2019 TOMPKINS COUNTY COMMUNITY GREENHOUSE GAS EMISSIONS AND ENERGY USE INVENTORY

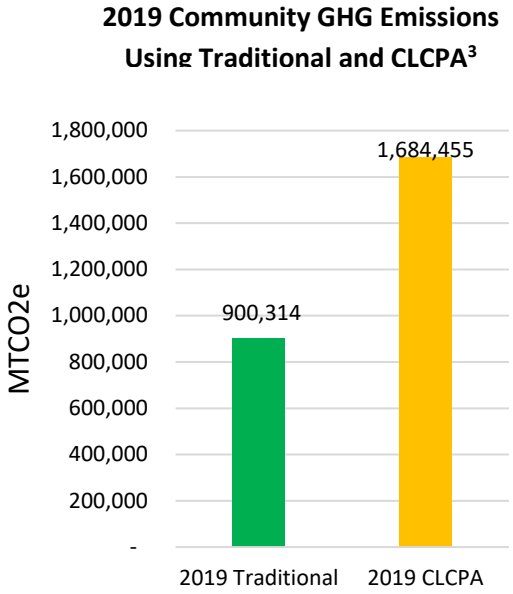
February 2021

TOMPKINS COUNTY DEPARTMENT OF PLANNING AND SUSTAINABILITY

Executive Summary

This Tompkins County Community Greenhouse Gas Emissions Inventory[1] was developed at a time when greenhouse gas (GHG) accounting methods are poised for changes that have not yet been incorporated into existing protocols and software. As a result, this Inventory tells two distinct stories: Narrative 1 compares the 2019 GHG emissions from community activities using two different methods — the traditional GHG accounting method and the new method anticipated to be adopted in New York State as part of implementing the Climate Leadership and Community Protection Act (CLCPA); Narrative 2 explores the details of the 2019 GHG emissions, calculated with the traditional method, to present a snapshot of GHG emissions in 2019 and a comparison of the 2019 emissions to previous inventories.

Narrative 1 – Comparison of GHG emissions accounting methods



The CLCPA became law in January 2020. In addition to setting goals for reducing GHG emissions, it requires that these emissions be calculated with a 20-year time horizon and account for out-of-state methane leakage associated with natural gas extraction. The traditional accounting method uses a 100-year time horizon and in-state emissions of all greenhouse gases. While New York has not yet issued guidance on how to perform the emissions calculations specified in the CLCPA, the climate scientist advising State officials on these calculations shared the anticipated CLCPA methodology with Tompkins County staff[2]. Using this method, community GHG emissions in the County are 1.9 times higher for 2019 than the total emissions calculated using traditional accounting methods.

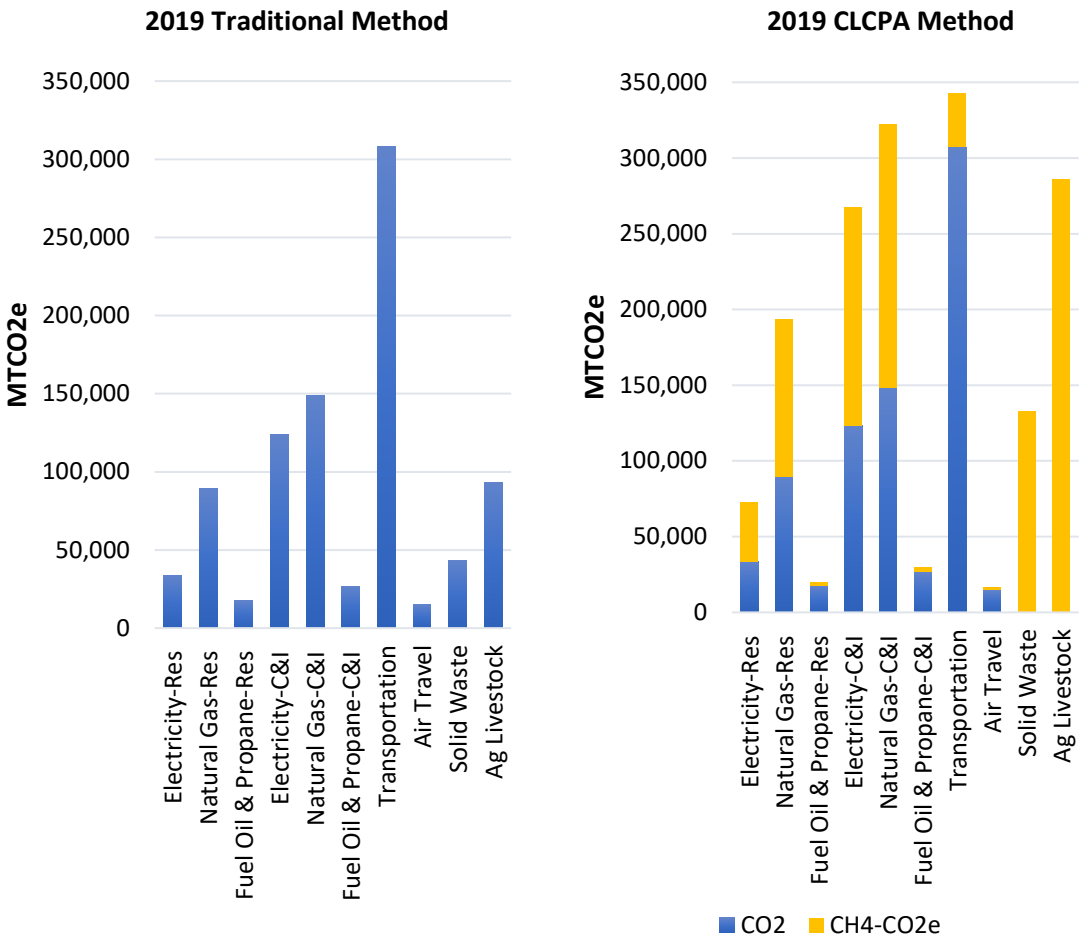
The difference between these two accounting methods can be further broken down to show the contribution of methane emissions for each fuel within a sector. The chart below, on the left-hand side, shows the traditional accounting method, and each bar represents all greenhouse gases combined as one emissions number (for each fuel and sector) because the methane contribution is too small to see on this scale with a 100-year global warming potential (GWP). Using the anticipated CLCPA method and separating the carbon dioxide and methane contributions of emissions, the chart below, on the right-hand side, shows that calculating emissions with a shorter time horizon, the 20-year GWP, emphasizes the significance of methane in GHG emissions.

---

[1] A greenhouse gas (GHG) inventory is a list of emission sources and the associated emissions quantified using standardized methods (US Environmental Protection Agency).

[2] Robert W. Howarth (2020) Methane emissions from fossil fuels: exploring recent changes in greenhouse-gas reporting requirements for the State of New York, Journal of Integrative Environmental Sciences, 17:3, 69-81, DOI: 10.1080/1943815X.2020.1789666.

[3] $MTCO_2e$ – a measure of the combined ability of emitted GHGs to trap heat.

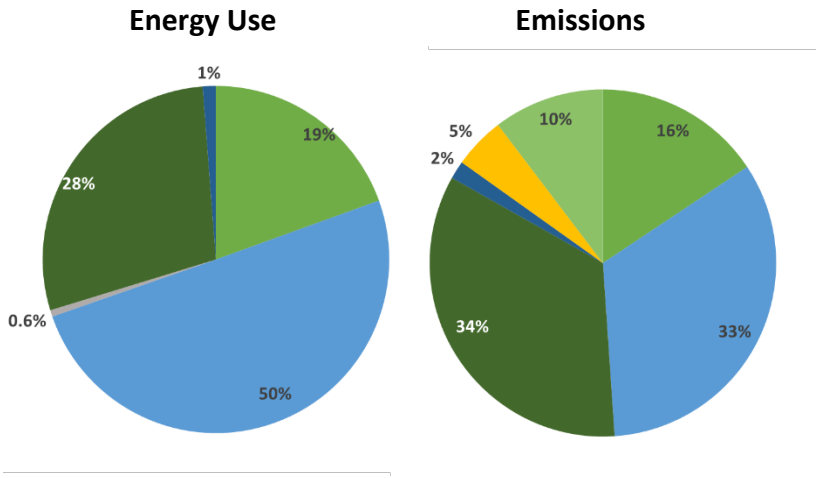


Main takeaways comparing traditional and CLCPA accounting methods

- The GHG emissions using the CLCPA accounting method are almost double what is calculated using the traditional method.
- The CLCPA method emphasizes the near-term contribution of natural gas usage on GHG emissions, pointing to the need to reduce natural gas usage for heating, as well as for electricity generation.
- The CLCPA method emphasizes the near-term impacts of solid waste and agricultural livestock on GHG emissions, pointing to the need to implement techniques to reduce the methane released in those sectors.
- As the electricity grid transitions from fossil fuel sources to renewables, emissions associated with electricity generation will decrease.

Since New York has not yet developed the formal guidance to calculate GHG emissions as required in the CLCPA, this Inventory primarily presents the results using the traditional GHG accounting method, as a way to compare the 2019 information with inventories conducted for 2008 and 2014. *As you read the remainder of this document, please recall the sense of urgency demonstrated by the significantly higher emissions calculations when using the CLCPA accounting method.*

Narrative 2 – Part A: 2019 inventory details using traditional accounting method



Sectors	Energy in MMBtu[4]	% of Total	Emissions MTCO2e	% of Total
Residential	2,961,816	19%	141,004	16%
Commercial and Industrial	7,626,171	50%	299,401	33%
Groton Electric	92,911	1%	0	0%
Transportation	4,330,588	28%	308,326	34%
Air Travel	186,600	1%	15,160	2%
Solid Waste	0	0%	43,295	5%
Agricultural Livestock	0	0%	93,128	10%
Total	***15,198,086***		**900,314**	

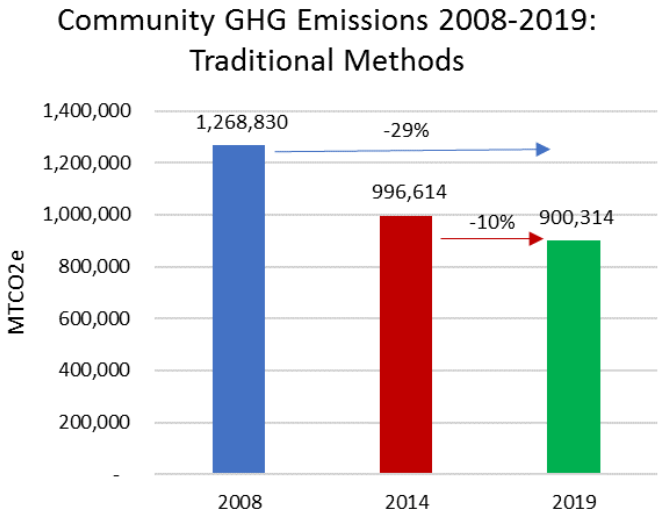
Main takeaways for 2019 emissions and energy use using traditional accounting method

