# LANSING AS A MICROCOSM OF NEW YORK STATE'S ENERGY PROBLEMS

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# EXECUTIVE SUMMARY

There are currently moratoriums on new natural gas service for utility customers in three areas of New York State because of an inability to construct pipelines. Those areas include the Lansing area in Tompkins County serviced by NYSEG, Westchester County serviced by Consolidated Edison, and Long Island serviced by National Grid. The goals of the opposition to the pipelines that have resulted in these moratoriums, is to restrict the use of natural gas to minimize the effect of methane on Greenhouse Gas Emissions (GHG) and promote renewable generation and electrified onsite heating to replace natural gas combustion.

While the installation of renewable generation is extremely important, its output is very limited relative to the large loads that society is expecting it to replace. As a result, it will take far longer to achieve an energy system devoid of fossil fuels than what would be the ideal timeframe. Further, energy storage is a major issue and the solutions are elusive. Therefore, it is essential that what renewable generation capacity is available is applied in the most efficient manner possible.

This paper uses quantitative analysis to analyze the oldest moratorium in Lansing, New York to show the effect of the moratoriums on energy usage and Greenhouse Gas Emissions. The math shows that Gas Pipeline Moratoriums will not significantly reduce GHG Emissions and may in fact increase both energy usage and GHG Emissions depending on the solutions employed to meet a community's energy needs in lieu of the pipeline. Further, they will cause renewable generation to be used ineffectively resulting in an opportunity cost being imposed on employing more effective methods of Greenhouse Gas Reduction.

Based upon the analysis, suggestions for a more effective solution appear at the end of the paper.

This analysis is only applicable to New York and areas with similar climates. The math for the heat pumps will be different for warmer climates as the heat pump efficiencies will be higher. Other areas may also have higher wind speeds on land or better solar resources. The math for the fossil fuel emissions from the generating plants will be the same. Further, nothing in the following pages is intended to be an indictment of renewables or to discourage their use. It is essential that we transition to a renewable based energy infrastructure but the available resources, the timeframe, and the most efficient way to accomplish that have to be carefully considered to avoid unintended side effects that will hamper society's ability to achieve that goal.

# ABSTRACT

There are currently moratoriums on new natural gas service for utility customers in three areas of New York State because of an inability to construct pipelines. Those areas include the Lansing area in Tompkins County serviced by NYSEG, Westchester County serviced by Consolidated Edison, and Long Island serviced by National Grid. The goals of the opposition to the pipelines that have resulted in these moratoriums, is to restrict the use of natural gas to minimize the effect of methane on Greenhouse Gas Emissions (GHG) and promote renewable generation and electrified onsite heating.

While the installation of renewable generation is extremely important, its output is very limited relative to the large loads that society is expecting it to replace. As a result, it will take far longer to achieve an energy system devoid of fossil fuels than what would be the ideal timeframe. Therefore, it is essential that what renewable generation capacity is available is applied in the most efficient manner possible. A positive example of this is the energy policy of the United Kingdom that has achieved a 42% carbon reduction over the past 30 years. Germany offers the opposite example of how policy can go wrong with only a 28% carbon reduction in the past 30 years and almost nothing for the past 9 years, coupled with extremely high energy prices. With its present policies, including these gas moratoriums, New York is more closely following Germany than the United Kingdom. This paper focuses on the oldest moratorium in Lansing, dating to 2017, to look at the ramifications after more than two years and show why New York is headed in the wrong direction. To do so, we explain the following effects and examine following issues:

- The Potential High Costs of Alternative Solutions to natural gas Pipelines.
- A need for natural gas, in spite of the moratoriums. How viable are the alternatives?
- Why Air Source heat pumps will not reduce carbon footprint and in many cases will actually raise it.
- Why relating heat pumps to methane reduction isn't a valid association.
- Why assumptions of many people in New York about the sources of a heat pumps electrical energy are incorrect. Why they will operate at the efficiency of fossil fuel generating plants and not at the state's current energy mix.
- Why the large thermal loads of onsite combustion will overwhelm the state's ability to install renewable generation to compensate for it.
- How renewables fit in to the larger energy landscape and their most efficient application.
- How the moratoriums will have a negative long term economic and carbon footprint impact on the state and how they will translate to more populous Westchester and Long Island.

