,621	22,034	21%	0.30
Onondaga	5,542	8,653	14,195	14%	0.03
Oswego	5,312	2,189	7,500	7%	0.06
Central New York Total	**87,310**	**15,502**	**102,812**	**100%**	**0.13**

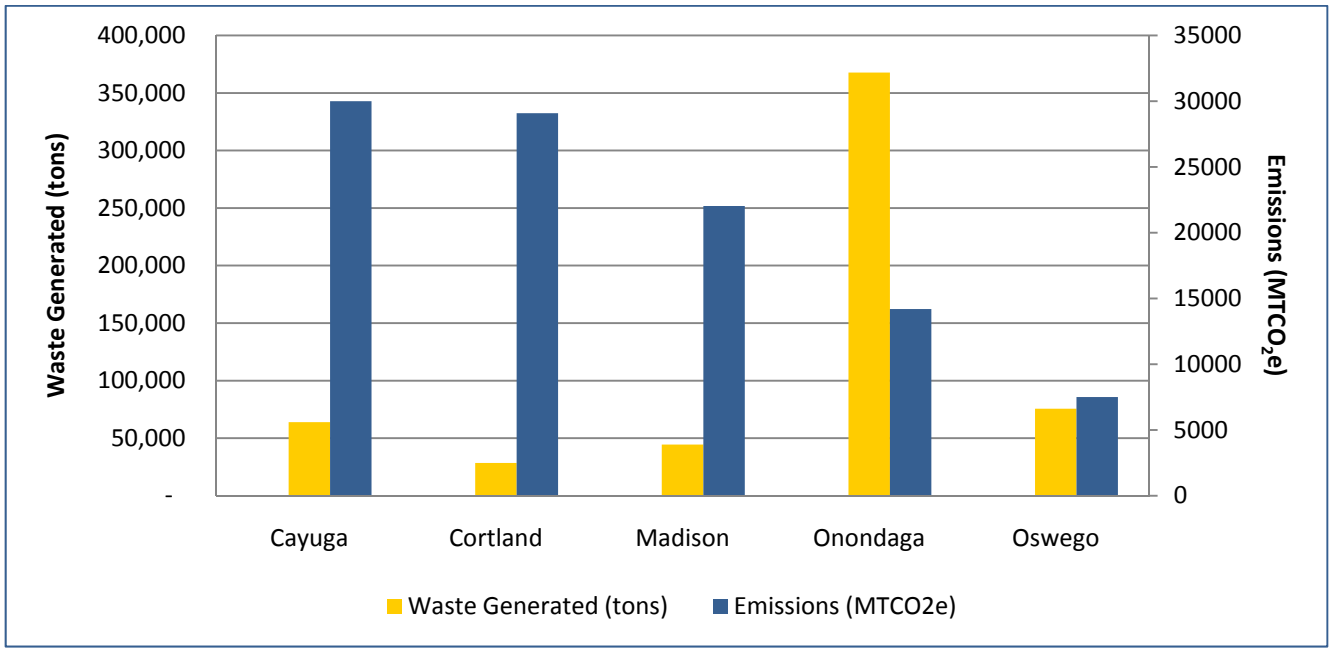
Note: Totals may not sum due to independent rounding.

Table 21 – 2010 Waste Generated by County (tons)

County	MSW Sent to Landfill Facilities (tons)	C&D Sent to Landfill Facilities (tons)	MSW Sent to Landfill Waste Combustion Facilities (tons)	C&D Sent to Landfill Waste Combustion Facilities (tons)	Total Waste Generated (tons)
Cayuga	53,245	10,661	-	-	**63,906**
Cortland	25,035	3,510	-	-	**28,545**
Madison	36,963	7,560	-	-	**44,523**
Onondaga	14,503	40,350	312,846	-	**367,699**
Oswego	5,972	10,205	56,852	2,545	**75,574**
Central New York Total	**135,719**	**72,288**	**369,698**	**2,545**	**580,252**

Note: Totals may not sum due to independent rounding.

Figure 11 – 2010 Waste Generation (tons) and Emissions ($MTCO_2e$) – Scope 3 Solid Waste



5.2. Wastewater

When organic waste material in wastewater degrades during the wastewater treatment process, it emits both methane and nitrous oxide. Methane is emitted during anaerobic digestion of wastewater, and nitrous oxide is emitted when nitrogen components in wastewater degrade. The amount of methane and nitrous oxide emitted from wastewater depends on the type of wastewater treatment processes used, such as septic systems, centralized wastewater treatment plants (WWTPs), and anaerobic digesters.

Data & Methods

Wastewater emissions are calculated based on the population served by wastewater treatment processes. Population data in Central New York were obtained from the Census.[25]

Wastewater emissions are calculated using EPA's State Inventory Tool (SIT) Wastewater module. Methane emissions from municipal wastewater treatment are calculated by multiplying the regional population from by the annual per-capita 5-day biological oxygen demand (BOD_5) rate, then by the emission factor of CH_4 emitted per quantity of BOD_5. Default values for New York State in the SIT were used. In some equations, the percentage of the population not on septic systems is used. For these, the default value for New York State is 79 percent. The actual value for the region may be lower, due to the largely rural character of the Central New York region, but given the relatively low emissions from this source, the State value was assumed to be suitable for this use. Both centralized wastewater treatment plants and septic systems are emission sources, though the emission factors and methods are slightly different. The SIT combines these two approaches in a manner appropriate for the relatively low emissions from this source.

[25] New York State Data Center, Census 2010, Revised2000to2009SubcountyTotals_Population.xls, http://www.empire.state.ny.us/NYSDataCenter/Census2010.html

$$CH_4\ Emissions\ (MT) = Population\ x\ Per\ capita\ BOD_5 \left(\frac{kg}{day}\right) \times \frac{Days}{year} \times \frac{MT}{kg} \times EF \left(\frac{GgCH_4}{GgBOD_5}\right) \times \%\ of\ WW\ anaerobically\ digested$$

Where:

Population	=	Regional population.
Per capita BOD_5	=	5-day biochemical oxygen demand per capita. Default value is 0.09 kg BOD_5/day.
EF	=	Emission factor of CH_4 emitted per quantity of BOD_5. Default value is 0.6 Gg CH_4/Gg BOD_5.
% of WW anaerobically digested	=	Fraction of wastewater BOD_5 that is anaerobically digested. Default value is 16.25%.

Nitrous oxide emissions form municipal wastewater treatment are calculated by multiplying the population served by the percent of the population using centralized wastewater treatment (not septic systems), then by the amount of direct N_2O emissions from wastewater treatment per person per year.

$$N_2O\ Emissions\ (MT) = Population \times Fraction\ of\ population\ not\ on\ septic \times Direct\ N_2O\ emissions\ from\ WWT \left(\frac{\frac{gN_2O}{person}}{year}\right) \times \frac{MT}{g}$$

Where:

Population	=	Regional population.
Fraction of population not on septic	=	Percent of population that is served by centralized WWTPs as opposed to septic systems. The default value for New York State is 79%. The actual value for the region is likely lower, due to the largely rural character of the region, but given the relatively low emissions from this source, the State value was assumed to be suitable for this use.
Direct N_2O emissions from WWT	=	The amount of N_2O emitted from WWTPs. Default value is 4.0 grams N_2O per person per year.

Nitrous oxide emissions from wastewater biosolids are calculated using the following equation:

$$N\ in\ Domestic\ Wastewater = Population \times Protein\left(\frac{kg}{\frac{person}{year}}\right) \times Frac(npr)\left(\frac{kg\ N}{kg\ protein}\right) \times Fraction\ nonconsumption\ N \times \left(\frac{MT}{kg}\right)$$

$$N_2O\ Emissions\ (MT) = N\ in\ Domestic\ WW\ (MT) - Direct\ N\ Emissions\ from\ Domestic\ WW\ (MT) \times (1 - \%\ of\ Biosolids\ used\ as\ fertilizer) \times EF\left(\frac{kgN_2O - N}{kgsewageN_{produced}}\right) \times \left(\frac{N_2O}{N_2}\right)$$

Where:

Population	=	Regional population.
Protein	=	Available protein per person per year (kg/person/year). Default value is 42.6 kg/person/year.[26]
Fraction of nitrogen in protein	=	Kg N per Kg protein. Default value is 16 percent. [27]
Fraction of non-consumption nitrogen	=	The ratio of total N to N consumed. Default value is 1.75. [28]
EF	=	Emissions of N in the form N_2O per unit of sewage-N produced. Default value is 0.01 kg N_2O-N per kg of sewage-N.

Results

Wastewater treatment emissions are approximately 77,046 $MTCO_2e$. Table 22 lists wastewater treatment emissions by county. These emissions are driven entirely by population.

