distribution. The findings are summarized by each of the four Focus Areas, with aggregate data for each building type.

TRC then used the projected square footages of the proposed and potential developments in the area to estimate the electrical and natural gas demand growth for the next 10 years based on average energy use values from US Energy Information Administration (EIA) for different facility types. The information sources and square footage for each projected new construction project are indicated on the associated tab for each area in the Tompkins County Energy Focus Areas Master Workbook September 2016[1]. This was done for three different scenarios: moderate growth, aggressive growth, and build out (maximum construction as permitted). Using these data TRC worked with NYSEG to determine if these loads could be met with the existing distribution infrastructure in the area. The areas of potential growth were mapped out and then overlaid with utility distribution maps in order to identify the circuits and capacities. The figures below summarize the projected growth in square footage, peak electric and peak natural gas for each of the Focus Areas. For example, the south hill area can expect to see an increase in peak demand of 2,401 kW under the moderate growth scenario across all sectors and an increase of 11.6 MMBtu/hr for natural gas peak demand across all sectors.

South Hill Area Summary

Aggregate Load Growth by Sector:		From Itemized Assumptions					
		Peak Electric (kW)			Peak Natural Gas (MMBTU/hr)		
Sector	SqFt	Build Out	10 Year - Aggressive	10 Year - Moderate	Build Out	10 Year - Aggressive	10 Year - Moderate
Residential	2,592,600	1,838	1,522	709	23.5	18.7	8.3
Commercial	371,633	1,301	1,091	492	1.8	1.6	0.6
Light Manufacturing	307,017	3,822	1,884	1,200	2.1	0.8	-
Light Manufacturing - Process	307,017	-	-	-	15.2	6.5	2.6
Parking	71,900	13	13	-	-	-	-
Total	**3,343,150**	**6,973**	**4,510**	**2,401**	**42.6**	**27.6**	**11.6**

Figure 1: South Hill Projected Sq. Footage and Peak Electric and Natural Gas Increases

Airport Area Summary

Aggregate Load Growth by Sector:		From Itemized Assumptions (table below)					
		Peak Electric (kW)			Peak Natural Gas (MMBTU/hr)		
Sector	SqFt	Build Out	10 Year - Aggressive	10 Year - Moderate	Build Out	10 Year - Aggressive	10 Year - Moderate
Residential	335,000	237	237	104	3	3	1
Commercial	279,859	1,134	1,134	583	1	1	1
Light Manufacturing	128,000	842	842	263	1	1	0
Light Manufacturing - Process	128,000	579	-	-	1	1	-
Parking	-	-	-	-	-	-	-
Total	**742,859**	**2,214**	**2,214**	**951**	**6.5**	**6.5**	**2.1**

Figure 2: Airport Area Projected Sq. Footage and Peak Electric and Natural Gas Increases

[1] This Microsoft Excel Workbook has been provided to the Tompkins County Planning Department. Access to this workbook is limited as it contains confidential information provided by NYSEG.

East Hill Summary

Aggregate Load Growth by Sector:		From Itemized Assumptions (table below)					
		Peak Electric (kW)			Peak Natural Gas (MMBTU/hr)		
Sector	**SqFt**	**Build Out**	**10 Year - Aggressive**	**10 Year - Moderate**	**Build Out**	**10 Year - Aggressive**	**10 Year - Moderate**
Residential	1,275,000	904	904	578	12	12	7
Commercial	325,000	961	961	961	1	1	1
Light Manufacturing	-	-	-	-	-	-	-
Light Manufacturing - Process	-	-	-	-	-	-	-
Parking	-	-	-	-	-	-	-
Total	**1,600,000**	**1,865**	**1,865**	**1,539**	**12.8**	**12.8**	**8.6**

Figure 3: East Hill Projected Sq. Footage and Peak Electric and Natural Gas Increases