- Total GHG emissions in Tompkins County in 2019 were estimated to be 900,314 metric tons of carbon dioxide equivalent ($MTCO_2e$).
- The top three sectors for energy consumption and GHG emissions
    - The Commercial and Industrial Sector consumed 50% of all energy and produced 33% of all GHG emissions, making it the highest energy consuming sector.
    - The Transportation Sector consumed 28% of all energy and produced 34% of all emissions, making it the highest emitting sector.
    - The Residential Sector accounted for 19% of energy use and 16% of emissions, making it number three for both consumption and emissions.
- The top three fuels that emitted GHGs
    - Gasoline accounted for 32% of emissions
    - Natural gas accounted for 31% of emissions
    - Electricity (including the grid-mix of fuels to generate it) accounted for 21% of emissions

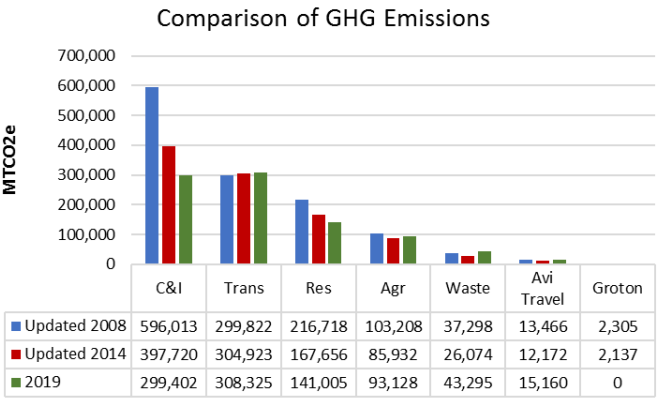
[4] MMBtu – a measure of the energy content in fuel; used as a basis for comparing the energy content of various fuels.

These findings emphasize the need to continue to focus on electrifying our heating and cooling systems, expanding the amount of electricity provided from renewable energy sources, reducing the number of miles driven, and transitioning to electric or highly efficient vehicles.

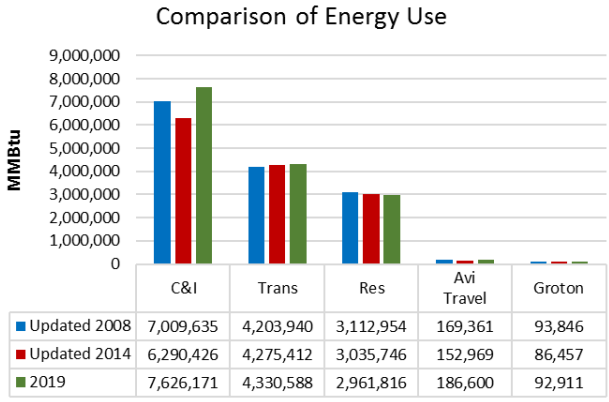
Narrative 2 – Part B: 2008-2019 comparison of emissions and energy use using traditional accounting method



Under the traditional accounting method, Tompkins County reduced GHG emissions from base year 2008 levels by 29% in 2019, with a 10% reduction between 2014 and 2019. These reductions show progress, but the community is still far from achieving net-zero emissions[5], which is the target set forth in the 2019 Tompkins County Energy Strategy.



	C&I	Trans	Res	Agr	Waste	Avi Travel	Groton
Updated 2008	596,013	299,822	216,718	103,208	37,298	13,466	2,305
Updated 2014	397,720	304,923	167,656	85,932	26,074	12,172	2,137
2019	299,402	308,325	141,005	93,128	43,295	15,160	0



	C&I	Trans	Res	Avi Travel	Groton
Updated 2008	7,009,635	4,203,940	3,112,954	169,361	93,846
Updated 2014	6,290,426	4,275,412	3,035,746	152,969	86,457
2019	7,626,171	4,330,588	2,961,816	186,600	92,911

Main takeaways for 2008-2019 comparison of emissions and energy use using traditional accounting method

Overall, under the traditional GHG accounting method, community-scale emissions declined between 2008 and 2019.

[5] The Energy Strategy defined net-zero to mean that GHG emissions are reduced 100%, to zero, although some emissions can be allowed if balanced by negative emissions achieved through actions such as drawing carbon from the air and tree-planting.

- The Commercial and Industrial Sector saw an increase in energy use but also the largest reduction in GHG emissions among all the sectors due to Cornell's 2009 decision to transition its central energy plant from coal to natural gas to produce its heat and electricity.
- The Transportation Sector had an increase in both energy use and emissions. However, it should be noted that it is difficult to see progress in the Transportation Sector at the County level, as the data are highly dependent on regional vehicle types as well as on local modeling to estimate vehicle miles traveled that has not been updated since the 2014 Inventory.
- Residential Sector energy consumption and emissions declined between 2008 and 2019.
- The power supplied to the Village of Groton's municipal electric system (Groton Electric) fully transitioned to emissions-free energy between 2014 and 2019, with 84% coming from hydropower and 16% from nuclear.
- Renewable energy generation increased 1,000% from 2008 to 2019.

As stated in the Tompkins County Energy Strategy (2019), the community needs to work together and take bold actions to continue to reduce emissions and energy consumption. This Inventory is a resource that can inform development of Tompkins County community actions to reduce emissions and transition to renewable energy.

Contents

2019 Tompkins County Community GHG Emissions and Energy Use

Introduction

A greenhouse gas (GHG) emissions inventory provides a quantification of the amount of greenhouse gases emitted to the atmosphere by a locality, as well as information about the activities that cause emissions and the associated fuels. The information is used to track emissions trends, develop strategies and policies, and assess progress.

The United Nations Intergovernmental Panel on Climate Change (IPCC) states that six greenhouse gases should be included in an emissions inventory: carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur Hexafluoride (SF_6). For ease of analysis, all the emissions are converted into an equivalent amount of CO_2 and reported as metric tons of carbon dioxide equivalent ($MTCO_2e$).

This report quantifies GHG emissions from the entire Tompkins County community, including governments, education, residents, non-profits, and businesses. Included in this report are results from two previous inventories of GHG emissions and energy use: 2014 and 2008, with values updated to reflect any methodological or accounting changes that have taken place since the compilation of the 2008 Inventory. This and previous inventories quantify GHG emissions released within Tompkins County's geographic boundary, plus some emissions that partially occur outside the boundary but are associated with the County, such as air travel and waste disposal.

Since 1998, Tompkins County has tracked community-wide GHG emissions to measure progress towards meeting climate mitigation goals. In 2008, the County Legislature set a goal on behalf of the community to reduce greenhouse gas emissions by at least 20% below 2008 levels by 2020 and 80% below 2008 levels by 2050, setting 2008 as the baseline year. The Energy Strategy adopted by the County Legislature in 2019 recognized that even faster progress is needed, and that the community should strive to achieve net-zero emissions[6].

The results presented in this report are based upon the *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.2, July 2019*. ClearPath Version 2019, an online application for the calculation and tracking of GHG emissions at both the government operations and community scale, was used to calculate emissions.

The 2019 Community Inventory uses the IPCC 5th Assessment Report's 100-year Global Warming Potential (GWP) values. The original 2008 Inventory used the IPCC 2nd Assessment Report's 100-year GWP values and has been updated to the 5th Assessment 100-year values.

---

[6] The Energy Strategy defined net-zero to mean that GHG emissions are reduced 100%, to zero, although some emissions can be allowed if balanced by negative emissions achieved through actions such as drawing carbon from the air and tree-planting.

In preparing the 2019 Inventory, three aspects of energy use and GHG emissions were quantified, with color themes carried through the document to make the distinctions clear.

Knowing the source of emissions helps in effectively planning and implementing emissions reduction actions. A GHG emissions inventory creates a quantitative foundation for a community to take concrete actions to address climate change and sustainability.

Overview of Natural Gas Impacts

Between 2008 and 2019, there has been a shift in the technique used to extract natural gas consumed by the community. New international recommendations are also emerging on the time horizon and the GWP of methane that should be used to calculate the GHG emissions for natural gas.

Studies conducted by local internationally-renowned experts, including Dr. Robert Howarth and Dr. Anthony Ingraffea, informed natural gas impact calculations for both the 2014 and 2019 Community Inventories, with Dr. Howarth providing appropriate figures to include in these calculations. For the 2014 Inventory, it was estimated that 5-19% of unburned methane leaks from the production wells and throughout the transmission and distribution process, where combustion occurs in the home, business, or electric generating plant. This leakage rate has since been revised downward to 3.6%, which is slightly less than the 3.8% leakage rate associated with conventional extraction.

This Inventory uses standard GHG accounting principles that includes applying the 100-year GWP to all GHGs. However, to capture the potency of methane associated with natural gas extraction by high-volume hydrofracking, additional calculations were performed using the 20-year GWP and 3.6% leakage rate as specified in the CLCPA. Below we compare the 2019 GHG emissions using this CLCPA method and the U.S. Community Protocol (or “traditional”) method.

Comparing Two Greenhouse Gas Emissions Accounting Methods

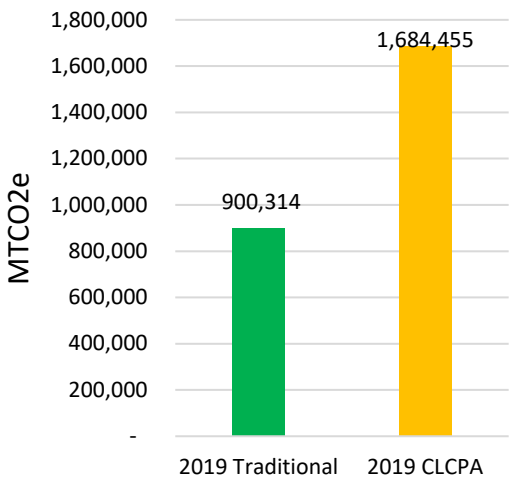


Figure 1. 2019 Community GHG Emissions Using Traditional and CLCPA Methods

CLCPA sets goals for reducing GHG emissions and requires that these emissions be calculated with a 20-year time horizon and account for out-of-state methane leakage associated with natural gas extraction. The traditional accounting method uses a 100-year time horizon and in-state emissions of all greenhouse gases. County staff worked with local experts to develop a method for calculating methane emissions based on the CLCPA calculations in Howarth 2020[7]. Using this method, community GHG emissions in the County are 1.9 times higher for 2019 than the total emissions calculated using traditional accounting methods.

The difference between these two accounting methods can be further broken down to show the contribution of methane emissions for each fuel within a sector. The left chart in Figure 2 shows the traditional accounting method with each bar representing all greenhouse gases combined as one emissions number because the methane contribution is too small to see on this scale with a 100-year GWP. Using the anticipated CLCPA method and separating the carbon dioxide and methane contributions of emissions, the right-hand side of Figure 2 shows that calculating emissions with a shorter time horizon, the 20-year GWP, emphasizes the significance of methane in GHG emissions.