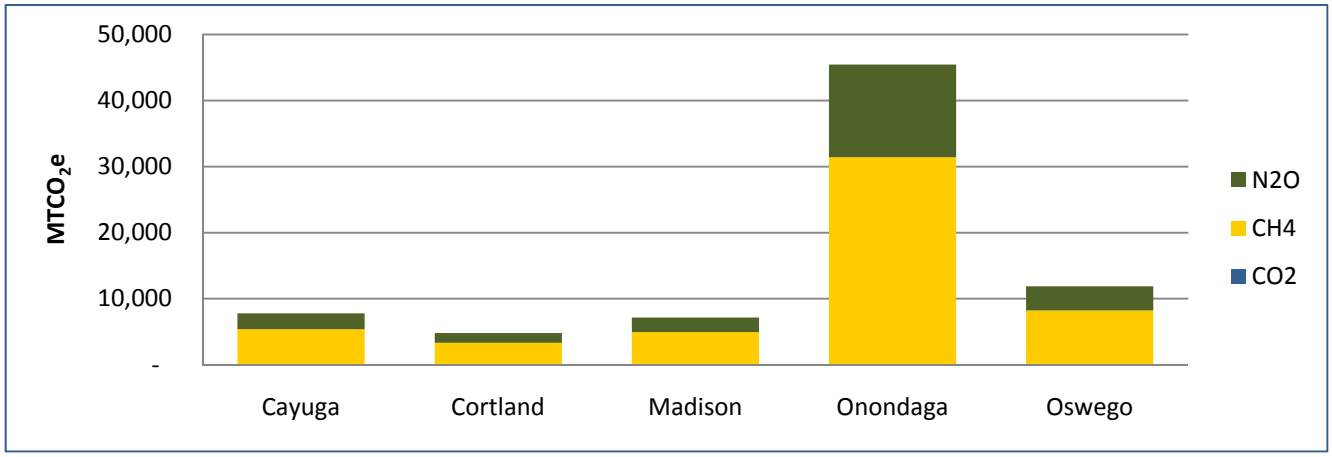
[26] U.S. EPA. 2012. Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2010. Table 8-14.
[27] Ibid.
[28] Ibid.

Table 22 – 2010 Wastewater Treatment Emissions

	CH_4 Emissions (MT CO_2e)	N_2O Emissions (MT CO_2e)	Total Emissions (MT CO_2e)	Percent of Total	Emissions per Capita
Cayuga	5,383	2,403	7,786	10%	0.10
Cortland	3,318	1,481	4,800	6%	0.10
Madison	4,940	2,205	7,145	9%	0.10
Onondaga	31,412	14,024	45,436	59%	0.10
Oswego	8,213	3,667	11,880	15%	0.10
Central New York Total	**53,266**	**23,780**	**77,046**	**100%**	0.10

Note: Totals may not sum due to independent rounding.

Figure 12 – 2010 Wastewater Treatment Emissions by County and Gas (MTCO$_2$e)



6. Industrial Processes

Industrial process emissions are those produced as by-products of non-energy-related industrial activities. In the Central New York region, such industrial activities relate primarily to manufacturing of products, including glass and glassware, concrete manufacturing, cement manufacturing, aluminum product manufacturing, and iron and steel.[29] The primary industrial actors in the region are Nucor Steel, an iron and steel producer and Owens-Brockway Glass, a glass manufacturer, both in the city of Auburn, in Cayuga County.

Data & Methods

Industrial process emissions for Central New York were estimated for two emission sources to cover the industrial process emissions in the region. These sources are (1) CO_2, CH_4, and N_2O from general industrial activity as reported by large facilities and (2) hydrofluorocarbon (HFC) emissions from ozone depleting substances (ODS) substitutes.

[29] U.S. Census Bureau, 2007 Economic Census

Data on industrial activity from large facilities came from EPA's GHGRP dataset for calendar year 2010.[30] This dataset includes emission information from large facilities (defined as those that emit > 25,000 $MTCO_2e$ per year) in nine industry groups, including: power plants, landfills, metals manufacturing, mineral production, petroleum refineries, pulp and paper manufacturing, chemicals manufacturing, government and commercial facilities, and other industrial facilities. The dataset contains total emissions by industrial process. Only two facilities in the Central New York region reported industrial process emissions: Nucor Steel Auburn Inc. and Owens-Brockway Glass Container Inc. Plant #35, both in the city of Auburn in Cayuga County. The emissions for these two facilities were pulled directly from the GHGRP dataset.

To supplement the GHGRP facility emissions, emissions were also calculated for ODS substitutes, a key industrial process emissions source category not covered in the EPA dataset. Equipment that use ODS Substitutes are widely distributed throughout all households and businesses. An implied per capita emissions factor was used, based on the national greenhouse gas inventory for 2010.[31] Total 2010 ODS substitution emissions (114.6 Tg CO_2e) were divided by total 2010 U.S. population (308,745,538[32]) to derive an implied per capita emission factor. This implied emission factor was multiplied by the population of each of the counties in the Central New York region to estimate emissions from this industrial process source category.

Results

Industrial process emissions are approximately 360,710 MT CO_2e. The majority of these emissions (79%) come from ODS substitution, which is driven directly by population. All other industrial process emissions are based on large facilities that report emissions through EPA's GHGRP, both of which are in Cayuga County. The results are shown below in Table 23 and Figure 13.

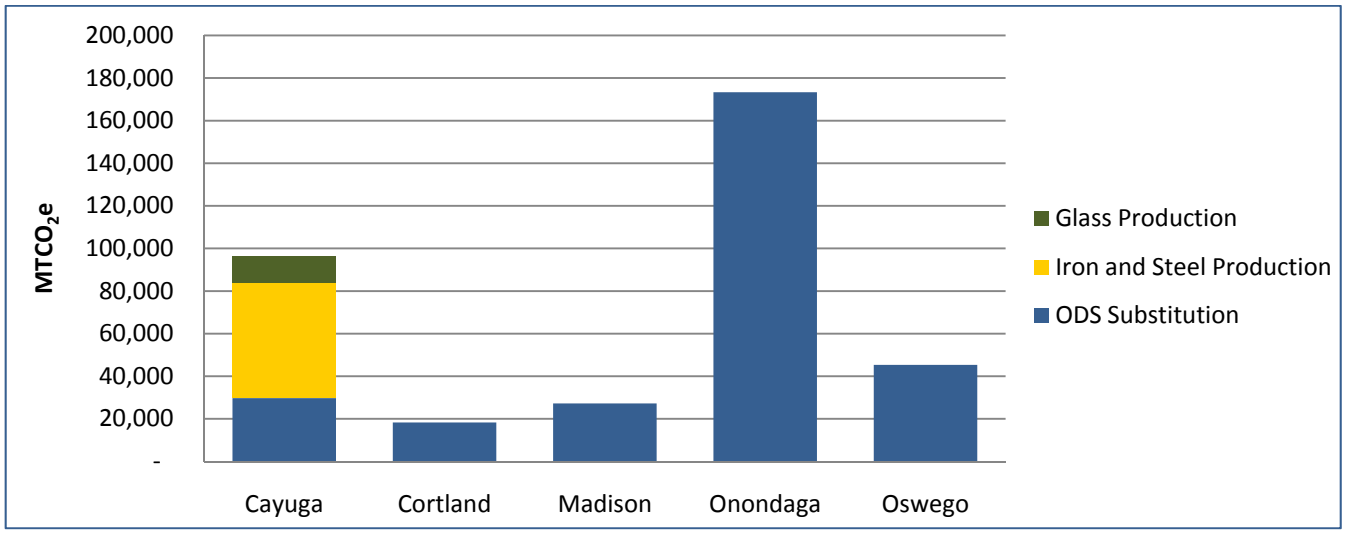
Table 23 – 2010 Industrial Process GHG Emissions by Industrial Activity (MT CO_2e)

County	Iron and Steel Production	Glass Production	ODS Substitution	Total	Percent of total
Cayuga	54,218	12,541	29,704	96,463	27%
Cortland	0	0	18,313	18,313	5%
Madison	0	0	27,260	27,260	8%
Onondaga	0	0	173,350	173,350	48%
Oswego	0	0	45,324	45,324	13%
Central New York Total	**54,218**	**12,541**	**293,951**	**360,710**	**100%**
Percent of Total	*15%*	*3%*	*81%*	*100%*	

Note: Totals may not sum due to independent rounding.

[30] Dataset is available at: http://epa.gov/climatechange/emissions/ghgdata/index.html
[31] U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2010, Table 4-1, http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2012-Chapter-4-Industrial-Processes.pdf
[32] U.S. Census Bureau, 2012, State and County QuickFacts – USA. http://quickfacts.census.gov/qfd/states/00000.html.

Figure 13 – 2010 Industrial Process Emissions by Process and County ($MTCO_2e$)



7. Agriculture

The Agriculture sector of the Central New York regional inventory includes non-carbon dioxide emissions from enteric fermentation in domestic livestock, livestock manure management, and agricultural soil management (including fertilizer application). Carbon dioxide emissions are not included as they are assumed to be biogenic and don't represent an anthropogenic emission source. The primary agricultural industry in the region is dairy industry, along with other livestock production. The primary crops in the region are corn (for grain and silage), and soybeans.