This paper analyzes these issues from a purely quantitative perspective, devoid of the emotion that has been omnipresent in discussions about methane, fossil fuels, and climate change. If the United Nations reports on climate change are correct, we have a limited amount of time to fix Greenhouse Gas Issues. The decisions that are made must be correct the first time and based upon math, the laws of science, and political realities. Idealistic objectives are noble but the implementation of solutions to the sources of GHG Emissions in a haphazard manner can run counter to the desired outcome. Mitigating damage from one gas may result in more damage from different gases such as NOx or refrigerants. Additionally, causing blackouts and energy shortages will not endear anyone to the effort to combat climate change.

This analysis is only applicable to New York and areas with similar climates. The math for the heat pumps will be different for warmer climates as the heat pump efficiencies will be higher. Other areas may also have higher wind speeds on land or better solar resources. The math for the fossil fuel emissions from the generating plants will be the same. Further, nothing in the following pages is intended to be an indictment of renewables or to discourage their use. It is essential that we transition to a renewable based energy infrastructure but the available resources, the timeframe, and the most efficient way to accomplish that have to be carefully considered to avoid unintended side effects that will hamper society's ability to achieve that goal.

A better, workable plan is presented on page 20 that factors in the realities of the sociopolitical environment, the available financial resources, and a realistic rate of renewable generation installation, while simultaneously resulting in the largest greenhouse gas reduction when compared with other options.

## INTRODUCTION

In the process of researching the gas moratoriums in New York State, information has been collected on the gas moratorium in the Town of Lansing, New York in the Ithaca area of Tompkins County. As a graduate of Cornell in Electrical Engineering and having spent nearly five years in Ithaca, I am very familiar with Lansing and actually lived there while I was in graduate school, near the intersection of Route 13 and Triphammer Road. Unfortunately, the energy issues in Lansing are a microcosm of the problems that New York State will encounter if it persists in its short sighted efforts to oversell the ability of renewables to solve the state's energy problems in lieu of all other options. The Town of Lansing has a population of approximately 11,000 in an area of 69 square miles (159 people/Square mile), an airport, and a commercial zone in the vicinity of the airport. NYSEG, the local utility, has had a natural gas moratorium in place for approximately two and a half years caused by an inability to build a supply pipeline to feed the area. This has resulted from opposition in neighboring communities and also in Lansing. If the problems described on the following pages are duplicated in Westchester with 90 times the population at over 980,000 and 14 times the population density on 430 square miles of land (2279 people/Square mile) or Long Island with over 7.5 million people, both areas currently with their own recent gas moratoriums, the train wreck will be unavoidable. The resulting economic ramifications will be disastrous and worse, they will occur with a net negative effect on greenhouse gas ($CO2_e$ or Carbon Dioxide Equivalent) reduction.

This analysis is only applicable to New York and areas with similar climates. The math for the heat pumps will be different for warmer climates as the heat pump efficiencies will be higher. Other areas may also have higher wind speeds on land or better solar resources. The math for the fossil fuel emissions from the generating plants will be the same. Further, nothing in the following pages is intended to be an indictment of renewables or to discourage their use. It is essential that we transition to a renewable based energy infrastructure but the available resources, the timeframe and the most efficient way to accomplish that have to be carefully considered to avoid unintended side effects that will hamper society's ability to achieve that goal.