Downtown Area Summary

Aggregate Load Growth by Sector:		From Itemized Assumptions (table below)					
		Peak Electric (kW)			Peak Natural Gas (MMBTU/hr)		
Sector	**SqFt**	**Build Out**	**10 Year - Aggressive**	**10 Year - Moderate**	**Build Out**	**10 Year - Aggressive**	**10 Year - Moderate**
Residential	1,340,059	1,703	1,703	1,703	10.5	10.5	10.5
Commercial	416,460	1,458	1,458	1,458	2.5	2.5	2.5
Light Manufacturing	-	-	-	-	-	-	-
Light Manufacturing - Process	-	-	-	-	-	-	-
Parking	320,000	56	56	56	-	-	-
Total	**2,076,519**	**3,217**	**3,217**	**3,217**	**13**	**13**	**13**

Figure 4: Downtown Projected Sq. Footage and Peak Electric and Natural Gas Increases

Part 1: Ability of Current Electric and Natural Gas Infrastructure to Meet 10 year Future Demand - Conclusions

For the electric side, NYSEG was able to specify how much additional load could be placed on each circuit, and whether the limiting factor was the transformer or the circuit capacity. These results can be found in the "New Load by Circuit" tab of the Tompkins County Energy Focus Areas Master Workbook September 2016. This workbook has been provided to the Tompkins County Planning Department. However, due to the confidential nature of the data, this information has been left out of this report.

Unfortunately, given the interconnected nature of natural gas distribution systems, excess capacity in the gas pipelines could not be provided by the utility. For our build-out growth projections, NYSEG was able to tell us which areas could support the projected load and which areas could not. This confirmed the known natural gas constraint in the Airport Energy Focus Area and did not identify any additional gas constraints.

TRC's primary task under the Energy Focus Area project was to project growth, develop associated load profiles and compare those projected loads to the existing energy infrastructure. This analysis revealed more than adequate capacity for the electric distribution infrastructure in the four Energy Focus Areas, even under the most robust "build-out" scenario, which may be seen in Figure 7, below. No additional gas constraints beyond the known natural gas constraints in the airport area were uncovered.

Total Growth and Load Projections

	Square Feet				
Sector	**Total**	**Downtown**	**South Hill**	**Airport Area**	**East Hill**
Residential	5,542,659	1,340,059	2,592,600	335,000	1,275,000
Commercial	1,392,952	416,460	371,633	279,859	325,000
Light Manufacturing	435,017	-	307,017	128,000	-
Light Manufacturing - Process	435,017	-	307,017	128,000	-
Parking	391,900	320,000	71,900	-	-
Total	7,762,528	2,076,519	3,343,150	742,859	1,600,000

Figure 5: Build Out SF Projection Summary

	kW Build Out				
Sector	**Total**	**Downtown**	**South Hill**	**Airport Area**	**East Hill**
Residential	4,682	1,703	1,838	237	904
Commercial	4,854	1,458	1,301	1,134	961
Light Manufacturing	4,664	-	3,822	842	-
Light Manufacturing - Process	579	-	-	579	-
Parking	69	56	13	-	-
Total	14,269	3,217	6,973	2,214	1,865

	MMBTU/hr Build Out				
Sector	**Total**	**Downtown**	**South Hill**	**Airport Area**	**East Hill**
Residential	48.6	10.5	23.5	3.0	11.6
Commercial	6.9	2.5	1.8	1.3	1.2
Light Manufacturing	3.0	-	2.1	0.9	-
Light Manufacturing - Process	16.5	-	15.2	1.4	-
Parking	-	-	-	-	-
Total	75.0	13.0	42.6	6.5	12.8

Figure 6: Build-Out - Electric and Natural Gas Summary. Green indicates no constraint. Red indicates constrained area.

Part 2: Ability to Address Natural Gas Constraints in Airport Area with All-Electric Buildings and Energy Efficiency - Methodology/Questions Asked

The County then tasked TRC to perform an initial analysis of proposed "non-pipe alternatives" to address the known natural gas constraint in the Airport Focus Area. The solutions evaluated are described below.