Data & Methods

Data on 2010 livestock populations and crop productions were available for New York State on the county-level from USDA's National Agricultural Statistics Service (NASS).[33] Livestock populations for 2010 included beef cows, milk cows, and all cattle (including calves). Calf populations were estimated by assuming that calves account for 17.4 percent of the total non-dairy cattle/cow population.[34] Data for crop production in Central New York counties covered hay alfalfa, corn for grain, wheat, oats, and soybeans.

Data from EPA's Regional GHG Inventory Guidance on livestock population percentage breakdowns in New York State were also used to allocate dairy cattle and beef cattle populations into sub-categories. The subcategories for dairy cattle are dairy cows and dairy replacement heifers.[35] The subcategories for beef cattle are beef cows, beef replacement heifers, heifer stockers, steer stockers, feedlot heifers, feedlot steer, and bulls.[36]

[33] USDA, 2012, National Agricultural Statistics Service, QuickStats. Data downloaded for All livestock items and All crops; Location: New York / All Counties. http://www.nass.usda.gov/QuickStats/.
[34] Because calf data are not split out at the county level, assumed statewide 17.4 percent applies.
[35] From Table A-24 of EPA's Regional GHG Inventory Guidance. Dairy cow population percentages by state, 2006.
[36] From Table A-25 of EPA's Regional GHG Inventory Guidance. Beef cow population percentages by state, 2006.

Fertilizer sales data came from the New York State Department of Agriculture and Markets dataset of total fertilizer and nutrients by county for calendar year 2010. For each county, the dataset included total fertilizer sales, broken into single, multi-nutrient, and other; Total N, P205, and K20 in multiple-nutrient fertilizer, and total N, P205, and K20 in all fertilizer.

County-level emissions for agriculture were calculated using EPA's State Inventory Tool (SIT), using default emission factors for New York State.

To calculate emissions from enteric fermentation and manure management, the tool requires population information for each livestock subcategory. Total county milk cow population and beef cow population from NASS were multiplied by the percentage breakdowns from EPA's Regional GHG Inventory Guidance to derive subcategory populations. The tool then multiplies the number of animals by a per-head enteric CH_4 emission factor to estimate total enteric fermentation emissions for each county. The tool multiplies the subcategory populations by New York defaults for Typical Animal Mass (TAM), volatile solids (VS), and methane conversion factors for different manure management systems to estimate CH_4 emissions from manure management and by TAM, K-Nitrogen factors, and nitrogen emission factors for different manure management systems to estimate N_2O emissions from manure management.

To calculate emissions from management of agricultural soils, the SIT follows three steps. The tool first calculates emissions from plant residues, and allows input of crop production data for 21 crop types. Six of these crop types are grown in the Central New York region: Alfalfa (pulled from NASS as "Hay Alfalfa (Dry)"), corn for grain, wheat, oats, and soybeans. The tool multiplies these production amounts by a series of factors, including residue dry matter fraction, fraction residue applied, and nitrogen content of residue to calculate the amount of nitrogen returned to soils and the amount of nitrogen fixed by crops.

The second step of calculating emissions from agricultural soil management estimates emissions from plant fertilizer application. The tool uses the total amounts of fertilizer nitrogen by type (synthetic fertilizers, dried blood, compost, dried manure, activated sewage sludge, other sewage sludge, tankage, or other organic amendments) to estimate direct and indirect N_2O emissions from fertilizer applications. For each county, the total N in all fertilizer types from the New York State dataset was entered into the tool under "Synthetic Fertilizer" to estimate fertilizer emissions.

Finally, the SIT calculates agricultural soil emissions from animals and runoff. This step uses the livestock population data entered under enteric fermentation and manure management and New York state default distributions of livestock management systems (e.g. managed systems, pasture, and daily spread) along with built-in emission factors to estimate N_2O emissions.

Results

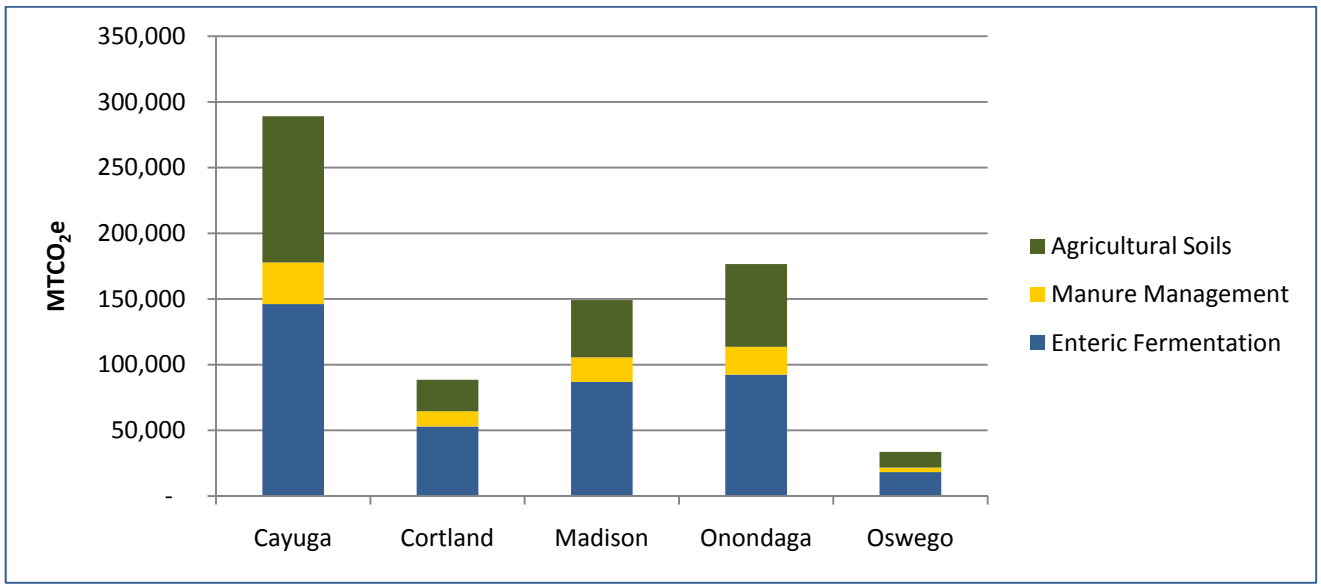
Agriculture emissions in CNY are approximately 736,914 $MTCO_2e$. Emissions are shown in Table 24 and Figure 14. Cayuga County, with the highest population of dairy and beef cows and the most crop production, has the largest emissions in the region, accounting for 39 percent of agriculture emissions. Onondaga and Madison counties follow in terms of livestock populations, crop production, and emissions.

Table 24 – 2010 Agriculture Emissions by Source ($MTCO_2e$)

	Enteric Fermentation	Manure Management	Agricultural Soils	Total	Percent of Total
Cayuga	146,160	31,609	111,330	289,098	39%
Cortland	52,894	11,666	23,922	88,483	12%
Madison	86,862	18,694	43,592	149,148	20%
Onondaga	92,451	21,185	62,944	176,580	24%
Oswego	18,224	3,391	11,991	33,606	5%
Central New York Total	**396,591**	**86,544**	**253,780**	**736,914**	**100%**

Note: Totals may not sum due to independent rounding.

Figure 14 – 2010 Agricultural Emissions by County and Source ($MTCO_2e$)



8. Land Use, Land-Use Change and Forestry

Land Use, Land-Use Change and Forestry (LULUCF) measures changes to forest carbon stocks. This measurement reflects the impact of changes in land use on the capacity of forests in the Central New York Region to sequester carbon.

This source is considered "optional" under the guidance of the NYGHG Working Group and is not included in the region's gross emission totals. It is included here for informational purposes due to the importance of forest resources to the region.

Data & Methods

Two datasets were collected to calculate net emissions from LULUCF: (1) the acres of forested land by county in 2005 and 2010 and (2) the carbon sequestration rates for forests in the region.

The acres of forested land were retrieved from the U.S. Forest Service's Forest Inventory and Analysis database via the Forest Inventory Data Online (FIDO) website.[37] Data were originally pulled by county by forest-type group for 1993, 2005 and 2010. The three data samples revealed some inconsistencies in the identification of specific forest-type groups. However, the differences between the total forested area per county demonstrated reasonable changes in acreage. Therefore, to minimize the influence of data sample errors, the calculations were based on the total forested area for each county, and not forest-type groups.

To minimize another source of potential data collection error, the 2005 and 2010 sample years were selected. This decision was based on the fact that the average annual change was more likely to be similar over a shorter time frame and that data collection methodology is more likely to have changed between the 1993 and 2010 data collection than the 2005 and 2010 samples.

The second set of data, the carbon sequestration rates for forested land in the eight counties was retrieved from the Carbon OnLine Estimator (COLE).[38] The composite rate for "All" forest-type groups in the Central New York region counties was selected, and the resulting output was 185 metric tons Carbon per hectare. This is a weighted rate that reflects the distribution of forest-type groups in the region. Only some of the forest-type groups had specific sequestration rates. This composite rate was used for all forest-types in the counties.