[7] Robert W. Howarth (2020) Methane emissions from fossil fuels: exploring recent changes in greenhouse-gas reporting requirements for the State of New York, Journal of Integrative Environmental Sciences, 17:3, 69-81, DOI: 10.1080/1943815X.2020.1789666.

[8] $MTCO_2e$ – a measure of the combined ability of emitted GHGs to trap heat.

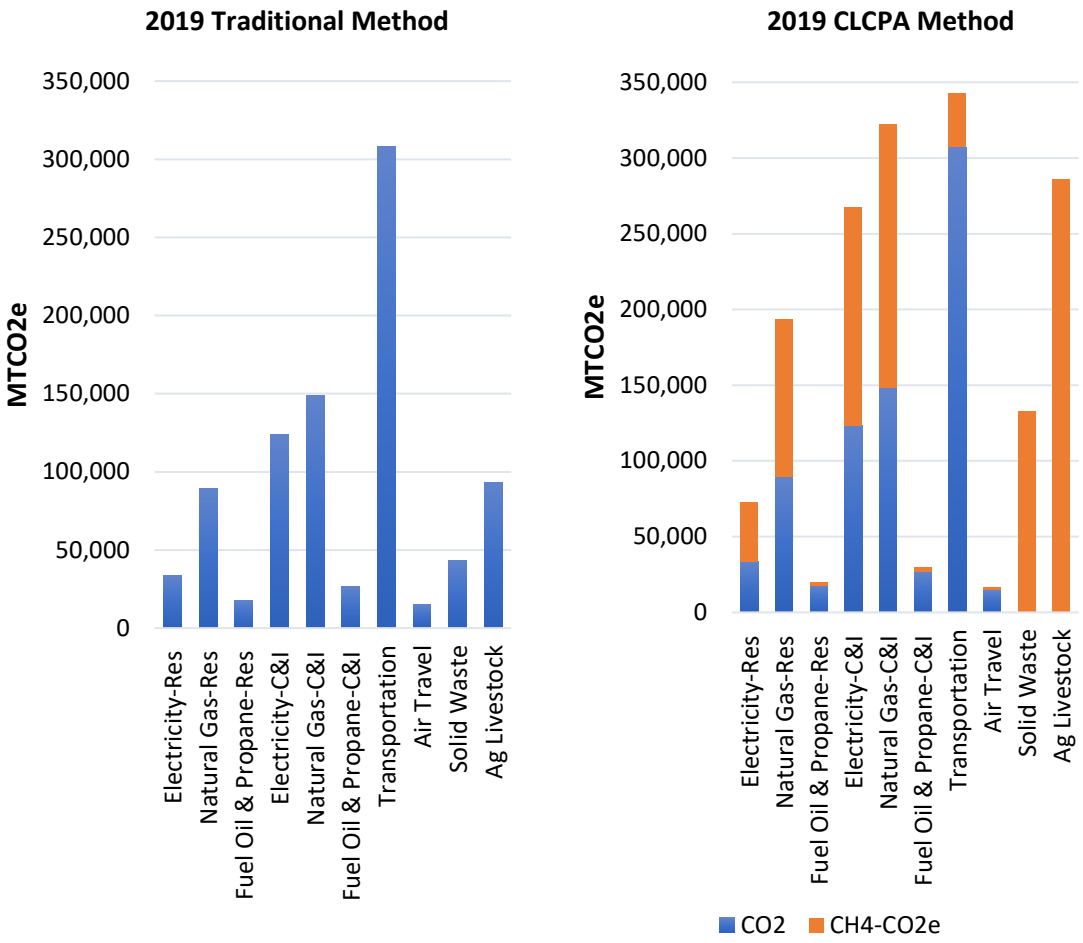


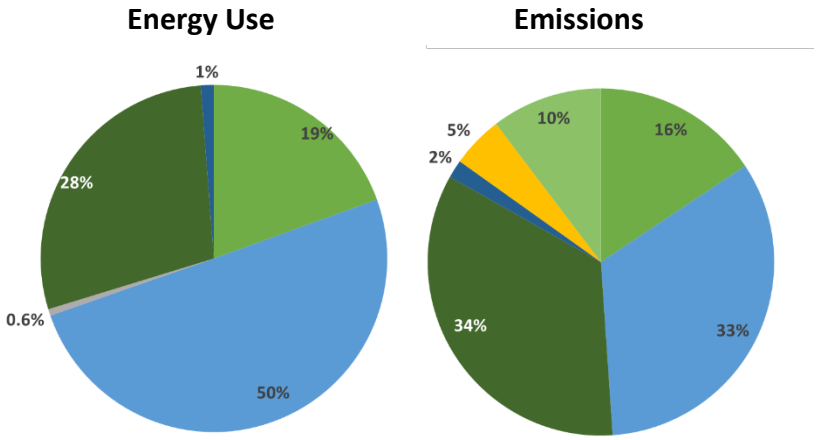
Figure 2. Breakdown of GHG Emissions by the Community in 2019 Using Traditional and CLCPA Accounting Methods

The CLCPA method emphasizes the near-term contribution of natural gas usage on GHG emissions, pointing to the need to rapidly transition to efficient electric heating systems and to increase renewable energy systems as part of the electric grid. In addition, the CLCPA method emphasizes the near-term impacts of solid waste and agricultural livestock on GHG emissions; innovative techniques are needed to reduce the methane released in those sectors. Although the remainder of this report focuses on data using the traditional method in order to enable comparison to previous inventories and use of existing software, these emphases should be incorporated into decisions regarding next steps for reducing community GHG emissions.

2019 Community GHG Emissions and Energy Use Inventory

2019 Inventory Results Summary

In 2019, the Commercial and Industrial (C&I) Sector consumed 50% of all energy and produced the 33% of emissions in Tompkins County. The Transportation Sector emitted 34% of total emissions – the highest level – but consumed less energy at 28% of the total. The Residential Sector was accountable for 16% of the community's GHG emissions and 20% of its energy use. Energy consumed by the Solid Waste and Agricultural Livestock Sectors is accounted for within other sectors, such as Transportation and C&I, but emissions from other related sectors' activities is captured directly. Other sectors tracked in the 2019 Inventory include the Village of Groton municipal electric system (Groton Electric) and Air Travel.



Sectors	Energy in MMBtu[9]	% of Total	Emissions MTCO2e	% of Total
Residential	2,961,816	19%	141,004	16%
Commercial and Industrial	7,626,171	50%	299,401	33%
Groton Electric	92,911	1%	0	0%
Transportation	4,330,588	28%	308,326	34%
Air Travel	186,600	1%	15,160	2%
Solid Waste	0	0%	43,295	5%
Agricultural Livestock	0	0%	93,128	10%
Total	***15,198,086***		**900,314**	

Table 1: Summary of 2019 Results

The following table provides a summary of energy and emissions for reference. Each sector is further broken down in detail in the associated report sections.

[9] MMBtu – a measure of the energy content in fuel; used as a basis for comparing the energy content of various fuels.

	Unit Measure	Energy in MMBtu	% of Total	Emissions MTCO2e	% of Total
Residential		**2,961,816**	**19.5%**	**141,004**	**15.7%**
Electricity (kWh)	302,859,496	1,033,650		33,706	
NYSEG Meters	292,398,000	997,945		33,706	
Renewables - Solar	10,461,496	35,705		0	
Natural Gas (therms)	16,808,988	1,680,900		89,401	
Fuel Oil (gallons)	1,491,941	205,888		15,330	
Propane (gallons)	454,700	41,378		2,568	
Commercial and Industrial		**7,626,171**	**50.3%**	**299,401**	**33.3%**
Electricity (kWh)	693,862,195	2,368,126		123,630	
NYSEG Meters	466,428,000	1,591,900		53,767	
Cornell Generation	258,482,000	882,191		76,768	
Cornell Elect. Purch	17,300,000	59,044		1,994	
Cornell Elect. Export	-77,200,000	-263,481		-8,899	
Renewables - Hydro	7,300,000	24,915		0	
Renewables - Solar	21,552,195	73,557		0	
Natural Gas (therms)	48,865,801	4,866,600		148,857	
NYSEG Meters	18,433,611	1,843,400		98,042	
Cornell Use	30,432,190	3,043,200		50,815	
Fuel Oil (gallons)	2,267,282	319,562		23,695	
Commercial, non-Cornell	2,247,199	315,049		23,488	
Cornell Use	20,083	4,513		206	
Propane (gallons)	570,144	51,883		3,220	
Groton Electric (kWh)	**27,222,930**	**92,911**	**0.4%**		**0%**
Transportation		**4,330,588**	**28.6%**	**308,326**	**34.2%**
Gasoline (gallons)	21,068,930	3,497,100		246,658	
Diesel (gallons)	4,982,651	833,488		61,667	
VMT (miles)	672,759,539				
Passenger Vehicles	512,151,422				
Motorcycles	3,177,118				
Light Trucks (incl. Para-Transit Buses)	123,713,305				
Transit and School Bus	2,963,191				
Medium-Duty Trucks	20,778,352				
Heavy-Duty Trucks	9,976,151				
Air Travel		**186,600**	**1.2%**	**15,160**	**1.7%**
Jet Fuel (gallons)	1,519,000	182,280		14,860	
Aviation Gasoline (gallons)	36,000	4,320		300	
Solid Waste (Landfilled waste, tons)	**58,482**			**43,295**	**4.8%**
Agricultural Livestock (# Animals)	**24,834**			**93,128**	**10.3%**
TOTAL	**NA**	**15,167,306**	**100%**	**900,314**	**100%**

Table 1: Detailed Inventory of 2019 GHG Emissions and Energy Consumption

2019 Analysis by Sector

Residential Sector

The Residential Sector accounted for 16% of all community GHG emissions. Within this sector, natural gas accounted for more than half of all emissions and electricity made up nearly 24%. While fuel oil and propane cumulatively accounted for 12.7% of emissions, consumption data were scaled down from state-level data utilizing proportions of households with heating fuel oil according to the U.S. Census American Community Survey (ACS); thus, the data for residential heating oil consumption were far less accurate than the consumption data for natural gas and electricity, which are specific to Tompkins County.

	Unit Measure	Energy in MMBtu	% of Subtotal	Emissions MTCO2e	% of Subtotal
Electricity (kWh)	302,859,496	1,033,650	34.9%	33,706	23.9%
NYSEG Meters	292,398,000	997,945	33.7%	33,706	23.9%
Renewables - Solar	10,461,496	35,705	1.2%	0	0.0%
Natural Gas (therms)	16,808,988	1,680,900	56.7%	89,401	63.4%
Fuel Oil (gallons)	1,491,941	205,888	7.0%	15,330	10.9%
Propane (gallons)	454,700	41,378	1.4%	2,568	1.8%
SUBTOTAL	**NA**	**2,961,816**	**100.0%**	**141,004**	**100.0%**

Table 2: Residential Sector 2019 GHG Emissions and Energy Consumption

In addition to energy consumption from fossil fuels, this Inventory tracks consumption from renewable energy sources, which accounted for nearly 3.4% of total residential electricity consumption in 2019.