A) Solution Evaluated: Promoting the Development of all-electric buildings

For the purpose of this study, all-electric buildings are considered those that use electricity as their primary heating source. This eliminates the use of fossil fuels onsite for heating and domestic hot water. This approach takes advantage of ample electric distribution infrastructure while not requiring additional natural gas utility infrastructure in constrained areas. Electric heat is typically associated with very high operating costs. However, new electric heating technologies and high performance building practices are proving that electric heat is extremely viable and competitive compared to traditional gas-fired heating equipment. Promoting and supporting all electric buildings can support the following goals:

1. Promote economic development and new construction in areas where natural gas is simply not available or capacity is constrained. Lack of natural gas availability is a barrier for developers considering new construction projects. Electricity or other alternatives such as oil or propane may be seen as non-competitive in terms of costs. A proven business case for all-electric buildings can help overcome this barrier.

2. All-electric represents an opportunity for buildings to be part of a zero carbon or carbon neutral solution. Electric fueled buildings paired with renewable electric generation can be carbon neutral.

Key Questions Considered:

Are all-electric buildings viable?

a. Is electric heating technology viable in terms of performance?

Yes, modern electric heating technology refers to heat pumps that use electricity to move heat, rather than old-fashioned electric resistance heat that uses electricity to make heat. Heat pumps do the job of both heating and air conditioning, eliminating the need for separate heating and cooling systems. Air source heat pumps have become more efficient, most significantly they are now able to maintain heating capacity when outside air is as cold as -22 F. The Northeast Energy Efficiency Partnerships (NEEP)[2], a non- profit regional energy efficiency organization (REEO) funded by the Department of Energy has created Cold Climate Air Source Heat Pump Specifications with additional requirements that

[2] http://www.neep.org/initiatives/high-efficiency-products/emerging-technologies/ashp/cold-climate-air-source-heat-pump#Listing Products

seek to ensure adequate cold climate performance. Their website maintains a list of qualified Cold Climate Heat Pumps for reference.

b. What is the initial cost and lifecycle cost?

The initial cost of installing an air source heat pump system, which does both heating and cooling, is typically more than the cost of installing a gas-fired system with a furnace for heating and central air conditioning for cooling. If the cost of adding new natural gas service piping is included for building sites that are not already served by natural gas, then electric heat pumps may have a lower initial cost.

The energy cost to operate electric heat pump heating compared to natural gas furnace heating depends on the relative cost of electricity compared to natural gas. Currently, using typical gas rates and typical electric rates without demand charges, electric heat pumps are cheaper to operate than natural gas furnaces. A NYSERDA Study on Heat Pump Potential[3] for energy savings found that the Upstate NY area was the most cost effective for heat pump use due to lower equipment and labor costs as well as the lowest winter electric costs in the state.

Using typical residential rates for electricity, natural gas, and propane, over a 20-year period, the higher initial cost for a heat pump system is offset by lower operating costs, and the heat pump system has a lower 20-year lifecycle cost. This also assumes that current costs of these fuels will remain the same.

Table: Estimated Costs for New Residential Construction

Technology Type	Installation Cost, $/sf	Energy Cost, $/sf/year	Maintenance Cost, $/sf/year	20 Year Lifecycle Cost, $/sf
Air-Source Heat Pumps	$8.00	$1.14	$0.10	$32.80
Natural Gas Furnace with Air Conditioning	$6.00	$1.36	$0.10	$35.20
Propane Furnace with Air Conditioning	$6.00	$1.80	$0.10	$44.00

Furthermore, electric heat pump heating may become increasingly attractive in a rising natural gas price environment. In recent years, natural gas has been at historic lows. In 2016, the EIA reported the lowest natural gas prices in nearly 20 years and some analysts believe that natural gas prices will remain low for the foreseeable future. However, there are numerous market forces, such as rising LNG exports, an increasing number of natural gas-fired power plants, reduced drilling and exploration (due to low commodity prices) that could increase natural gas fuel costs within the near future and certainly within the 20 year horizon. It is also plausible to see the emergence of a carbon tax at some point over the

[3] Bower, Steve. "Heat Pumps Potential for Energy Savings in New York State *NYSERDA*." N.p., n.d. Web. <https://www.nyserda.ny.gov/About/Publications/EA-Reports-and-Studies/EERE-Potential-Studies>.