Calculations estimated the average annual rate of change for carbon sequestration in the counties. The methodology included a four step calculation:

(1) Subtracted the 2005 acres of forest per county from the 2010 acres of forest per county.

(2) Divided the change by five (years) to get the annual rate of change in acres.

(3) Converted acres of forest to hectares.

(4) Multiplied the annual rate of change in hectares by the composite carbon sequestration rate.

(5) Converted carbon sequestered/released to carbon dioxide by multiplying by 44/12 (g CO_2/g C).

Results

Land use changes in the Central New York region in 2010 resulted in a net sequestration of 2,942,162 $MTCO_2e$. Results by county are shown in Table 25. Madison and Onondaga Counties showed net emissions from LULUCF while Cayuga, Cortland, and Oswego Counties had net carbon sequestration from LULUCF. These net carbon emissions are driven by the change in forested acres in each county between 2005 and 2010. As shown in Figure 15, counties that gained acres of forest in that period were carbon sinks in 2010 and counties that lost acres of forest were carbon sources.

[37] US Forest Service, FIA Program: Forest Inventory Data Online, http://apps.fs.fed.us/fido/

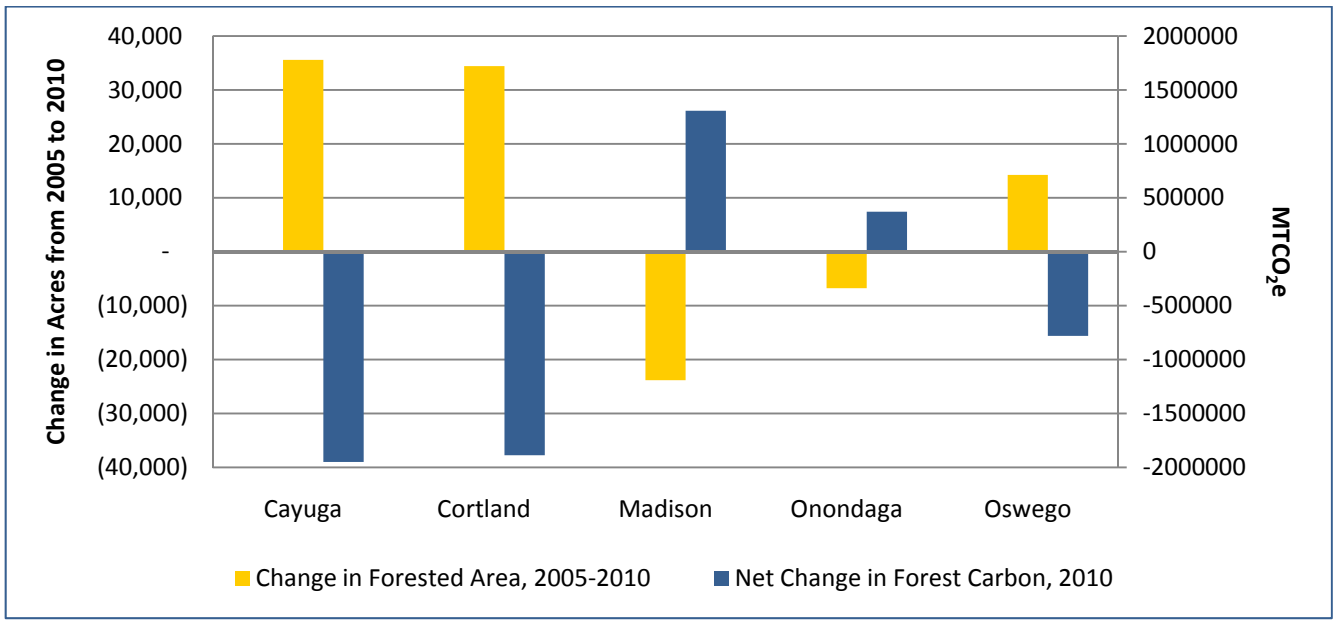
[38] Carbon OnLine Estimator (COLE) data are based on USDA Forest Service Forest Inventory & Analysis and Resource Planning Assessment data, http://www.ncasi2.org/COLE/

Table 25 – 2010 Net Change in Forest Carbon Stocks ($MTCO_2e$)

	Total Net Change in Forest Carbon Stocks ($MTCO_2e$)
Cayuga	(1,950,565)
Cortland	(1,888,264)
Madison	1,306,939
Onondaga	371,225
Oswego	(781,498)
Central New York Total	**(2,942,162)**

Note: Totals may not sum due to independent rounding.

Figure 15 – 2005-2010 Net Change in Forested Acres and 2010 Net Change in Forest Carbon from LULUCF ($MTCO_2e$)



9. Municipal-Level Allocation

9.1. Municipal-Level Allocation

In addition to the regional GHG inventory presented above, this analysis included a municipal-level allocation of regional emissions. The inventory team allocated the region's emissions to individual towns, cities, and villages based on available data. This effort is intended to provide municipalities with baseline information about their community-level GHG emissions. Because it was not feasible to develop bottom-up GHG inventories for each of the region's 148 cities, towns, and villages, the allocation process was driven by readily available demographic and geographic data. A detailed, bottom-up inventory would likely provide more reliable results for any one community, but these estimates serve as a useful resource for those communities unable to complete their own GHG inventories. The challenges and limitations of this process are described below, followed by a description of the methods for each sector. The results are presented in county tables at the end of this report, and may also be viewed in the inventory municipal allocation spreadsheet that accompanies this report.

Municipal Boundaries

The Central New York region is comprised of 6 cities and 94 towns, in addition to 47 villages that lie within them. The region is also home to the Onondaga Nation Reservation, for a total of 148 municipalities. This municipal allocation reports total estimates for each city and town, *including* activity in the underlying villages. Activity and emissions for each village are also tracked and reported separately, but not counted in the totals.

Some sectors, however, report activity data for towns *excluding* village activities. In these cases, the primary means of assigning villages to towns is based on information from the New York State Data Center, which provides information on which villages lie within each town.[39] When activity data are reported for towns (excluding villages) and villages, the town activity data are added with those of the village(s) within it. However, five villages in the Central New York region are split between towns. To assign reported village activity data to the correct towns, the percentage of the village's population in each town is used. This population breakdown is available from the New York State Data Center.[40] The split activity data are then included in the totals for each town as appropriate.

9.2. Challenges

Data Limitations and Unallocated Portion

As expected at the outset of this process, it was not practical to fully allocate all emissions from each sector in the region. The team allocated those sources where available local-level activity data could be used to reasonably approximate the spatial distribution of emissions. In cases where no such data were available or such allocation would not be appropriate, regional emissions were not allocated to the local level. Specifically, emissions from Scope 1 electricity generation, rail transportation, marine transportation, air transportation, and LULUCF have not been allocated to the municipal level for this inventory. It would be possible to allocate sources such as aviation based on a survey of passenger air travel habits by municipality, but conducting such a survey was beyond the scope of this analysis. In addition, portions of industrial fuel combustion emissions and off-road emissions have not been allocated to the municipal level.

---

[39] New York State Data Center, Estimates of the Resident Population: New York State Governmental Units, 2000 to 2009 – Revised September 2010, http://www.empire.state.ny.us/NYSDataCenter/Data/Population_Housing/REVISED2000to2009SubcountyTotals.pdf

[40] Ibid.

The percentage not allocated by sector is shown below in Table 26. Furthermore, Scope 1 emissions from electricity generation—which were calculated for informational purposes but not included in the regional total—were not included in the municipal allocation.

Table 26 – Percentage of Emissions Not Allocated, by Sector

Category	Allocated to Municipalities?	Percentage Not Allocated
Stationary Energy Consumption		**4%**
Residential	Yes	N/A
Commercial	Yes	N/A
Industrial	Partially	14%
Energy Supply	Partially	0%
Mobile Energy Consumption		**12%**
On-Road	Yes	N/A
Air	No	100%
Marine	No	100%
Rail	No	100%
Off-Road	Partially	39%
Waste Management		**N/A**
Solid Waste	Yes	N/A
Wastewater Treatment	Yes	N/A
Industrial Processes	**Yes**	**N/A**
Agriculture	**Yes**	**N/A**
LULUCF	No	100%
Across All Sectors		**7%**

Village Allocation

Although village populations are also included within town population estimates, the inventory has allocated to the village level, where possible. Because there is overlap between towns and villages, these allocations should not be viewed additively. For example, three villages could be part of one town; the emissions allocated to each village should not be viewed as mutually exclusive from the town, but are also included in the town's emissions estimates. However, there is value in understanding emissions from each village for facilitating planning activities to target reducing emissions from specific sectors and locales.

9.3.Methods by Sector

9.3.1. Stationary Energy Consumption

Electricity-Scope 1

Electricity generation emissions were not allocated to the municipal level, as they are not counted in county emission totals.