	Electricity (kWh)	Energy in MMBtu	Emissions MTCO2e
Small-Scale Solar	10,461,496	35,705	0
% of total sector electricity	3.4%	3.4%	0.0%

Table 3: Residential Sector 2019 Renewables

Commercial and Industrial Sector

For the 2019 data, NYSEG reported both the Commercial Sector's and Industrial Sector's energy consumption under a single category. Therefore, in this Inventory, these two sectors are aggregated to generate a uniform assessment. Together, the C&I Sector accounted for 33% of all GHG emissions. Within this sector, natural gas use accounted for 50% of the emissions.

Accounting for emissions and energy consumption in the C&I Sector is complicated by the fact that Cornell University both generates and consumes large quantities of energy to heat and power the Ithaca campus's 15.8 million square feet of gross building space and energy-intensive laboratories. Cornell accounted for 57% of all C&I Sector emissions from electricity and 34% from natural gas. Cornell also accounted for a significant portion of renewable power generation in this sector, with Cornell Snyder Road Solar Farm generating 2,019,086 kWh and Cornell Hydropower generating 7,300,000 kWh in 2019.

	Unit Measure	Energy in MMBtu	% of Subtotal	Emissions MTCO2e	% of Subtotal
Electricity (kWh)	693,862,195	2,368,126	31.1%	123,630	41.3%
NYSEG Meters	466,428,000	1,591,900	20.9%	53,767	18.0%
Cornell Generation	258,482,000	882,191	11.6%	76,768	25.6%
Cornell Elect. Purch	17,300,000	59,044	0.8%	1,994	0.7%
Cornell Elect. Export	-77,200,000	-263,481	-4.5%	-8,899	-3.0%
Renewables - Hydro	7,300,000	24,915	0.3%	0	0.0%
Renewables - Solar	21,552,195	73,557	0.9%	0	0.0%
Natural Gas (therms)	48,865,801	4,886,600	41.8%	148,857	49.7%
NYSEG Meters	18,433,611	1,843,400	24.2%	98,042	32.7%
Cornell Use	30,432,190	3,043,200	39.9%	50,815	17.0%
Fuel Oil (gallons)	2,267,282	319,562	4.2%	23,695	7.9%
Commercial, non-Cornell	2,247,199	315,049	4.2%	23,488	7.8%
Cornell Use	20,083	4,513	<0.1%	206	0.1%
Propane (gallons)	570,144	51,883	0.7%	3,220	1.1%
SUBTOTAL	**NA**	**7,626,171**	**100%**	**299,401**	**100.0%**

Table 4: Commercial and Industrial Sector 2019 GHG Emissions and Energy Consumption

Renewable energy generated in the Commercial Sector accounted for 4.2% of the total C&I electricity consumed, and 1.3% of all C&I energy consumption in 2019. There were nine commercial solar projects in Tompkins County, three of which had an installed capacity between 200 kilowatts (kW) and 1 megawatt (MW) and six with an installed capacity greater than 1MW. All hydropower within the County was generated by Cornell's hydroelectric plant.

	Electricity (kWh)	Energy in MMBtu	Emissions MTCO2e
Small-Scale Solar	3,702,140	12,635	0
Large- and Utility-Scale Solar	17,850,055	60,922	0
Hydro	7,300,000	24,915	0
TOTAL	**28,852,195**	**98,472**	**0**
% of total sector electricity	4.2%		0.0%
% of total sector energy		1.3%	

Table 5: Commercial Sector 2019 Renewables

Village of Groton Electric

Groton Electric supplies electricity within the Village of Groton's boundaries and accounts for 0% of all GHG emissions. The fuel sources for energy purchased by the utility fully transitioned away from fossil fuels between 2014 and 2019, with 84% of energy coming from hydropower and 16% from nuclear.

	Unit Measure	Energy in MMBtu	% of Subtotal	Emissions MTCO2e	% of Subtotal
Electricity (kWh)	27,222,903	92,911	100%	0	100.0%

Table 6: Village of Groton Electric 2019 GHG Emissions and Energy Consumption

Transportation

Transportation accounted for 34% of all community GHG emissions. Most emissions were from gasoline-powered vehicles (81% of total transportation emissions). Vehicles cumulatively drove approximately 673 million miles in 2019, though a large portion of this calculation draws upon 2014 community estimates. While emissions associated with electricity used to charge electric vehicles (EVs) were not separated out from electricity consumption and emissions in other sectors in this Inventory, there were 644 EVs registered in the County as of December 31,2019, which represents 1.3% of all registered vehicles.

	Unit Measure	Energy in MMBtu	% of Subtotal	Emissions MTCO2e	% of Subtotal
Gasoline (gallons)	21,068,930	3,497,100	80.7%	246,658	80.0%
Diesel (gallons)	4,982,651	833,488	19.3%	61,667	20.0%
VMT (miles)	672,759,539				
Passenger Vehicles	512,151,422				
Motorcycles	3,177,118				
Light Trucks (incl. Para-Transit Buses)	123,713,305				
Transit and School Bus	2,963,191				
Medium-Duty Trucks	20,778,352				
Heavy-Duty Trucks	9,976,151				
SUBTOTAL	**NA**	**4,330,588**	**100.0%**	**308,325**	**100.0%**

Table 7: Transportation 2019 GHG Emissions and Energy Consumption

Air Travel

Air travel accounted for 1.7% of all GHG emissions for the community. Nearly all these emissions were due to the burning of jet fuel by commercial carriers operating out of the Ithaca Tompkins International Airport.

	Unit Measure	Energy in MMBtu	% of Subtotal	Emissions MTCO2e	% of Subtotal
Jet Fuel (gallons)	1,519,000	182,280	97.7%	14,860	98.0%
Aviation Gasoline (gallons)	36,000	4,320	2.3%	300	2.0%
SUBTOTAL	**NA**	**186,600**	**100.0%**	**15,160**	**100.0%**

Table 8: Air Travel 2019 GHG Emissions and Energy Consumption

Solid Waste

Solid waste accounted for 4.8% of total GHG emissions. These emissions result from the natural decay of solid waste generated in the community and disposed of in landfills outside the County. All landfills used for disposal of municipal solid waste and biosolids were equipped with methane collection systems, which reduces the GHG emissions associated with the decay of solid waste. In 2019, 21% of all municipal solid waste was recycled.

	Unit Measure	Energy in MMBtu	% of Subtotal	Emissions MTCO2e	% of Subtotal
Landfilled Waste (tons)	58,482			43,295	100.0%

Table 9: Solid Waste 2019 GHG Emissions

Agricultural Livestock

Agricultural livestock accounted for 10.3% of all GHG emissions. These emissions were calculated from livestock that had methane emissions factors available from the U.S. Environmental Protection Agency.

	Unit Measure	Energy in MMBtu	% of Subtotal	Emissions MTCO2e	% of Subtotal
Number of Animals	24,834			93,128	100.0%

Table 10: Agricultural Livestock 2019 GHG Emissions

Power Generation at the Cayuga Power Plant (formerly AES Cayuga)

Although this source of emissions is not included in the emissions accounting protocol and therefore not included in the overall community emissions total, it is tracked as part of the Inventory since it has historically been a significant energy facility in the community. In 2019, the Cayuga Power Plant produced 80.4 gigawatt hours (GWh) of electricity and emitted 98,083 MTCO2e. One unit of the plant was retired in July 2018, and the plant went completely offline in August 2019.

Wastewater Treatment and Distribution

Emissions associated with the denitrification and nitrification processes in wastewater treatment are not included in this Inventory's accounting. They have been documented for tracking purposes and for reference in future inventories.

	Unit Measure	Energy in MMBtu	% of Subtotal	Emissions MTCO2e	% of Subtotal
Population Served	50,794			60.84	100.0%

Table 11: Wastewater Treatment and Distribution 2019 GHG Emissions

2019 Analysis by Fuel Source

All Fuels

Natural gas supplied 43% of all the energy used in the community across all sectors and accounted for slightly less than a third of all energy-related emissions. Gasoline and electricity provided 24% and 22% of the community's energy needs, respectively. On-site renewables, including solar and hydro, met 0.9% of the community's energy needs.

	Unit Measure	Energy in MMBtu	% of Total	Emissions MTCO2e	% of Total
Natural Gas (therms)	65,674,789	6,567,500	42.7%	238,258	31.2%
Gasoline (gallons)	21,068,930	3,678,200	23.9%	246,658	32.3%
Electricity (kWh) (not incl. hydro or solar)	983,183,923	3,331,028	21.7%	157,336	20.6%
Fuel Oil (gallons)	3,759,223	525,450	3.4%	39,025	5.1%
Diesel (gallons)	4,989,045	864,715	5.6%	61,667	8.1%
Jet Fuel (gallons)	1,519,000	182,280	1.2%	14,860	1.9%
Propane (gallons)	1,024,844	93,261	0.6%	5,788	0.8%
Aviation Gasoline (gallons)	36,000	4,320	<0.1%	300	0.0%
Hydro (kWh)	7,300,000	24,915	0.2%	0	0.0%
Solar (kWh)	32,013,691	109,262	0.7%	0	0.0%
TOTAL	**NA**	**15,380,931**	**100%**	**763,893**	**100%**

Table 12: All Fuels 2019 GHG Emissions and Energy Consumption

Electricity

The C&I Sector consumed 68% of the energy produced by electricity in the community, with Cornell generating 25.3% of total electricity consumed countywide and exporting 7.6% of this electricity back to the grid. The Residential Sector consumed 30% of total electricity energy.

	kWh	Energy in MMBtu	% of Total	Emissions MTCO2e	% of Total
Residential	**302,859,496**	**1,033,650**	**29.6%**	**33,706**	**21.4%**
NYSEG Meters	292,398,000	997,945	28.5%	33,706	21.4%
Renewables - Solar	10,461,496	35,705	1.1%	0	0.0%
Commercial and Industrial	**693,862,195**	**2,368,126**	**67.8%**	**123,622**	**78.6%**
NYSEG Meters	466,428,000	1,591,900	45.5%	53,767	34.2%
Cornell Generation	258,428,000	882,191	25.3%	76,768	48.8%
Cornell Elect. Purch	17,300,000	59,044	1.7%	1,994	1.3%
Cornell Elect. Export	-77,200,000	-264,481	-7.6%	-8,899	-5.7%
Renewables - Hydro	7,300,000	24,915	0.7%	0	0.0%
Renewables - Solar	21,552,195	73,557	2.1%	0	0.0%
Groton	**27,222,903**	**92,911**	**2.6%**	**0**	**0%**
TOTAL	**1,023,944,594**	**3,494,687**	**100.0%**	**157,336**	**100.0%**

Table 13: Electricity - 2019 GHG Emissions and Energy Consumption

Thermal Energy

The C&I Sector consumed 71% of the thermal energy required to heat spaces and provide hot water in the community, and the Residential Sector consumed 29% of the community's thermal energy needs.