Figure 7: Natural Gas Efficiency Potential[8]

2. *What are the types of energy efficiency upgrades and those that represent the highest opportunity?*
    a. Within the residential sector, there are three main areas to target for energy efficiency upgrades. Water Heating, Space Heating, and Appliances. The savings potentials are shown below as a percent of total potential.

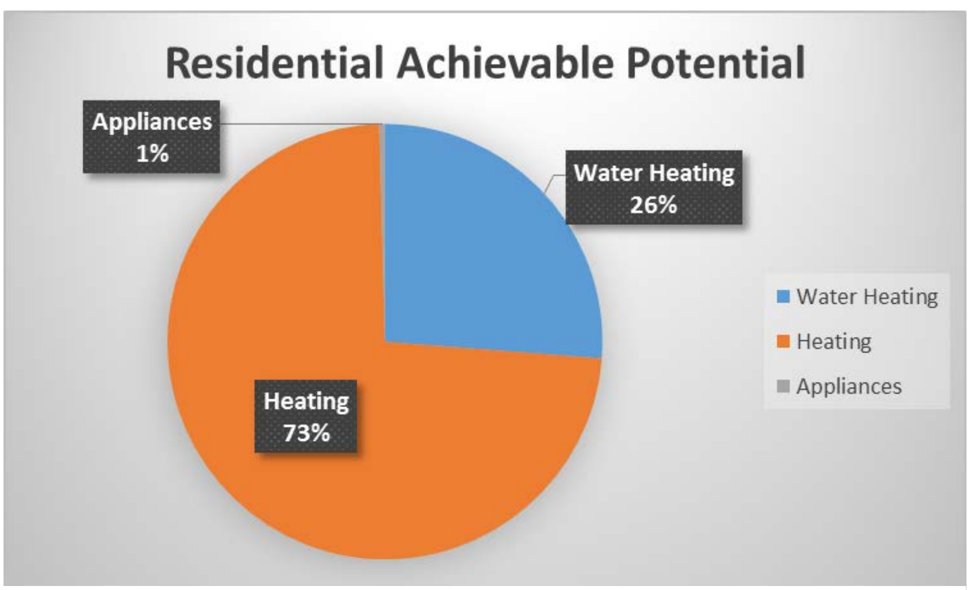


Figure 8: Residential Sector NG Efficiency Potential[6]

[8] Mosenthal, Philip. "Energy Efficiency and Renewable Energy Potential Study of New York State." *NYSERDA*. N.p., n.d. Web. <https://www.nyserda.ny.gov/About/Publications/EA-Reports-and-Studies/EERE-Potential-Studies>.

b. The space heating energy efficiency measures include measures such as insulating and sealing the building shell, as well as technologies such as condensing hot water boilers and condensing furnaces. Condensing-style space heaters can maximize the useful heat created by burning natural gas by condensing the exhaust gases formed during combustion. Depending on the application, condensing furnaces and boilers can reach efficiencies varying between 88% and 95%. These heaters provide savings from 10 % to 15% over traditional systems. Additionally using smart thermostats and controls can provide additional savings of up to 10%.
c. The water heating energy efficiency measures include condensing storage and tankless hot water heaters as well as low flow aerators on showers and faucets. Installing low flow aerators on shower heads and faucets can reduce water consumption by up to 55% and consequently eliminate the energy that would have been required to heat the extra water. While it is not economically feasible to replace functioning natural gas water heaters with electric heat pump water heaters, it is feasible to do so at end of life. Promoting such products can help to decrease the load but it will come as additional electric load. For the area in question, however, electric capacity is currently not an issue.