Electricity-Scope 2

Electricity consumption emissions were calculated "bottom-up" at the municipal level based on utility data. Utilities provided total electricity consumption by municipality. The data fully cover 143 municipalities. For the locations fully served by the utility, the reported usage for that area (in MWh) serves as the full electricity data

for that town or village. For areas only partially covered by the utility data or not covered at all, different methodologies were used for each sector to estimate the missing consumption data.

For residential electricity, estimates of residential electricity consumption for each municipality were used, based on the approach described for Scope 1 fuels below. Similarly, for commercial electricity, estimates of commercial electricity consumption for each municipality were used, based on the commercial fuels method described below. For the industrial sector, only reported utility data were used because no proxy data (such as industrial employment) were available to apportion industrial activity to the municipal level.

Electricity usage information from the utilities separated usage between non-village components of towns and villages. To aggregate all activity data to the city and town level (to include village activity), the method of assigning villages and village components to towns, described in Section 9.1, was used. Electricity usage in MWh was then converted to MMBTU and emissions using the 2009 eGRID emission factors for the NYUP eGRID subregion.

Fuels – Scope 1

Residential fuel consumption at the municipal level was calculated using the same methodology described in the main inventory text, based on Census data for housing units, heating fuel use, and statewide residential fuel consumption. See Section 3.3 for details. Electricity or natural gas utility data for each municipality, if available, overrode these estimates.

County-level commercial fuel emissions were allocated to the municipal level based on occupied housing units. The proportion of each county's occupied housing units in each municipality was multiplied by the county-level fuel consumption for each fuel type to get fuel consumption in each municipality. Then emission factors were applied to fuel consumption.

Industrial fuel consumption at the municipal level is based on reported data from three sources: EPA's Greenhouse Gas Reporting Program industrial facilities, the New York State Department of Environmental Conservation (NYS DEC) Title V facilities database, and electric and natural gas utility data. Industrial stationary combustion emissions from any GHGRP or Title V facilities within a municipality were assigned to that municipality. For natural gas combustion, utility data override GHGRP/Title V facilities data if both are available. The estimated emissions for consumption not covered by these three sources were not allocated due to the lack of sufficient local level data.

Energy Supply

Electricity and natural gas transmission and distribution emissions at the municipal level were calculated using the same methodology as at the county level. Electricity and natural gas consumption for each municipality was multiplied by a transmission and distribution loss factor and converted to emissions. SF_6 emissions were also calculated in the same manner for municipalities as for counties, using municipal-level electricity consumption multiplied by the SF_6 loss rate in $MTCO_2e$ per MWh. See Section 3.4 for details.

9.3.2. Transportation

For the transportation sector, on-road motor vehicle activity and off-road terrestrial vehicle activity have been allocated to the town level. However, due to lack of data and solid methodological options, rail, marine, and air subsectors have not been similarly allocated.

On-Road Transportation

On-road emissions in Central New York were allocated to municipalities based on the number of occupied housing units (households) in cities, towns, and villages adjusted based on the journey-to-work mode preference. Household data were obtained from the American Communities Survey 5-year estimates on

selected housing characteristics, as were journey-to-work percentages. First, the weighted proportion of commuters driving alone was calculated for each municipality and each county:

$$Weighted\ drive\ alone\ \% = Drive\ alone\ \% + \frac{two\ person\ Carpool\ \%}{2} + \frac{three\ person\ Carpool\ \%}{3} + \frac{four\ or\ more\ person\ Carpool\ \%}{4}$$

Next, the weighted proportion of commuters driving alone was normalized by dividing by the county-wide average for each county to provide a "journey-to-work factor" (JTWF, in the equation below). Municipal on-road emissions were estimated by multiplying the county-level emission estimates by a weighting based on the number of households within each municipality and the prevalence of vehicle use for commuting relative to the rest of the county:

$$Emissions_{Municipality} = Emissions_{County} \times \frac{(\#Households \times JTWF)_{Municipality}}{\sum(\#Households \times JTWF)_{All\ Munipalities\ in\ a\ County}}$$

Off-Road Transportation

The methodologies for allocating off-road emissions to the municipal level vary by equipment type.

Emissions from recreational and logging equipment were allocated based on the inverse of population density, given the assumption that these types of equipment are more common in areas with more space available per person. The population density was normalized to the county average by dividing the inverse of the log of the each municipality's population density by the inverse of the log of the county's population density. The normalized population density was multiplied by the municipality's 2010 population. This was divided by the sum of the products of the population and normalized density of towns and cities to find the proportion of population density with respect to the county. The proportion was multiplied with the county's emissions from recreational and logging equipment. The net result of this weighting is that usage was weighted by population, but given a higher weighting in places with low population density, and a lower weighting in places with high population density.

Emissions from construction and mining equipment were allocated based on population. The municipalities' population proportions within their respective county were multiplied by the county's emissions from construction and mining equipment.

Residential and commercial lawn and garden equipment emissions were apportioned based on the number of single family housing units. The number of total single family detached and attached housing units within the municipality was divided by the total within their respective county. The housing unit proportion was multiplied with the county's emission from residential and commercial lawn and garden equipment.

Emissions from commercial equipment were allocated based on commercial fuel emissions. The commercial fuel emission from each municipality was divided by the total emissions from their respective county. The commercial fuel proportion was multiplied with the county's emission from commercial equipment.

Emissions from industrial, agricultural, airport, and railroad equipment, which account for 39 percent of off-road emission in the region, were not allocated at the municipal level due to lack of available data or method to do so.

9.3.3. Waste Management

Solid Waste

Scope 1 solid waste emissions were allocated to municipalities based on location of the landfill facilities. Scope 1 emissions are not included in the allocation *totals* for solid waste, however, to avoid double-counting. Scope 3 emissions were allocated to municipalities based on Census-derived populations. The towns, cities, and villages' population proportions within each of their respective counties were multiplied by the county's overall Scope 3 emissions.

Wastewater

Wastewater emissions were allocated to municipalities based on Census-derived populations. The proportion of the county population residing in each town, city, and village was multiplied by their respective county's CH_4 and N_2O emissions to obtain municipal-level wastewater emissions.

9.3.4. Industrial Processes

Industrial process emissions at the municipal level were calculated using the same methodology as calculating emissions at the county level (see Section 6). The two facilities in the region with industrial process emissions, Nucor Steel Auburn Inc. and Owens-Brockway Glass Container Inc. Plant #35, are both located in Auburn, New York, and their emissions were assigned to that city. Emissions from ODS substitution were calculated for each municipality based on population and the implied per capita ODS emission factor.

9.3.5. Agriculture

Emissions from the agricultural sector were apportioned to the municipal level using GIS-based land use data from the USDA's National Agricultural Statistics Service.[41] The dataset provides land area by crop type throughout the United States. Using this dataset, the area of each land use type within the Central New York municipalities was determined.

To apportion emissions, first, the relevant land use types were determined. For Ag Soils, the land uses for the crop types grown in CNY and calculated in the State Inventory Tool were used. These crop types are Alfalfa, Corn, Winter Wheat, Oats, and Soybeans. The sum of the land area for each of these crops for each municipality was considered its "Ag Soils Land Area."

For livestock emissions (Manure Management and Enteric Fermentation in the SIT), land area categorized as "Pasture/Grass" was used to determine the "Livestock Land Area."

Finally, total agricultural emissions (Ag Soils Emissions plus Livestock emissions) for each municipality were determined using the equations below:

$$Ag\ Soils\ Emissions_{Municipal} = Emissions_{County} \times \frac{Ag\ Soils\ Land\ Area_{Municipal}}{Ag\ Soils\ Land\ Area_{County}}$$

$$Livestock\ Emissions_{Municipal} = Emissions_{County} \times \frac{Livestock\ Land\ Area_{Municipal}}{Livestock\ Land\ Area_{County}}$$

[41] USDA National Agricultural Statistics Service Cropland Data Layer. 2010 Published crop-specific data layer. Available at http://nassgeodata.gmu.edu/CropScape

9.4.Results

Emissions for each municipality by sector are presented in Table 27 through Table 31, organized by county. Emissions in the Stationary Energy sector include both electricity consumption and Scope 1 stationary fuel combustion. Note that totals may not sum due to independent rounding.