	Unit Measure	Energy in MMBtu	% of Total	Emissions MTCO2e	% of Total
Residential		**2,157,628**	**29.1%**	**115,051**	**39.6%**
Electricity (kWh)	67,251,541	229,462	4.0%	7,752	2.7%
Natural Gas (therms)	16,808,988	1,680,900	22.7%	89,401	30.7%
Fuel Oil (US gallon)	1,491,941	205,888	2.8%	15,330	5.3%
Propane (US gallon)	454,700	41,378	0.6%	2,568	0.9%
Commercial and Industrial		**5,258,045**	**70.9%**	**175,771**	**60.4%**
Natural Gas (therms)	48,865,801	4,886,600	65.8%	148,857	51.2%
Sub-Category: NYSEG Meters	18,433,611	1,843,400	24.8%	98,042	33.7%
Sub-Category: Cornell Use	30,432,190	3,043,200	41.0%	50,815	17.5%
Fuel Oil (US gallon)	2,267,282	319,562	4.3%	23,694	8.1%
Sub-Category: Comm, non-Cornell	2,247,199	315,049	4.2%	23,488	8.1%
Sub-Category: Cornell Use	20,083	4,513	0.1%	206	0.1%
Propane (US gallon)	570,144	51,883	0.7%	3,220	1.1%
TOTAL	**NA**	**7,415,673**	**100.0%**	**290,822**	**100%**

Table 14: Thermal Energy - 2019 GHG Emissions and Energy Consumption

Transportation Fuels

Gasoline accounted for 78% of transportation-related energy consumption in 2019 and accounted for 76% of transportation fuels emissions.

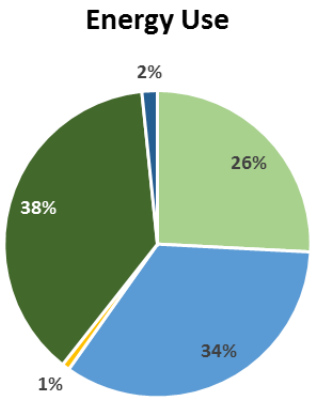
	US Gallons	Energy in MMBtu	% of Total	Emissions MTCO2e	% of Total
Gasoline	21,068,930	3,678,200	77.8%	246,658	76.3%
Diesel	4,982,651	864,715	18.3%	61,667	19.1%
Jet Fuel	1,519,000	182,280	3.9%	14,680	4.5%
Aviation Gasoline	36,000	4,320	0.1%	300	0.1%
TOTAL	**27,606,581**	**4,729,515**	**100.0%**	**323,305**	**100.0%**

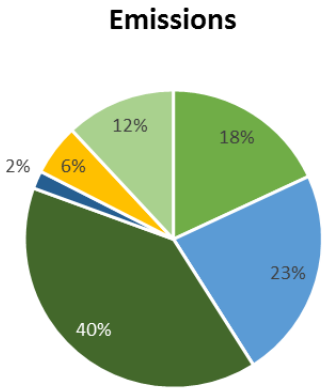
Table 15: Transportation Fuels - 2019 GHG Emissions and Energy Consumption

Further Analysis to Inform the 2019 Inventory

Removing Cornell University Data

To better understand 2019 GHG emissions and energy consumption, it is helpful to remove Cornell University from the data to determine whether (a) the C&I Sector still contributes more than one-third of the community's emissions and (b) natural gas remains the largest contributor of GHG emissions. As seen below, with Cornell central energy plant's (CEP, also known as the Combined Heat and Power Plant) electricity generation and consumption removed from the analysis, emissions associated with gasoline consumption account for the largest share of the community's emissions. Nonetheless, natural gas is second to gasoline in its contribution to the community's emissions. The largest change is seen in the C&I Sector: while natural gas only meets 48% of the sector's needs, it accounts for 55% of its emissions. This disproportionate effect on emissions can be attributed in part attributed to the huge increase in commercial solar photovoltaic (PV) production.





Sectors	Energy in MMBtu	% of Total	Emissions MTCO2e	% of Total
Residential	2,961,816	26%	141,004	18%
Commercial and Industrial	3,900,704	34%	178,517	23%
Groton Electric	92,911	1%	0	0%
Transportation	4,330,588	38%	308,326	40%
Air Travel	186,600	2%	15,160	2%
Solid Waste	0	0%	43,295	6%
Agricultural Livestock	0	0%	93,128	12%
Total	***11,472,619***	***100%***	***779,430***	***100%***

Figure 3: Summary without Cornell of 2019 GHG Emissions and Energy Consumption

Commercial and Industrial Sector without Cornell

With Cornell data removed, the natural gas share of the commercial and industrial energy remained the highest at 47.6% and accounted for 54.9% of the total emissions. NYSEG metered electricity accounted for 41% of the C&I Sector's energy consumption.

	Unit Measure	Energy in MMBtu	% of Total	Emissions MTCO2e	% of Total
Electricity (kWh)	490,253,530	1,665,457	43.9%	53,767	30.1%
NYSEG Meters	466,428,000	1,591,900	41.1%	53,767	30.1%
Renewables - Solar	21,552,195	73,557	1.9%	0	0.00%
Natural Gas (therms)	18,433,611	1,843,400	47.6%	98,042	54.9%
Fuel Oil (gallons)	2,247,199	315,049	8.1%	23,488	13.12%
Propane (gallons)	570,144	51,883	1.3%	3,220	1.8%
TOTAL	**NA**	**3,875,789**	**100.0%**	**178,517**	**100.0%**

Table 16: C&I Sector without Cornell 2019 GHG Emissions and Energy Consumption

All Fuels without Cornell

After removing Cornell's dedicated natural gas line, gasoline accounted for the largest share of the community's energy emissions, following second by natural gas.

	Unit Measure	Energy in MMBtu	% of Total	Emissions MTCO2e	% of Total
Gasoline (gallons)	21,068,930	3,497,100	31.1%	246,658	38.4%
Natural Gas (therms)	35,242,599	3,524,300	31.3%	187,443	29.2%
Electricity (kWh) (Not including solar)	758,826,000	2,589,845	23.0%	87,473	13.6%
Fuel Oil (gallons)	3,739,140	520,937	4.6%	38,818	5.9%
Diesel (gallons)	4,982,651	833,488	7.4%	61,667	9.6%
Jet Fuel (gallons)	1,519,000	182,280	1.6%	14,673	2.3%
Propane (gallons)	1,024,844	93,261	0.8%	5,778	0.9%
Aviation Gasoline (gallons)	36,000	4,320	<0.1%	307	<0.1%
Solar (kWh)	32,013,691	109,262	1.0%	0	0.0%
TOTAL	**NA**	**11,254,793**	**100.0%**	**642,817**	**100.0%**

Table 17: All Fuels without Cornell 2019 GHG Emissions and Energy Consumption

Weather Conditions in 2019

In 2019, there were 7,201 Heating Degree Days (HDD) where the average temperature was below 65° Fahrenheit, the temperature below which buildings are considered to need to be heated. There were 384 Cooling Degree Days (CDD) where the average temperature is above 65° Fahrenheit and people start to use air conditioning to cool their buildings. During the past 49 years (1970-2019), there were an average of 6,991 HDD and 449 CDD. This indicates that 2019 was cooler in the summer and colder in the winter than past years. Therefore, one would expect that less electricity would be needed in 2019 compared to the past 45 years for air conditioning, and more natural gas and other thermal fuels for space heating. When compared to data from the baseline calendar year, we find that 2019 experienced a colder winter and slightly cooler summer.

	HDD (Higher number = colder winter)	CDD (Higher number = hotter summer)
2008	6,975	387
2009	7,031	272
2010	6,641	622
2011	6,615	526
2012	6,202	543
2013	7,106	479
2014	7,403	342
2015	6,954	445
2016	6,703	555
2017	6,791	346
2018	7,176	528
2019	7,201	384
1970-2019	6,991	449

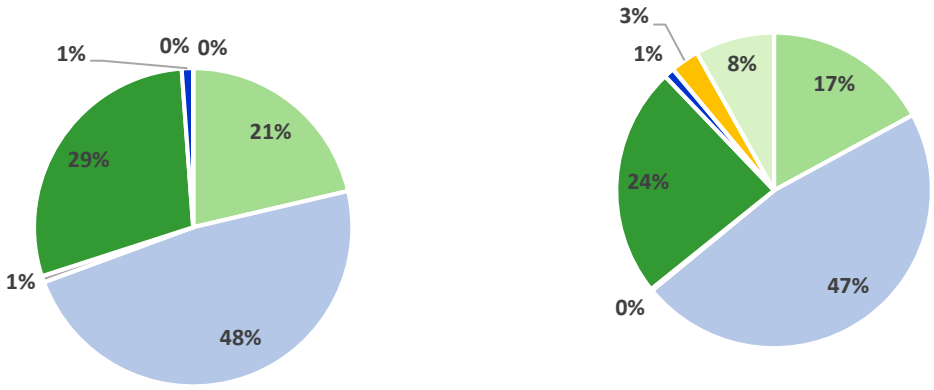
Table 18: Historical Heating and Cooling Degree Days

2008 - 2019 GHG Inventory Comparison

Summary of Past Inventories Comparison

The Tompkins County Department of Planning and Sustainability has accounted for community emissions since 1998 and produced the "Tompkins County Community Greenhouse Gas Emissions Report, 1998-2008," which presents the results of the 2008 GHG Emissions Inventory. In 2014, the Department updated the 2008 Inventory methodology significantly to ensure compliance with the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, thus making a comparison to 1998 impossible. The original 2008 Inventory was compared to the 1998 Inventory within the 2014 Community Emissions Report. This report builds upon the updates made in 2014 to provide a more accurate analysis utilizing new solid waste models along with new. EPA and U.S. Census Bureau data.

Summary of Updated 2008 Community GHG and Energy Use Inventory



Sectors	Energy in MMBtu	% of Total	Emissions MTCO2e	% of Total
Residential	3,112,954	21%	216,718	17%
Commercial and Industrial	7,009,635	48%	596,013	47%
Groton Electric	93,846	1%	2,305	0%
Transportation	4,203,940	29%	299,822	24%
Air Travel	169,361	1%	13,466	1%
Solid Waste	0	0%	37,298	3%
Agricultural Livestock	0	0%	103,208	8%
Total	***14,589,736***	***100%***	***1,268,830***	**100%**

Figure 4: Summary of Updated 2008 GHG Emissions and Energy Consumption

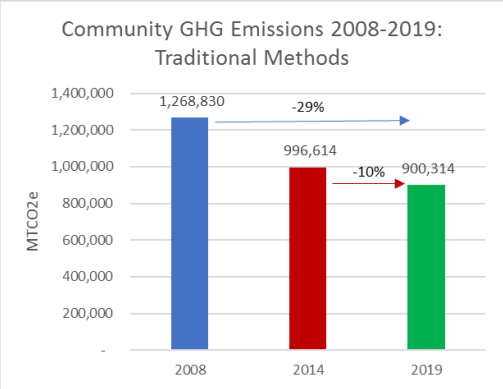
Since many community efforts have used the original 2008 Inventory results to plan programs, below is a table comparing the updated 2008 Inventory from 2014 and the 2008 Inventory with 2019 updates. Only the final updated Inventory should be used in the future, as the methodology improves upon the Residential, Solid Waste, and Agricultural sectors' calculations.