3. *Using the statewide market potential research, what savings would be realized in the Airport Area? Describe how you arrived at that estimate.*

We cannot answer this question to a high degree of accuracy without additional data. NYSEG has not provided any detailed information about gas loads in the area. They have stated that the dynamic nature of gas infrastructure makes it difficult to provide loads and capacity of the gas infrastructure in the airport area. To date, NYSEG has been a strong collaborator on the Energy Focus Area project and has provided detailed load information about their electric distribution, however, has stopped short of providing detailed loads and capacities for natural gas. NYSEG could provide billing data for customers in the focus area in a format where customers remain anonymous to avoid consumer privacy concerns. However, peak gas demand is our concern and since customers are not billed for peak on the gas side NYSEG simply does not have this data. The data analysis effort could also be significant, as the existing building types and square footages, natural gas loads, and end uses would be required for a detailed estimate.

However, using some basic assumptions we can begin to estimate the load in the constrained area. The Village of Lansing within Tompkins County makes up the majority of the constrained Airport Area. It had a population of 3417 as of the 2010 census with 1620 households. Assuming the median square footage of 2338 from census.gov, we can estimate the residential load of Village of Lansing using a residential square footage of 3,787,569 gives roughly 34 MMBTU/Hr peak using the same assumptions used in phase 1 of the study. As discussed in question 1, there is an 11% achievable potential for natural gas reduction, which if achieved through targeted efficiency programs would allow for 3.74 MMBTU/Hr of additional load. Our 10 year moderate growth projection would only require 2.1 MMBTU/Hr of additional peak loads. However, this is still well short of the aggressive load projection of 6.5 MMBTU/Hr.

Natural gas efficiency strategies will likely lead to deferring distribution system upgrades on a utility scale level, however, targeted “non-pipe solutions” to address natural gas constraints are relatively new and lack a proven track record of results. Nonetheless, the fact that they are new and emerging does not necessarily mean they cannot be effective. Market innovation has shown that non-wire alternatives can effectively defer investments in electric infrastructure. More and more utilities are considering “non-pipe alternatives”. Vermont Gas Systems, for example, builds energy efficiency program results into its integrated resource planning stating that natural gas energy efficiency programs would reduce gas purchases as well defer investments in infrastructure. Unfortunately, we are aware of no studies published on targeted natural gas energy efficiency for deferred infrastructure investment. There are many studies that have proven that targeted energy efficiency projects intended to delay electric infrastructure investments are effective. Developing a targeted solution for the Airport Area would require additional information and cooperation from the utility as well as a detailed cost-benefit analysis to quantify the economic, social, and environmental benefits. We recommend that targeted energy efficiency be considered as a key component of a multiple faceted solution.

Environmental Benefits

4. *Explain the basic relationship of energy efficiency upgrades within buildings and the reduction in carbon emissions?*

The figure below represents New York State’s natural gas consumption by end use. Aside from the natural gas used to produce electricity, the largest end user of natural gas in New York State is the residential sector. As shown below, 34% of all natural gas used in New York State is used for residential buildings including space heating, domestic hot water, and cooking. Nearly 60% of the natural gas is used in the commercial and residential sectors making them prime candidates for targeted energy efficiency measures.