Table 27 – Cayuga County Municipalities; Total Allocated Emissions by Municipality and Sector ($MTCO_2e$)

		Stationary Energy										
Municipality	Type	Residential	Commercial	Industrial	Mobile Energy	Solid Waste	Wastewater Treatment	Industrial Processes	Agriculture	Energy Supply	Total, All Sectors	Emissions per Capita
Auburn	City	77,902	72,445	102,628	128,360	10,378	2,694	77,035	836	25,356	497,633	18
Aurelius	Town	8,257	9,798	2,008	14,462	1,046	272	1,036	23,085	1,549	61,514	22
Brutus	Town	13,004	6,120	126	20,778	1,673	434	1,657	9,636	1,390	54,819	12
Cato	Town	7,873	3,287	0	11,725	951	247	942	12,169	522	37,716	15
Conquest	Town	5,320	1,895	0	7,236	682	177	675	11,065	320	27,371	15
Fleming	Town	9,282	1,918	17	12,596	988	256	978	12,632	747	39,415	15
Genoa	Town	5,752	4,545	4	8,690	725	188	718	18,270	504	39,397	20
Ira	Town	7,591	3,925	0	12,803	827	215	819	11,838	505	38,523	17
Ledyard	Town	4,631	2,772	417	3,966	707	183	700	16,784	368	30,528	16
Locke	Town	5,141	937	4	7,443	731	190	724	9,337	303	24,810	13
Mentz	Town	6,131	3,143	65	9,388	891	231	883	7,442	681	28,854	12
Montezuma	Town	3,310	650	132	4,685	479	124	474	8,569	228	18,650	15
Moravia	Town	7,307	8,513	434	10,593	1,359	353	1,346	13,656	1,328	44,889	12
Niles	Town	3,357	1,177	0	4,549	448	116	443	18,087	203	28,380	24
Owasco	Town	13,733	5,385	0	18,615	1,422	369	1,408	9,249	1,770	51,952	14
Scipio	Town	5,406	2,307	0	7,046	642	167	636	18,183	345	34,732	20
Sempronius	Town	2,189	859	6	3,311	335	87	332	6,134	138	13,391	15
Sennett	Town	10,264	9,409	12,434	13,720	1,347	350	1,334	14,544	2,507	65,910	18
Springport	Town	6,874	2,959	248	9,904	887	230	879	12,270	736	34,986	15
Sterling	Town	8,538	3,815	0	13,450	1,139	296	1,128	8,095	579	37,040	12
Summerhill	Town	2,869	1,092	0	4,138	456	118	452	8,753	175	18,053	15
Throop	Town	5,733	691	2	7,559	746	194	739	12,542	433	28,639	14
Venice	Town	3,958	2,296	0	4,786	513	133	508	16,182	309	28,683	21
Victory	Town	5,374	2,293	0	9,643	622	161	616	9,741	345	28,796	17

Municipality	Type	Stationary Energy			Mobile Energy	Solid Waste	Wastewater Treatment	Industrial Processes	Agriculture	Energy Supply	Total, All Sectors	Emissions per Capita
		Residential	Commercial	Industrial								
Allocated Total		229,796	152,234	118,524	349,444	29,995	7,786	96,462	289,098	41,340	1,314,679	16
Village emissions, included in town totals												
Aurora	*Village*	1,028	1,454	22	410	271	70	269	301	133	3,959	5
Cato	*Village*	1,461	863	0	2,537	199	52	197	0	113	5,423	10
Cayuga	*Village*	1,311	554	25	2,184	206	53	204	587	198	5,321	10
Fair Haven	*Village*	2,688	1,265	0	3,897	279	72	277	386	191	9,055	12
Meridian	*Village*	788	317	0	1,101	116	30	115	269	45	2,781	9
Moravia	*Village*	3,771	3,502	433	5,314	481	125	476	0	656	14,756	12
Port Byron	*Village*	3,319	2,058	0	4,645	484	126	479	306	504	11,920	9
Union Springs	*Village*	3,543	2,363	246	4,472	449	116	444	1,697	581	13,912	12
Weedsport	*Village*	4,862	3,506	79	7,435	680	177	674	287	834	18,533	10

Table 28 – Cortland County Municipalities; Total Allocated Emissions by Municipality and Sector ($MTCO_2e$)

Municipality	Type	Stationary Energy			Mobile Energy	Solid Waste	Wastewater Treatment	Industrial Processes	Agriculture	Energy Supply	Total, All Sectors	Emissions per Capita
		Residential	Commercial	Industrial								
Cortland	City	36,732	49,049	13,036	102,193	11,322	1,868	7,128	166	10,915	232,409	12
Cincinnatus	Town	2,673	1,844	0	5,430	623	103	392	5,339	232	16,635	16
Cortlandville	Town	21,037	20,510	36,423	58,989	5,017	828	3,158	11,775	7,545	165,282	19
Cuyler	Town	1,666	1,004	0	5,713	578	95	364	5,717	135	15,273	16
Freetown	Town	1,804	742	0	3,795	446	74	281	6,423	126	13,690	18
Harford	Town	2,413	1,769	0	5,910	556	92	350	2,596	209	13,896	15
Homer	Town	17,275	6,936	793	41,292	3,776	623	2,377	10,732	2,081	85,885	13
Lapeer	Town	1,553	834	0	3,448	452	75	285	5,296	127	12,069	16
Marathon	Town	3,547	2,616	17	14,597	1,160	191	730	7,831	324	31,013	16

Municipality	Type	Stationary Energy			Mobile Energy	Solid Waste	Wastewater Treatment	Industrial Processes	Agriculture	Energy Supply	Total, All Sectors	Emissions per Capita
		Residential	Commercial	Industrial								
Preble	Town	3,580	2,715	0	10,227	821	136	517	3,965	292	22,253	16
Scott	Town	2,955	1,568	0	8,873	693	114	437	2,903	208	17,751	15
Solon	Town	2,680	1,322	0	7,633	636	105	401	3,708	181	16,666	15
Taylor	Town	1,300	578	0	3,028	308	51	194	4,590	98	10,147	19
Truxton	Town	2,775	1,725	0	7,391	668	110	421	4,759	215	18,064	16
Virgil	Town	6,081	2,859	0	13,808	1,416	234	891	8,472	445	34,205	14
Willet	Town	2,265	944	0	5,003	615	101	387	4,210	152	13,678	13
Allocated Total		110,336	97,014	50,269	297,330	29,087	4,800	18,313	88,483	23,286	718,917	15
Village emissions, included in town totals												
Homer	*Village*	11,044	4,987	625	22,275	1,940	320	1,222	0	1,774	44,188	13
Marathon	*Village*	1,169	5,543	0	7,270	542	89	341	0	450	15,404	17
McGraw	*Village*	2,634	1,539	410	7,215	621	102	391	139	472	13,524	13

Table 29 – Madison County Municipalities; Total Allocated Emissions by Municipality and Sector ($MTCO_2e$)

Municipality	Type	Stationary Energy			Mobile Energy	Solid Waste	Wastewater Treatment	Industrial Processes	Agriculture	Energy Supply	Total, All Sectors	Emissions per Capita
		Residential	Commercial	Industrial								
Oneida	City	22,670	24,740	14,176	64,849	3,418	1,108	4,229	3,683	5,944	144,817	13
Brookfield	Town	6,208	2,901	4	13,823	764	248	945	10,056	376	35,323	14
Cazenovia	Town	19,733	8,827	1,546	38,082	2,126	689	2,630	13,191	2,216	89,041	13
DeRuyter	Town	4,081	1,554	130	7,053	477	155	590	5,907	387	20,334	13
Eaton	Town	9,075	13,816	68	14,675	1,577	511	1,951	12,746	1,800	56,218	11
Fenner	Town	4,056	2,003	72	9,079	518	168	641	9,296	230	26,062	15
Georgetown	Town	2,050	1,223	5	3,432	292	95	362	7,860	159	15,478	16
Hamilton	Town	14,158	6,630	8,788	19,830	2,007	651	2,483	11,719	1,642	67,908	10
Lebanon	Town	4,114	1,776	24	8,658	400	130	494	13,255	241	29,092	22
Lenox	Town	20,249	19,239	5,484	53,299	2,737	887	3,386	5,369	3,692	114,342	13

Municipality	Type	Stationary Energy			Mobile Energy	Solid Waste	Wastewater Treatment	Industrial Processes	Agriculture	Energy Supply	Total, All Sectors	Emissions per Capita
		Residential	Commercial	Industrial								
Lincoln	Town	5,634	1,683	552	11,087	604	196	747	7,044	203	27,750	14
Madison	Town	9,454	3,426	95	17,383	902	293	1,117	11,847	340	44,856	15
Nelson	Town	4,564	3,170	180	9,600	594	193	735	7,065	293	26,394	13
Smithfield	Town	3,191	1,533	14	5,748	386	125	478	8,667	201	20,343	16
Stockbridge	Town	5,553	2,814	777	12,287	631	205	781	11,016	413	34,476	16
Sullivan	Town	34,040	15,486	1,240	89,662	4,602	1,492	5,694	10,426	3,801	166,442	11
Allocated Total		168,828	110,821	33,154	378,547	22,034	7,145	27,260	149,148	21,939	918,876	13
Village emissions, included in town totals												
Canastota	*Village*	8,961	12,476	3,444	28,665	1,441	467	1,783	293	2,399	59,930	12
Cazenovia	*Village*	5,846	5,415	1,248	15,527	851	276	1,052	0	1,204	31,418	11
Chittenango	*Village*	6,491	6,454	758	29,759	1,524	494	1,886	204	1,274	48,845	10
DeRuyter	*Village*	1,687	939	130	1,965	167	54	207	0	293	5,443	10
Earlville	*Village*	2,730	1,097	24	5,286	262	85	324	161	140	10,108	12
Hamilton	*Village*	6,632	3,131	8,754	5,354	1,272	412	1,573	0	1,159	28,288	7
Madison	*Village*	1,323	695	0	2,356	92	30	113	0	75	4,683	15
Morrisville	*Village*	2,226	11,312	0	2,465	660	214	816	130	1,466	19,289	9
Munnsville	*Village*	926	1,710	614	2,003	142	46	176	236	266	6,119	13
Wampsville	*Village*	1,118	2,711	1,345	2,251	163	53	202	134	481	8,458	16