MTCO2e	*Updated 2008 Community Emissions (2014)*		*Updated 2008 Community Emissions (2019)*	
	Overall Total = 1,273,043 MTCO2e (including 13,466 MTCO2e from aviation travel but not listed)		Overall Total = 1,268,266 MTCO2e (including 13,466 MTCO2e from aviation travel and 140,204 MTCO2e from coal, but not listed below)	
	Total Emissions	**Percent of Total**	**Total Emissions**	**Percent of Total**
Residential	254,293	20.2	216,718	17.3
Commercial and Industrial	369,595 (does not include Cornell CEP)	29.3	363,154 (does not include Cornell CEP)	29.4
Transportation	299,822	23.8	299,822	23.9
Waste	29,298	2.3	37,298	3.0
Agriculture	78,400	6.2	103,208	8.2
Local Power Generation (Cornell CEP and Groton Electric)	228,169	18.1	234,610	18.2
Total Sector	*1,259,577*	*100%*	*1,254,810*	*100%*
Energy Source				
Electricity	258,255 (does not include Cornell CEP or Groton Electric)	20.5	346,183	31,1
Natural Gas	226,375	18.0	226,375	20.3
Fuel Oil	128,906	10.2	95,233	8.5
Propane	10,352	0.8	6,477	0.5
Gasoline	253,715	20.1	253,715	22.8
Diesel	46,107	3.6	46,107	4.1
Methane (Ag +Waste)	107,698	8.5	140,506	12.6
Total Fuel Type	*1,259,577*		*1,114,596*	*100%*

Table 19: Comparison of Updated 2008 (2014) and Updated 2008 (2019) GHG Emissions

2008 - 2019 Emissions and Energy Use

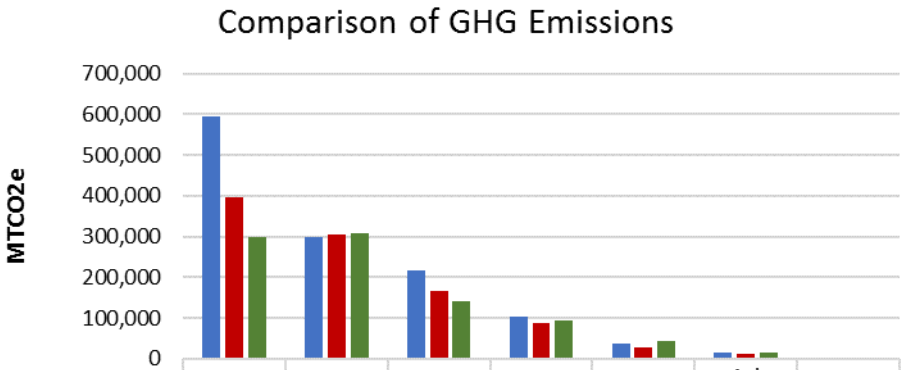
Summary



During the 11 years from 2008 to 2019, the Tompkins County community reduced its GHG emissions by 29%. While this decrease shows great progress, the urgent need for dramatic emissions reductions to limit the worst impacts of climate change cannot be overstated. To this end, with the adoption of the Energy Strategy in 2019, the County accelerated its commitment to community emissions reductions by setting an ultimate goal of net-zero emissions.

Figure 5: GHG Emissions Goals and Progress

Figure 6 provides a time series comparison of GHG emissions from updated 2008 data and updated 2014 and 2019 data by sector. The C&I Sector saw the largest decrease in emissions, followed second by the Residential Sector. While transportation-related emissions have slightly increased, this result is nuanced by the methodology that relies on some raw data and modeling that was also used for the 2014 Inventory.



	C&I	Trans	Res	Agr	Waste	Avi Travel	Groton
Updated 2008	596,013	299,822	216,718	103,208	37,298	13,466	2,305
Updated 2014	397,720	304,923	167,656	85,932	26,074	12,172	2,137
2019	299,402	308,325	141,005	93,128	43,295	15,160	0

Figure 6: Summary of Emissions 2008-2019

Figure 7 provides a time series comparison of energy consumption from updated 2008 data, updated 2014 data, and 2019 by sector. Overall, energy consumption across the sectors has remained relatively flat with the exception of the C&I Sector.

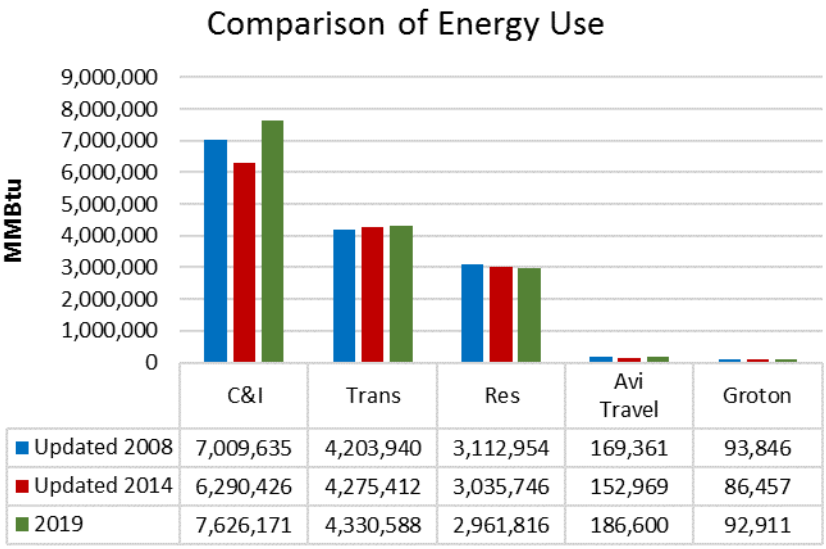


Figure 7: Summary of Energy Consumption 2008-2019

Overarching Considerations

Weather Conditions in 2008 and 2019

An evaluation of HDD and CDD for 2008 and 2019 shows that the winter was colder in 2008 than in 2019, so the consumption of fuels that heat homes and businesses would be higher in 2019. Summer temperatures in 2008 and 2019 were similar; therefore, electricity consumption for air conditioning would not have driven the change in the community's electricity needs. This trend is reflected in the data from 2008 to 2019, as NYSEG metered electricity for the Residential and C&I Sectors only rose by 2.2% and declined by 5.3%, respectively. Despite the colder winter temperatures in 2019, fuel oil consumption decreased by 42.6% in the Residential Sector and 64.8% in the C&I Sector. This indicates that weather conditions are simply one facet in the analysis of fuel consumption, pointing towards other influential factors such as energy conservation and home efficiency measures.

	2008	2019	Change	Percent Change
HDD (<65°need heat) Higher number = colder winter	6,975	7,201	+226	3.2%
CDD (>65°need a.c.) Higher number = hotter summer	387	384	-3	-0.7%

Table 20: Heating and Cooling Degree Days 2008-2019

NYSEG Electric and Natural Gas Meters

While these data are provided directly from NYSEG, it is important to remember that electric and gas figures are based on consumption for the calendar year in which the meter was billed, regardless of dates of consumption and whether or not it was an estimated bill or actual meter-read, which has inherent inconsistencies and makes it difficult to accurately track changes from year to year.

Changes in the Electric Grid

There were large changes in the sources used to generate electricity between 2008 and 2019, with natural gas, hydro, wind, and nuclear power growing as oil and coal usage dropped substantially. This transition from coal to natural gas, in conjunction with a substantial growth in renewable energy, is reflected in the County's 29.7% reduction in GHG emissions.

Inventory Year Fuel Mix of Upstate NY in Percent	2008 (%) (EPA eGRID 2005)	2019 (%) (EPA eGRID 2018)	Percent Change
Natural Gas	15.5	25.9	67.0%
Hydro	26.4	34.6	31.0%
Nuclear	27.0	31.3	15.9%
Coal	21.5	0.8	-96.3%
Wind	0.1	4.7	4,600.0%
Biomass	1.2	2.0	66.6%
Other Fossil	0.4	0.0	-100%
Oil	7.8	0.6	-92.3%
Solar	0.0	0.2	NA
Geothermal	0.0	0.0	0%
Other Unknown/Purchased Fuel	0.0	0.0	0%

Table 21: Electricity Generation - Fuel Mix of Upstate New York 2008-2019

Fuel Oil and Propane

Fuel oil and propane are distributed by many private companies in the area and are therefore difficult to quantify at the local level. The best available source for these fuels was statewide information from the U.S. Energy Information Administration (EIA). The data were scaled down by two methods: (1) for the Residential Sector, American Community Survey data of the number of households with heating fuel was used as a proportion to the EIA data, and (2) for the C&I Sector, total electricity and natural gas consumption was used as a proportion of the EIA data. While these are good proxies for the data and indicate statewide trends, they are not grounded truths for conditions in Tompkins County and must therefore be viewed with some skepticism.

Trends

Energy consumption and GHG emissions have declined in all sectors except for transportation, which saw a slight increase in emissions. The C&I Sector saw the largest reduction in GHG emissions due to Cornell's decision to transition its CEP from coal to natural gas to produce its heat and electricity. In 2019, Cornell's CEP consumed 30.4 million therms of natural gas, accounting for 51.2% of the C&I Sector's total natural gas consumption.

Renewable energy, and solar specifically, has substantially grown in Tompkins County, with small-scale commercial projects seeing the largest increase in total energy generation. Specifically, small-scale commercial solar PV projects with an installed capacity lower than 2 MW experienced 12,253.6% growth from 2008 and 2019. Overall, total renewable generation in the community has risen by 999%.

	Updated 2008 (kWh)	2019 (kWh)	% Change
Solar	474,311	32,013,691	6,649.5%
Small-Scale (Residential)	444,343	10,461,496	2,254%
Small-Scale (Commercial)	29,968	3,702,140	12,253.6%
Large- and Utility-Scale	0	17,850,055	NA
Hydro – Large-Scale	3,100,000	7,300,000	135%
Micro-hydro	0	0	0%
Wind	0	0	0%
Total Generation	**3,574,311**	**39,313,691**	**999.9%**

Table 22: Local Renewable Energy Generation 2008-2019

2008 - 2019 Comparison by Sector

Residential Sector

Similar to the trend documented in 2014, emissions from the Residential Sector have continued to decline, with an overall 34.9% decrease between 2008 and 2019; however, energy consumption remained relatively stagnant between 2008, 2014, and 2019. The emissions decrease is largely explained by the County's shift towards less carbon-intensive fuels. Between 2008 and 2019, there was a rapid adoption of solar PV in conjunction with a 42.6% reduction in fuel oil energy consumption.