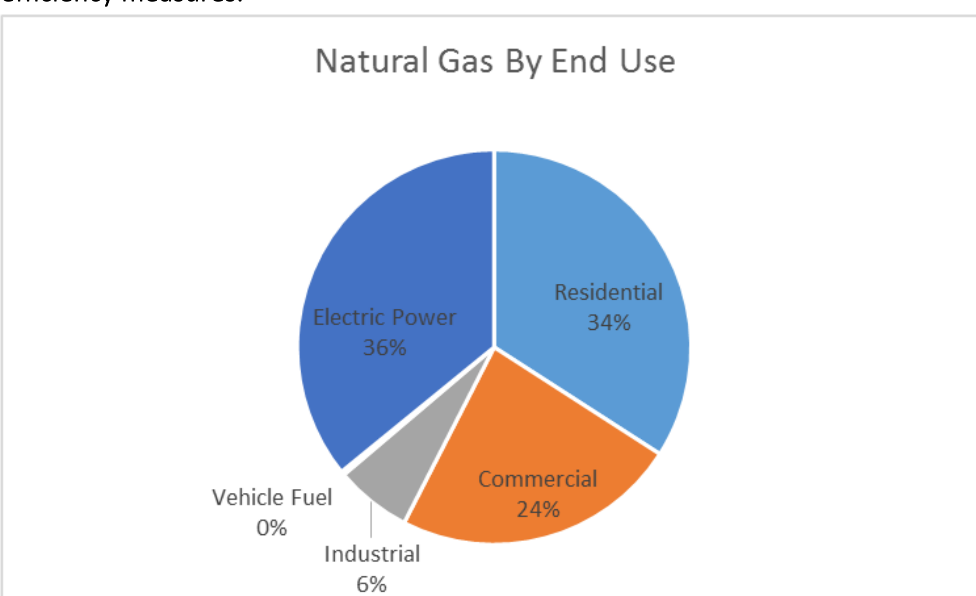


Figure 9: EIA State Data NG by End Use 2014

Approximately 40% of the power produced in New York State comes from traditional fossil fuel combustion, with the remaining percentages composed of primarily hydroelectric and nuclear. So it is important to understand that while consumer sentiment in the area may not want additional natural gas infrastructure in the area, the electricity used to heat facilities instead will in part be generated from fossil fuels. This generation mix is likely to change as New York State has established a goal of 50% renewable generation by 2030.

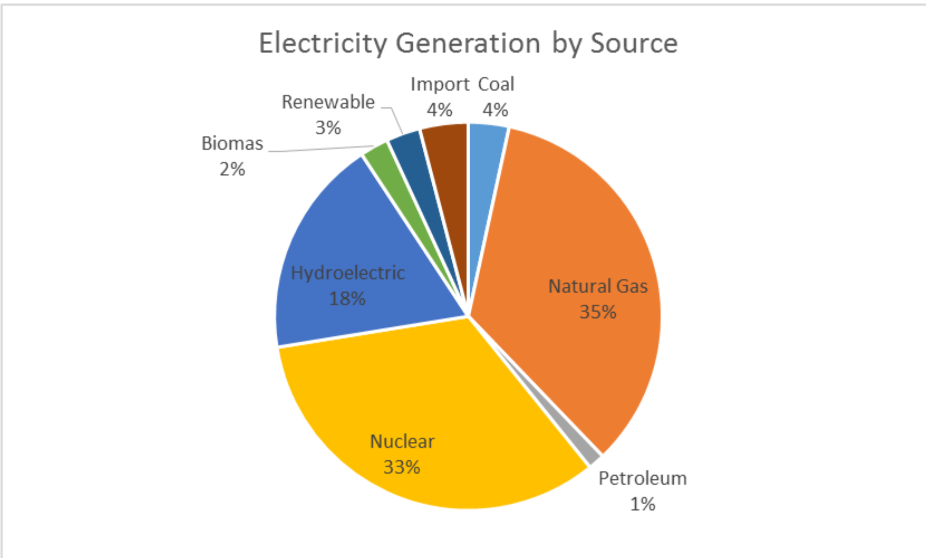


Figure 10: Electricity Generation by End Use - EIA State Data 2014

Aside from logistical concerns for developers and county planning officials, there are also environmental impacts that need to be considered, as well as interactions within the distribution system, energy policy and consumer sentiment.

Additionally, New York State's move towards natural gas has produced a net decrease in CO2 emissions as coal and oil power plants are replaced with natural gas. However, this does not account for methane leakage associated with Hydraulic Fracking. The majority of New York State's natural gas comes from the Marcellus Shale site which relies on fracking for extracting natural gas. Estimates suggest that the State emissions could increase by up to 25% if methane leakage is accounted for[9]. New regulations are in place to mitigate leakages, however, only apply to new facilities.