Table 30 – Onondaga County Municipalities; Total Allocated Emissions by Municipality and Sector ($MTCO_2e$)

Municipality	Type	Stationary Energy			Mobile Energy	Solid Waste	Wastewater Treatment	Industrial Processes	Agriculture	Energy Supply	Total, All Sectors	Emissions per Capita
		Residential	Commercial	Industrial								
Syracuse	City	224,459	209,827	162,587	599,387	4,412	14,123	53,884	483	63,225	1,332,387	9
Onondaga Nation	Reservation	55	52	0	86	14	46	174	0	12	438	1
Camillus	Town	56,034	24,524	5,830	130,619	735	2,351	8,970	6,569	8,506	244,137	10

Municipality	Type	Stationary Energy			Mobile Energy	Solid Waste	Wastewater Treatment	Industrial Processes	Agriculture	Energy Supply	Total, All Sectors	Emissions per Capita
		Residential	Commercial	Industrial								
Cicero	Town	66,389	32,706	11,651	169,831	961	3,077	11,741	3,654	10,529	310,541	10
Clay	Town	113,891	71,874	21,514	306,666	1,769	5,663	21,605	5,948	19,791	568,720	10
De Witt	Town	59,018	111,326	147,459	132,939	785	2,514	9,591	1,891	32,585	498,107	19
Elbridge	Town	16,327	6,429	10,377	30,155	180	576	2,198	10,553	2,584	79,380	13
Fabius	Town	6,709	4,701	337	11,263	60	191	729	11,892	731	36,612	19
Geddes	Town	37,626	36,629	155,752	94,298	520	1,665	6,354	314	19,857	353,015	21
LaFayette	Town	14,334	3,158	530	25,933	151	482	1,838	11,459	878	58,763	12
Lysander	Town	51,170	23,422	82,123	113,037	661	2,117	8,076	11,273	16,222	308,102	14
Manlius	Town	82,373	32,619	10,339	171,452	984	3,149	12,015	7,522	12,291	332,744	10
Marcellus	Town	18,069	6,808	7	31,005	189	604	2,305	13,251	2,219	74,458	12
Onondaga	Town	52,644	18,260	1,875	114,677	702	2,247	8,575	18,979	6,756	224,716	10
Otisco	Town	6,546	747	399	12,768	77	247	943	11,076	328	33,132	13
Pompey	Town	17,227	1,831	0	29,652	215	689	2,628	19,047	919	72,207	10
Salina	Town	68,352	57,206	39,366	195,050	1,025	3,280	12,512	251	16,590	393,633	12
Skaneateles	Town	22,733	17,618	2,475	34,183	219	701	2,676	17,747	4,166	102,519	14
Spafford	Town	6,092	413	0	10,451	51	164	626	10,207	180	28,182	17
Tully	Town	6,329	4,183	1,408	13,351	83	266	1,016	6,607	882	34,127	12
Van Buren	Town	37,559	34,324	2,029	78,964	401	1,283	4,894	7,857	7,855	175,164	13
Allocated Total		963,938	698,655	656,060	2,305,767	14,195	45,436	173,350	176,580	227,104	5,261,086	11
Village emissions, included in town totals												
Baldwinsville	*Village*	21,117	17,881	31,450	42,015	224	718	2,739	165	8,665	124,973	17
Camillus	*Village*	2,431	1,050	0	6,687	37	118	450	0	352	11,125	9
East Syracuse	*Village*	5,829	8,205	41,403	18,560	94	300	1,145	8	5,648	81,191	26
Elbridge	*Village*	3,268	1,889	61	5,158	32	103	393	0	558	11,463	11
Fabius	*Village*	1,296	987	94	2,311	11	34	131	0	153	5,017	14
Fayetteville	*Village*	12,016	5,538	1,223	24,307	133	425	1,623	16	1,944	47,224	11
Jordan	*Village*	3,531	1,566	2,448	5,634	42	133	508	259	702	14,822	11

Municipality	Type	Stationary Energy			Mobile Energy	Solid Waste	Wastewater Treatment	Industrial Processes	Agriculture	Energy Supply	Total, All Sectors	Emissions per Capita
		Residential	Commercial	Industrial								
Liverpool	*Village*	9,090	4,315	548	14,443	71	228	871	1	1,498	31,065	13
Manlius	*Village*	7,498	5,333	3,065	25,452	143	458	1,746	0	1,485	45,179	10
Marcellus	*Village*	5,033	2,981	0	8,896	55	176	673	0	805	18,619	10
Minoa	*Village*	6,605	2,601	401	18,092	105	336	1,280	22	938	30,379	9
North Syracuse	*Village*	25,836	23,411	821	42,766	207	662	2,524	5	5,466	101,697	15
Skaneateles	*Village*	8,666	7,989	0	13,037	74	238	909	0	1,798	32,711	13
Solvay	*Village*	27,346	22,729	108,909	39,265	200	641	2,444	10	12,175	213,719	32
Tully	*Village*	1,805	2,316	464	4,287	27	85	324	0	463	9,771	11

Table 31 – Oswego County Municipalities; Total Allocated Emissions by Municipality and Sector ($MTCO_2e$)

Municipality	Type	Stationary Energy			Mobile Energy	Solid Waste	Wastewater Treatment	Industrial Processes	Agriculture	Energy Supply	Total, All Sectors	Emissions per Capita
		Residential	Commercial	Industrial								
Fulton	City	20,260	24,764	9,180	55,446	731	1,157	4,416	42	5,066	121,063	10
Oswego	City	34,845	29,964	41,722	84,888	1,114	1,765	6,734	0	11,122	212,155	12
Albion	Town	4,570	2,034	0	8,025	127	202	769	777	274	16,778	8
Amboy	Town	3,418	1,272	0	6,648	78	123	469	700	184	12,892	10
Boylston	Town	1,088	409	0	2,077	34	53	204	411	64	4,340	8
Constantia	Town	13,934	4,741	323	22,710	305	484	1,846	739	757	45,839	9
Granby	Town	15,876	4,395	1,319	33,666	419	664	2,532	3,378	1,192	63,440	9
Hannibal	Town	11,139	2,890	815	21,287	298	472	1,802	2,657	558	41,918	9
Hastings	Town	23,030	8,217	1,328	44,551	580	919	3,508	1,967	1,962	86,063	9
Mexico	Town	12,818	6,159	1,227	26,285	319	506	1,929	3,622	1,217	54,081	10
Minetto	Town	4,765	1,072	132	8,383	102	161	616	165	575	15,971	10
New Haven	Town	6,622	1,119	0	12,058	175	278	1,060	789	219	22,321	8
Orwell	Town	2,866	1,048	0	5,647	72	114	433	771	148	11,099	10

Municipality	Type	Stationary Energy			Mobile Energy	Solid Waste	Wastewater Treatment	Industrial Processes	Agriculture	Energy Supply	Total, All Sectors	Emissions per Capita
		Residential	Commercial	Industrial								
Oswego	Town	10,577	2,615	0	13,270	490	777	2,963	1,210	950	32,852	4
Palermo	Town	8,759	3,201	0	16,904	225	356	1,360	1,875	497	33,178	9
Parish	Town	6,252	2,745	351	12,085	157	249	949	686	373	23,846	9
Redfield	Town	1,426	569	0	3,234	34	54	204	345	82	5,946	11
Richland	Town	12,682	10,839	980	28,100	351	556	2,122	3,431	1,704	60,766	11
Sandy Creek	Town	9,669	2,618	589	17,718	242	383	1,462	2,131	659	35,472	9
Schroeppel	Town	18,741	7,151	922	38,449	522	827	3,155	3,414	1,741	74,922	9
Scriba	Town	14,628	3,907	7,179	33,309	420	665	2,539	1,037	1,550	65,234	10
Volney	Town	14,114	5,444	50,494	26,855	364	577	2,200	1,502	7,777	109,324	18
West Monroe	Town	10,997	1,721	0	19,058	261	414	1,578	1,323	400	35,753	8
Williamstown	Town	3,277	1,208	2,805	5,940	78	124	474	635	359	14,900	12
Allocated Total		266,351	130,101	119,367	546,595	7,500	11,880	45,324	33,606	39,430	1,200,154	10
Village emissions, included in town totals												
Altmar	*Village*	813	650	0	1,717	25	40	151	47	64	3,506	9
Central Square	*Village*	2,896	2,630	170	9,722	114	180	686	66	520	16,983	9
Cleveland	*Village*	2,477	913	0	4,174	46	73	278	21	128	8,111	11
Hannibal	*Village*	1,418	1,534	815	2,790	34	54	206	0	323	7,175	13
Lacona	*Village*	1,127	512	0	2,647	36	57	216	63	147	4,804	8
Mexico	*Village*	3,645	4,244	821	8,928	100	158	603	0	862	19,361	12
Parish	*Village*	1,128	798	0	2,003	28	44	167	0	84	4,252	9
Phoenix	*Village*	4,280	3,036	655	12,260	146	232	884	32	770	22,295	9
Pulaski	*Village*	4,609	5,985	980	11,817	145	230	878	150	1,131	25,925	11
Sandy Creek	*Village*	1,638	1,156	589	3,750	47	75	286	0	332	7,874	10

10. Emissions Forecast to 2030

10.1. County-Level Forecast

In addition to the regional GHG inventory and municipal-level allocation presented above, this analysis included a forecast of estimates to 2030 under a Business as Usual (BAU) scenario. The inventory team considered forecasting estimates at the municipal-level, however the projection drivers for each sector were not available at that level of granularity. The challenges and limitations of developing a forecast to 2030 are described below, followed by a description of the methods for each sector. The results are presented in county tables at the end of this report, and may also be viewed in the forecast spreadsheet that accompanies this report.