Unit Measure	Updated 2008	2019	% Change
Natural Gas (therms)	17,018,828	16,808,988	-1.23%
Electricity (kWh)	293,815,424	302,895,496	3.09%
NYSEG Res Figure	293,371,081	292,398,000	-0.33%
Solar	444,343	10,461,496	2254.40%
Fuel Oil (US gal)	2,600,044	1,491,941	-42.62%
Propane (US gal)	543,774	454,700	-16.38%
MMBtu	**Updated 2008**	**2019**	**% Change**
Natural Gas	1,701,883	1,680,900	-1.23%
Electricity	1,002,782	1,033,650	3.08%
NYSEG Res Figure	1,001,266	997,945	-0.30%
Solar	1,516	35,705	2255%
Fuel Oil	358,806	205,888	-42.62%
Propane	49,483	41,378	-16.38%
TOTAL	**3,112,954**	**2,961,816**	**-4.86%**
MTCO2e	**Updated 2008**	**2019**	**% Change**
Natural Gas	90,517	89,401	-1.20%
Electricity	96,405	33,706	-65%
Fuel Oil	26,715	15,330	-42.60%
Propane	3,071	2,568	-16.40%
TOTAL	**216,718**	**141,005**	**-34.90%**

Table 23: GHG Emissions and Energy Use in the Residential Sector, 2008-2019

Another way to examine residential data is by household. Despite a 7.5% increase in the number of households in the County, the community saw a decrease in energy consumption and emissions on a per household basis, with a 39.6% reduction in GHG emissions per household between 2008 and 2019.

	Updated 2008	Updated 2008 Per HH	2019	2019 Per HH	% Change 2008-2019
Households (1-yr ACS estimates)	37,443	NA	40,250	NA	NA
Natural Gas (therms)	17,018,828	454.5	16,808,988	417.6	-8.1%
Electricity (kWh)	293,815,424	7,847.0	302,859,496	7,524.5	-4.1%
Emissions ($MTCO_2e$)	216,718	5.8	141,005	3.5	-39.6%

Table 24: GHG Emissions and Energy Use by Household, 2008-2019

Commercial and Industrial Sector

The C&I Sector includes businesses, municipal government, nonprofits, higher education institutions, and most multi-unit residential buildings, depending on the NYSEG classification of the meters. This sector saw a 31.2% decline in emissions from 2008 to 2014 while total energy use increased by 8.8%. As reported in the 2014 Community Inventory, Cornell University made the significant decision to cease the use of coal at its CEP in 2009 and switched to natural gas. This fuel change is reflected in the sector's 91% increase in natural gas consumption, despite non-Cornell commercial and industrial operations reducing their consumption by 24.3%. In 2019, Cornell CEP used 30.4 million therms of natural gas, accounting for 66% of all natural gas consumed in the C&I Sector.

In continuance with the 2014 Community Inventory, Cornell CEP saw a 7,485% increase in fuel oil used between 2008 and 2014. This spike was explained by Cornell's need to rent fuel oil-fired boilers in 2014 to provide back-up heat in the event of primary boiler or turbine failure while Cornell waited for the installation of new boilers. Since 2014, Cornell has installed new additional permanent back-up gas-fired boilers and no longer needs temporary boilers, thus explaining the 1,473% rise in Cornell CEP's fuel oil consumption between 2008 and 2019.

Renewable energy increased exponentially between 2008 and 2019, with solar PV projects expanding by 71,818.3% and Cornell's hydroelectric plant by 135.5% due to a turbine re-build project between 2008 and 2019 that improved hydro plant operations.

Unit Measure	Updated 2008	2019	% Change
Total Natural Gas (therms)	25,552,696	48,865,801	91.20%
NYSEG Commercial & Industrial	24,341,696	18,433,611	-24.30%
Cornell CEP Use	1,211,000	30,432,190	2413.00%
Total Electricity (kWh)	492,615,286	693,862,195	40.80%
NYSEG Commercial Figure	492,529,663	466,428,000	-5.30%
Cornell CEP Generation	26,700,000	258,482,000	868.10%
Cornell Elec Purchase	220,100,000	17,300,000	-92.10%
Cornell Elec Export	0	-77,200,000	NA
Solar	29,968	21,552,195	71818.30%
Hydro	3,100,000	7,300,000	135.50%
Total Fuel Oil (US gal)	6,441,541	2,267,282	-64.80%
Commercial Figure	6,438,341	2,247,199	-65.10%
Cornell CEP Use	3,200	20,083	527.60%
Propane (US gal)	603,893	570,144	-5.60%
Coal (ton)	65,420	0	-100%
MMBtu	**Updated 2008**	**2019**	**% Change**
Total Natural Gas	2,555,269	4,886,600	91.20%
NYSEG Commercial Figure	2,434,169	1,843,400	-24.30%
Cornell CEP Use	121,100	3,043,200	24137%
Total Electricity	2,523,243	2,368,126	-6.15%
NYSEG Commercial Figure	1,680,944	1,591,900	-5.30%
Cornell CEP Generation	91,104	882,191	868.30%
Cornell Elec Purchase	751,195	59,044	-92.10%
Cornell Elec Export	0	-263,481	NA
Solar	10,578	73,557	595.40%
Hydro	102	24,915	24326.50%
Total Fuel Oil	915,454	319,562	-65.10%
Commercial Figure	915,167	315,049	-65.60%
Cornell CEP Use	287	4,513	1472.50%
Propane	54,960	51,883	-5.60%
Coal	960,709	0	-100.00%
TOTAL	**7,009,635**	**7,626,171**	**8.80%**
MTCO2e	**Updated 2008**	**2019**	**% Change**
Total Natural Gas	135,858	148,857	9.57%
NYSEG Commercial Figure	129,417	98,042	-24.24%
Cornell CEP Use	6,441	50,815	688.93%
Total Electricity	248,027	123,622	-50.20%
NYSEG Commercial Figure	161,850	53,767	-66.80%
Cornell CEP Generation	13,296	76,768	477.40%
Cornell Elec Purchase	72,327	1,986	-97.20%
Cornell Elec Export	0	-8,899	NA
Solar	0	0	NA
Hydro	0	0	NA
Fuel Oil	68,518	23,694	-65.40%
Commercial Figure	68,481	23,488	-65.70%
Cornell CEP Use	37	206	456.70%
Propane	3,406	3,220	-5.50%
Coal	140,204	0	-100.00%
TOTAL	**596,013**	**299,401**	**-49.80%**

Table 25: GHG Emissions and Energy Use in the Commercial and Industrial Sector, 2008-2019

Village of Groton Electric

The Groton Electric system reduced the amount of electricity it purchased by 1% between 2008 and 2019; however, emissions decreased by 100% as a result of its municipal electric system's transition to renewable energy.

kWh	Updated 2008	2019	% Change
Electricity	27,503,611	27,222,903	-1.0%
MMBtu	**Updated 2008**	**2019**	**% Change**
	93,846	92,911	-1.0%
MTCO2e	**Updated 2008**	**2019**	**% Change**
	2,305	0	-100%

Table 26: GHG Emissions and Energy Use in the Village of Groton, 2008-2019

Transportation

There are distinct caveats in these transportation data that should be considered when doing a time series comparison. Vehicle Miles Traveled (VMT) is based on modeling software that changes over time and reflects only residential journey-to-work trips with bus miles driven added to the total and truck and motorcycle miles driven also added based on estimates of percentage of those vehicles in local class counts. In 2019, updated VMT was not available, so updated class counts were applied to historic VMT data to produce the energy and emissions estimates.

The other concern is that the miles per gallon data by vehicle class (e.g., "passenger vehicles") from National Transportation Statistics are not granular enough to be able to see much change in emissions from local conversion to EVs, hybrids, or very fuel-efficient vehicles. Even if the local mix becomes highly efficient or electrified, these numbers will not change until such advancements are seen on the national level. Therefore, the number of EVs registered in Tompkins County is now being tracked — increasing to 644 by the end of 2019, a significant jump from the 136 EVs registered in 2014. Given that EVs were included in the class counts for "passenger vehicles," the increased penetration of EVs in the community may explain the 26.4% decrease in total gasoline gallons consumed from 2008 to 2019, despite total gasoline VMT remaining flat.

US gal	Updated 2008	2019	% Change
Gasoline	28,645,469	21,068,930	-26.4%
Diesel	4,532,044	4,982,651	9.9%
TOTAL	**33,177,513**	**26,051,581**	**-21.5%**
MMBtu	**Updated 2008**	**2019**	**% Change**
Gasoline	3,580,900	3,497,100	-2.3%
Diesel	623,040	833,488	33.8%
TOTAL	**4,203,940**	**4,330,588**	**3.0%**
MTCO2e	**Updated 2008**	**2019**	**% Change**
Gasoline	253,715	246,658	-2.8%
Diesel	46,107	61,667	33.7%
TOTAL	**299,822**	**308,325**	**2.8%**

Table 27: GHG Emissions and Energy Use in the Transportation Sector, 2008-2019

Fuel	Vehicle	Annual VMT		
		Updated 2008	2019	% Change
Gasoline	Passenger Vehicle	521,667,155	512,151,422	-1.8%
	Motorcycle	5,070,884	3,177,118	-38.5%
	Light Truck (incl Gadabout)	112,707,455	123,713,305	9.8%
	Subtotal	**639,445,494**	**639,041,845**	**-0.1%**
Diesel	Transit & School Bus	2,800,000	2,963,191	5.8%
	Medium Truck	20,156,762	20,778,352	3.1%
	Heavy Truck	8,747,274	9,976,151	14.0%
	Subtotal	**31,704,037**	**33,717,694**	**6.3%**
Total		671,149,530	672,759,539	0.2%

Table 28: Vehicle Miles Travelled by Vehicle Class, 2008-2019

Air Travel

The amount of fuel used to power aircraft flying out of Ithaca Tompkins International Airport declined by 10% between 2008 and 2019, correlating to similar decreases in emissions and energy use.

US Gallon	Updated 2008	2019	% Change
Jet Fuel	1,367,012	1,519,000	11.2%
Aviation Gasoline	44,334	36,000	-18.8%
TOTAL	1,411,346	1,555,000	10.2%
MMBtu	**Updated 2008**	**2019**	**% Change**
Jet Fuel	164,041	182,280	11.1%
Aviation Gasoline	5,320	4,320	-18.8%
TOTAL	169,361	186,600	10.2%
MTCO2e	**Updated 2008**	**2019**	**% Change**
Jet Fuel	13,096	14,680	12.1%
Aviation Gasoline	370	300	-18.9%
TOTAL	13,466	15,160	12.6%

Table 29: GHG Emissions and Energy Use in Air Travel, 2008-2019

Solid Waste

While solid waste generated by the community has declined in total by 55.9%, emissions associated with the decomposition of municipal solid waste and biosolids at the landfills has increased by 13.8%. This is due to a larger fraction of biosolid waste reported in 2019, which emits a higher rate of methane emissions in landfills. This rise in emissions from 2008 to 2019 may be a result of incomplete reporting in 2008.