[9] Anthony J. Marchese, Methane Emissions From United States Natural Gas Gathering and Processing. American Chemical Society, 2015 Web. < http://pubs.acs.org/doi/pdf/10.1021/acs.est.5b02275>.

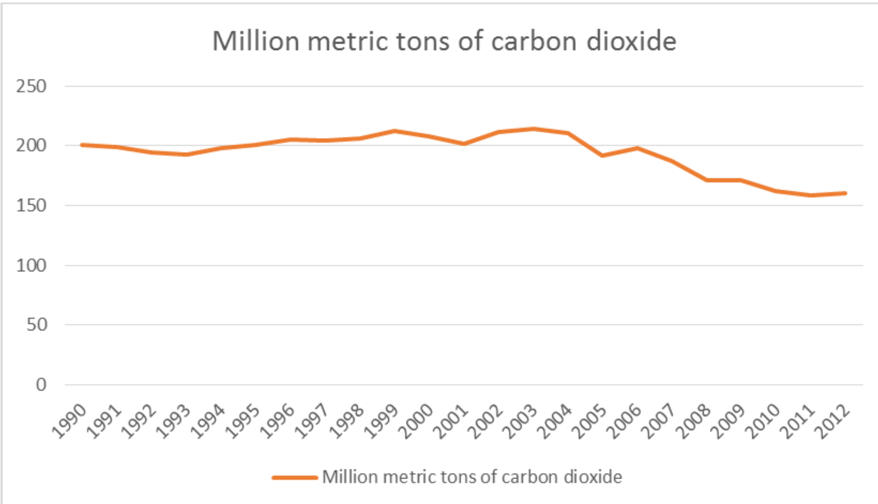
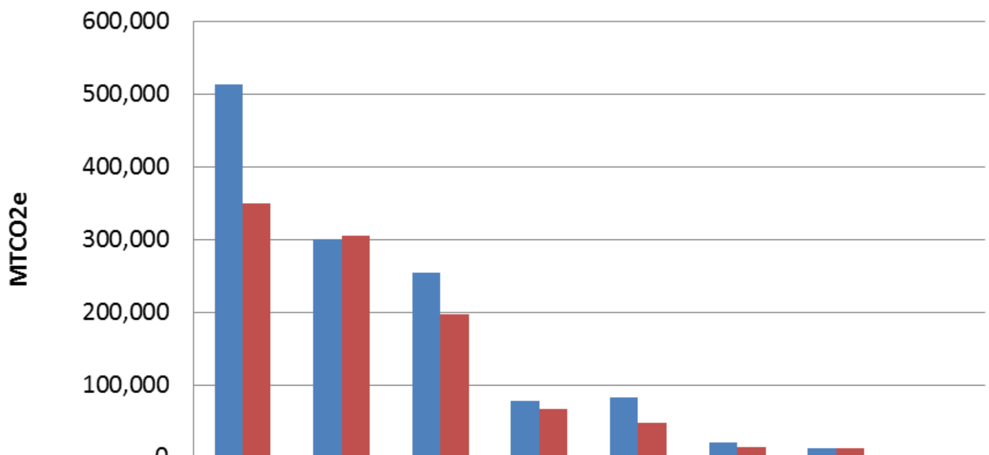


Figure 11: New York State Emissions - EIA State Data 2014

Trends in Tompkins County have followed a similar decrease in emissions as shown below.



	Com	Trans	Res	Agr	Ind	Waste	Avi Travel	Groton
Updated 2008	513,452	299,822	254,293	78,400	82,007	21,318	13,466	2,305
2014	349,579	304,923	197,241	66,612	48,141	15,114	12,172	2,137

However, when the GHG data is analyzed with the inclusion of methane leakage, the reduction is not so evident. Additionally, if the leakage is closer to 19% percent estimate the County will have seen an increase in GHG emissions of 143% since 2008.