10.2. Challenges

Data Limitations

As expected at the outset of the forecasting process, most projection drivers do not extend beyond the 2020 timeframe. As a result, numerous annual growth rates were held constant through 2030. In addition, Scope 1 waste emissions were not projected as emissions from this source are pending future plans for the Cortland county landfill extension. The overall projection results for 2030 are shown below in Table 32.

Table 32 – 2010 Baseline and 2030 Projected Emissions ($MTCO_2e$), and Percent Change

Category	2010 Baseline Emissions ($MTCO_2e$)	2030 Projected Emissions ($MTCO_2e$)	2030 Percent Change
Electricity Generation*	**2,159,564**	**2,360,565**	**9.3%**
Energy Supply	**353,098**	**368,205**	**4.3%**
Stationary Energy Consumption	**2,652,101**	**2,664,849**	0.5%
Residential	1,227,911	1,043,881	-15.0%
Commercial	833,220	904,488	8.6%
Industrial	590,970	716,480	21.2%
Electricity Consumption	**1,406,418**	**1,403,638**	-0.2%
Residential	511,339	495,035	-3.2%
Commercial	355,604	404,128	13.6%
Industrial	539,475	504,475	-6.5%
Mobile Energy Consumption	**4,218,612**	**6,636,916**	57.3%
On-Road	3,663,556	5,975,612	63.1%
Off-Road	351,180	458,517	30.6%
Rail	85,049	103,008	21.1%
Marine	118,827	99,779	-16.0%
Air*	167,537	161,915	-3.4%
Waste Management	**179,859**	**209,797**	16.6%
Solid Waste(Scope 3)	102,812	133,353	29.7%
Wastewater Treatment	77,046	76,444	-0.8%
Industrial Processes	**360,710**	**360,106**	**-0.2%**
Glass Manufacture	12,541	12,859	2.5%
Iron & Steel Production	54,218	55,595	2.5%
ODS Substitutes	293,951	291,652	-0.8%
Agriculture	**736,914**	**538,257**	**-27.0%**
Across All Sectors	**9,907,712**	**11,821,662**	**19.3%**

*Not included in emissions total

10.3. Methods by Sector

10.3.1. Stationary Energy Consumption

Electricity-Scope 1

Electricity generation projections are based on projections on electricity generation from the New York Independent System Operator (NYISO) Gold Book from 2010. Since the majority of Central New York falls into the Zone C area (as classified by NYISO), the rate of increase for the region is consistent with the electricity generation forecast for this zone. The forecast only extends to 2020, and as a result, the growth rate from 2020 to 2030 is held consistent to the 2010 to 2020 growth rate. Emissions were increased for electricity generators at this same rate of growth.

Electricity-Scope 2

Electricity consumption emissions were calculated based on projections, by fuel type, from the Department of Energy's Annual Energy Outlook. Within this publication, electricity consumption is projected for the Mid-Atlantic Region through 2035. To determine projections for the Central New York Region, it was assumed that CNY electricity consumption relative to the Mid-Atlantic Region in 2010 will be equal to the same proportion in 2030. Consumption estimates were then converted into emission estimates based on the emission factors from the NYUP eGRID subregion.

For residential electricity, consumption estimates for each county were forecasted based on population growth for each county. For commercial and industrial electricity, these estimates were directly forecasted based on the projected consumption from the Annual Energy Outlook.

Fuels – Scope 1

Fuel consumption emissions were calculated based on projections, by fuel type, in the Department of Energy's Annual Energy Outlook. Within this publication, energy consumption is projected for the Mid-Atlantic Region through 2035. To determine projections for the Central New York Region, it was assumed that CNY consumption relative to the Mid-Atlantic Region in 2010 will be equal to the same proportion in 2030. This assumption was carried through to the residential, commercial, and industrial sectors. In addition, the projected fuel consumption by fuel type was distributed to the commercial and industrial sectors based on the projected employment in the county in 2030.

Energy Supply

Forecasted electricity and natural gas transmission and distribution emissions were projected by sector according to the projected natural gas and electricity consumption estimated under Electricity Scope 2, and Fuels Scope 1 above.

10.3.2. Transportation

For the transportation sector, on-road motor vehicle activity, off-road terrestrial vehicle activity, rail, marine, and aviation have been forecasted to 2030.

On-Road Transportation

On-road emissions in Central New York were projected based on the New York State Department of Transportation projections of vehicle miles traveled (VMT) to 2035. An emissions rate of 506.2 g CO_2/mile was assumed.

Off-Road Transportation

The methodologies for projecting off-road transportation vary by equipment type. Growth factors were assumed by equipment type, which are based on various emission drivers as shown in Table 33.

Table 33 – Off-Road Equipment Category and Estimated Growth Factor

Equipment Category	Driver	Calculated/Estimated Growth Factor
Agriculture	Agricultural Land	85%
Airport Support Equipment	Aviation Emissions	97%
Commercial Equipment	Population	99%
Construction and Mining	Population	99%
Industrial Equipment	Population	99%
Lawn & Garden	Population	99%
Logging	Population	99%
Railroad Equipment	Population	110%
Recreational Equipment	Population	99%
Recreational Marine	Population	99%

Rail

Emissions from freight rail in the region were forecasted by calculating projected ton-miles from 2010 to 2030 using the FHWA's Freight Analysis Network.[42] Using this online database tool, it was assumed that the origin and destination were equal to the "Remainder of New York" region. The resulting growth in rail was used to project emissions to 2030. For passenger rail, it was assumed that there was an annual growth of 2 percent, which translated into 40 percent over the 30 year projection timeframe.

Marine

Emissions from marine in the region were forecasted by calculating projected ton-miles from 2010 to 2030 using the FHWA's Freight Analysis Network. Using this online database tool, it was assumed that the origin and destination were equal to the "Remainder of New York" region. The resulting change in marine transport was used to project emissions to 2030.

Aviation

Emissions from aviation in the region were forecasted by assuming the same projection rate as the Mid-Atlantic jet fuel consumption from 2010 to 2030. This projection found a 3 percent decrease in fuel consumption across the projection timeframe.

10.3.3. Waste Management

Solid Waste – Scope 1

Scope 1 waste emissions were not projected as emissions from this source are pending future plans for the Cortland county landfill extension.

[42] http://ops.fhwa.dot.gov/freight/freight_analysis/faf/faf3/netwkdbflow/index.htm

Solid Waste – Scope 3

Scope 3 solid waste emissions were projected based on historic per capita waste generation rates for the state, developed from state population and total waste generated. The estimate subtracted any amount of waste combusted- which applied to Onondaga and Oswego counties. The estimate relies on a first order decay (FOD) model that estimates the potential CH_4 emissions that occur during the inventory year, but are associated with the waste landfilled over the past thirty years.

Wastewater

Wastewater emissions were projected according to forecasted population estimates to 2030.

10.3.4. Industrial Processes

Industrial process emissions at the county level were calculated for iron and steel production, glass production, and ODS substitution. For iron and steel production, the forecasted emissions were dependent on the projected emissions from iron and steel in the state, calculated from the New York State Climate Action Plan.[43] Due to lack of projection data for the glass industry, it was assumed that glass manufacturing increased at the same rate of the iron and steel industry. Projected ODS substitute emissions were calculated based on projected population in the region.

10.3.5. Agriculture

Emissions from the agricultural sector were projected based on historical changes in crop land and cattle populations. For Agricultural Soils, it was assumed that the 2002 to 2007 observed trend in crop land from the USDA National Agriculture Statistics Service (NASS) would hold true through 2030. Similarly, for manure management and enteric fermentation, it was assumed that the 2002 to 2007 observed trend for livestock population would hold true through 2030 as well.

[43] New York State Climate Action Plan: http://www.dec.ny.gov/energy/80930.html