Short Tons	Updated 2008	2019	% Change
Total Waste	185,724	81,920	-55.9%
Recycled Waste	114,994	17,158	-85.1%

Disposed of Waste in Landfills	70,730	64,762	-8.4%
MTCO2e	**Updated 2008**	**2019**	**% Change**
Waste	37,298	43,295	13.8%

Table 30: GHG Emissions in the Solid Waste Sector, 2008-2019

Agricultural Livestock

There was a 20.6% reduction in livestock populations in Tompkins County between 2008 and 2019, which has resulted in a 9.8% decrease in emissions from the Agricultural Sector.

Number	Updated 2008	2019	% Change
Cattle and calves	23,639	21,502	-9.0%
Sheep and lambs	3,355	1,242	-63.0%
Hogs and pigs	606	249	-58.9%
Goats	962	566	-41.2%
Horses	2,718	1,275	-53.1%
TOTAL	**31,280**	**24,834**	**-20.6%**
MTCO2e	**Updated 2008**	**2019**	**% Change**
Agriculture	103,208	93,128	-9.8%

Table 31: GHG Emissions in the Agricultural Sector, 2008-2019

Power Generation at the Cayuga Power Plant (formerly AES Cayuga)

Cayuga Power Plant reduced generation and emissions substantially between 2008 and 2019 as the plant ceased operations in August 2019.

	2008	2019	Percent Change
Power Generation (GWh)	2,178	80.4	-96.2%
Emissions (MTCO2e)	1,995,806	98,083	-95.1%

Table 32: Power Generation and GHG Emissions at the Cayuga Power Plant, 2008-2019

2008 - 2019 Comparison by Fuel Source

All Fuels

Between 2008 and 2019, Tompkins County entirely shifted away from coal, which largely was replaced by natural gas. As described in the C&I Sector analysis, Cornell University has transitioned its CEP away from coal and has increased its consumption of natural gas. Electricity emissions as a share of the community's total emissions have decreased by 55%, which is further discussed in the section below.

Unit Measure	Updated 2008	2019	% Change
Gasoline (US gallon)	28,645,469	21,068,930	-26.45%
Diesel (US gallon)	4,532,055	4,989,045	10.08%
Natural Gas (therms)	42,571,524	65,674,789	54.27%
Electricity (kWh)	1,063,778,666	1,022,497,614	-3.88%
Fuel Oil (US gallon)	9,041,585	3,759,223	-58.42%
Propane (US gallon)	1,147,667	1,024,844	-10.70%
Jet Fuel (US gallon)	1,367,012	1,519,000	11.12%
Aviation Gasoline (US gallon)	44,334	36,000	-18.80%
Coal (ton)	65,420	0	-100%
TOTAL	NA	NA	NA
MMBtu	Updated 2008	2019	% Change
Gasoline	3,580,900	3,678,200	2.72%
Diesel	623,040	864,715	38.79%
Natural Gas	4,257,152	6,567,500	54.27%
Electricity	3,630,551	3,465,205	-4.55%
Fuel Oil	1,274,260	525,450	-58.76%
Propane	104,443	93,261	-10.70%
Jet Fuel	164,041	182,280	11.12%
Aviation Gasoline	5,320	4,320	-18.80%
Coal	960,709	0	-100.00%
TOTAL	14,600,416	15,380,931	5.35%
MTCO2e	Updated 2008	2019	% Change
Gasoline	253,715	246,658	-2.78%
Diesel	46,107	61,667	33.75%
Natural Gas	226,375	238,258	5.25%
Electricity	346,183	157,336	-54.55%
Fuel Oil	95,233	39,025	-59.00%
Propane	6,477	5,788	-10.64%
Jet Fuel	13,096	14,860	13.47%
Aviation Gasoline	370	300	-18.90%
Coal	140,204	0	-100.00%
TOTAL	1,127,760	763,893	-32.26%

Table 33: All Fuels Use and Emissions, 2008-2019

Electricity

GHG emissions from electricity have declined in the community between 2008 and 2019 due to a shift in the types of electricity consumed. While the amount of energy consumed has marginally declined by 4.3%, emissions fell 55%. This dichotomy indicates the community's shift away from traditionally more carbon-intensive electricity fuels like coal and towards natural gas, which has a lower emission rate. The adoption of renewable energy has substantially increased in the community since 2008, with solar PVs contributing a larger share of electricity consumption while minimizing emissions.

kWh	Updated 2008	2019	% Change
Commercial & Industrial	**742,459,631**	**693,862,195**	**-6.55%**
NYSEG Com Figure	481,529,663	466,428,000	-3.10%
Cornell CEP Generation	26,700,000	258,482,000	868.10%
Cornell Elec Purchase	220,100,000	17,300,000	-92.10%
Cornell Elec Export	0	-77,200,000	NA
Solar	29,968	21,552,195	71817.40%
Hydro	3,100,000	7,300,000	135.50%
Residential	**293,815,424**	**302,859,496**	**3.1%**
NYSEG Res Figure	293,371,081	292,398,000	-0.30%
Solar	444,343	10,461,496	2254.40%
Groton	**27,503,611**	**27,222,903**	-1.00%
TOTAL	**1,063,778,666**	**1,026,217,929**	**-3.50%**
MMBtu	**Updated 2008**	**2019**	**% Change**
Commercial and Industrial	**2,533,923**	**2,368,126**	**-6.50%**
NYSEG Com Figure	1,680,944	1,591,900	-5.30%
Cornell CEP Generation	91,104	882,191	868.30%
Cornell Elec Purchase	751,195	59,044	-92.10%
Cornell Elec Export	0	-264,481	NA
Solar	102	73,557	72014.70%
Hydro	10,578	24,915	135.50%
Residential	**1,002,782**	**1,033,650**	**-3.08%**
NYSEG Res Figure	1,001,266	997,945	-0.30%
Solar	1,516	35,705	2255.20%
Groton	**93,846**	**92,911**	**-1.00%**
TOTAL	**3,650,551**	**3,493,687**	**-4.30%**
MTCO2e	**Updated 2008**	**2019**	**% Change**
Commercial and Industrial	**247,473**	**123,662**	**-50.03%**
NYSEG Commercial Figure	161,850	53,767	-66.80%
Cornell CEP Generation	13,296	76,768	477.40%
Cornell Elec Purchase	72,327	1,994	-97.24%

Cornell Elec Export	0	-8,899	NA
Solar	0	0	NA
Hydro	0	0	NA
Residential	**96,405**	**33,706**	**-65.00%**
NYSEG Res Figure	96,405	33,706	-65.00%
Solar	0	0	NA
Groton	**2,305**	**0**	**-100%**
TOTAL	**346,183**	**157,336**	**-54.55%**

Table 34: Electricity Use and Emissions, 2008-2019

Thermal Energy

The consumption of energy used to heat water and buildings decreased in the Residential Sector and increased in the C&I Sector between 2008 and 2019, while emissions for both decreased by a total of 40%. This decline in emissions is likely explained by Cornell CEP's decision in 2009 to shift from coal to natural gas.

Unit Measure	Updated 2008	2019	% Change
Residential			
Electricity (kWh)	41,134,159	67,251,540	63.50%
Natural Gas (therms)	17,018,828	16,808,988	-1.20%
Fuel Oil (US gallon)	2,600,044	1,491,941	-42.60%
Propane (US gallon)	543,774	454,700	-16.40%
Commercial and Industrial			
Natural Gas (therms)	25,552,696	48,865,801	91.20%
Sub-category: NYSEG Meters	24,341,696	18,433,611	-24.30%
Sub-category: Cornell Use	1,211,000	30,432,190	2413.00%
Fuel Oil (US gallon)	6,441,541	2,267,282	-64.80%
Sub-category: Commercial and Industrial, non-Cornell	6,438,341	2,247,199	-65.10%
Sub-category: Cornell Use	3,200	20,083	527.60%
Propane (US gallon)	603,893	570,144	-5.60%
Coal (tons)	65,420	0	100%
MMBtu	**Updated 2008**	**2019**	**% Change**
Residential	**2,250,562**	**2,157,628**	**-4.13%**
Electricity	140,390	229,462	63.40%
Natural Gas	1,701,883	1,680,900	-1.20%
Fuel Oil	358,806	205,888	-42.60%
Propane	49,483	41,378	-16.40%
Commercial and Industrial	**4,372,251**	**5,258,045**	**20.26%**
Natural Gas	2,555,269	4,886,600	91.20%

Sub-category: NYSEG Meters	2,434,169	1,843,400	-24.30%
Sub-category: Cornell Use	121,100	3,043,200	24222.50%
Fuel Oil	801,318	319,562	-60.10%
Sub-category: Commercial, non-Cornell	801,031	315,049	-60.67%
Sub-category: Cornell Use	287	4,513	1472.50%
Propane	54,955	51,883	-5.60%
Coal	960,709	0	-100.00%
TOTAL	**6,622,812**	**7,415,673**	**11.97%**
MTCO2e	**Updated 2008**	**2019**	**% Change**
Residential	**133,800**	**115,051**	**-14.00%**
Electricity	13,497	7,752	-42.50%
Natural Gas	90,517	89,401	-1.20%
Fuel Oil	26,715	15,330	-42.60%
Propane	3,071	2,568	-16.40%
Commercial and Industrial	**347,986**	**175,771**	**-49.50%**
Natural Gas	135,858	148,857	9.60%
Sub-category: NYSEG Meters	129,417	98,042	-24.20%
Sub-category: Cornell Use	6,441	50,815	688.90%
Fuel Oil	68,518	23,694	-65.40%
Sub-category: Commercial, non-Cornell	68,481	23,488	-65.70%
Sub-category: Cornell Use	37	206	456.80%
Propane	3,406	3,220	-5.50%
Coal	140,204	0	-100.00%
TOTAL	**481,786**	**290,822**	**-39.60%**

Table 35: Thermal Energy Use and Emissions, 2008-2019

Transportation Fuels

There was a 26.4% reduction in gasoline utilized from 2008 to 2019, resulting in an overall decline of 21.5% in transportation fuels used. This may, in part, be a result of the growth of EV adoption in the County.

US Gallons	Updated 2008	2019	% change
Gasoline	28,645,469	21,068,930	-26.4%
Diesel	4,532,055	4,982,651	9.9%
TOTAL	**33,177,524**	**26,051,581**	**-21.5%**

Table 36: Transportation Fuels Use, 2008-2019

Next Steps

The detailed results of this Community Inventory should be used to implement the Energy Strategy of 2019, which looks to achieving net-zero emissions as soon as reasonably possible. In addition to local actions to promote renewable energy, beneficial electrification of heating and cooling systems, and electric vehicles, it will be important to support the electric grid's transition to renewable energy and to support the New York State Climate Leadership and Community Protection Act's aggressive goals to expand renewable energy with a 2040 target of 100% zero-emissions electricity.