## THE PROBLEM

To counter the Lansing moratorium, on December 3, 2019, New York State Electric & Gas (NYSEG) issued a request for proposals (RFP) for an end user reduction or new supply of 120 Mcfh (120,000 cubic feet per hour) of natural gas in the Lansing area to support maintaining the Lansing Gas supply at 70% of its maximum operating pressure during periods of peak natural gas demand during cold weather. These peak load days will occur from October to April, and cold weather and snow can persist into May as I personally experienced during my time there. During the winter of 2018 - 2019, between October 2 and May 6 there were 26 days where the temperature reached 0 degrees-F, some days as low as -8 or -12, and several other days where the temperature was below 10 degrees-F. Temperature data for 8 months of last winter, measured at Ithaca Tompkins Regional Airport in Lansing, is included at the end of the document in Appendix A. The RFP is requiring November, 2021 as the In Service date for the equipment. The cover page of the RFP is included at the end of this document in Appendix D. The RFP, which will be for a period of ten years, allows for a variety of solutions to meet this demand, including efficiency solutions, trucked in natural gas in either liquid (LNG) or compressed (CNG) form, demand response, or air source or ground source heat pumps. The issues with this RFP as it pertains to the goals of the people opposing the pipeline and overall New York State policy are analyzed, as follows.

## ANALYSIS

NYSEG and Lansing have encountered this shortfall only 2.5 years after the implementation of the moratorium. If 10% of the shortfall can be achieved with efficiency measures or demand response, that will still leave 108 Mcfh of natural gas or the equivalent needed to address the problem. This is a number that needs to be put into perspective. 108,000 cubic feet of gas per hour (cfh) is equal to 2,592,000 cubic feet per day. 100 Cubic feet of gas equals a therm (100,000 BTU). So 108,000 cubic feet per hour is 25,920 Therms per day or 2592 Dekatherms (DT) per day. If the trucked in CNG option is used, 2,592,000 cubic feet will result in 15 truckloads per day of the type shown in Figure 1 below, or a similar vehicle, traveling over Lansing's and Tompkins County's roads during the time of year with the worst weather. The vehicle in the photo can hold approximately 170,000 cubic feet (SCF) of CNG and the vehicle specifications appear below it. Trucks are by far the worst method of transporting fossil fuels. Every gallon of diesel fuel consumed during transportation releases 10,180 grams of $CO_2$ (22.44 pounds), as well as significant quantities of NOx which has 298 times the Global Warming Potential (GWP) of $CO_2$ and 25 times that of methane. A list of gases and their GWP appears in Appendix E. As of 2017, the average tractor trailer had a fuel economy of 7 miles per gallon, resulting in every mile of trucked fuel transport releasing 3.2 pounds of $CO_2$, plus additional $CO_2$ on the return trip after unloading. If the average diesel NOx emissions are included, the $CO2_e$ calculates to 7.72 pounds per mile (Appendix E). Just bringing the gas down Route 13 from Cortland, 20 miles away, will result in over two additional tons per day of $CO2_e$ released into the atmosphere. If the gas is being transported from Pennsylvania, just the portion of the trip from NY-PA border on Route 81 via Routes 79 or 96 will result in over 130 miles round trip and between 6 and 8 additional tons of $CO2_e$ daily. In addition, when compared with pipelines, trucks have approximately six times the fatality rate per unit transported, approximately four times the cost, and a 21% higher spill rate. The information can be found in a pdf at the following link: **https://www.strata.org/pdf/2017/pipelines.pdf**

**Figure 1 - 8 Tube Gas Transport Trailer with specifications**

**New 8 Tube Jumbo Trailer (3AAX or UN)**

| Argon SCF | Helium SCF | Nitrogen SCF | Oxygen SCF | Hydrogen SCF | Natural Gas* SCF | Ethylene lbs | Heliox SCF | Air SCF |
|---|---|---|---|---|---|---|---|---|
| 139,579 | 121,412 | 126,774 | 140,076 | 118,442 | 169,766 | 14,636 | 125,553 | 129,730 |

SCF @ 2640 PSI and 70F (or higher)
Tare weight 55,000 lbs app.; Dimensions: 44' long x 98" wide x 8'6" high;
Water Volume: 728 cubic feet; DOT 3AAX-2400+ PSI;
New Trailer; To Meet all US DOT / Transport Canada requirements for above listed gases
*Special permit may be required for NG transport

The 2,592 DT of CNG per day from the RFP is 2.5 times as much as the 1,050 DT that NYSEG used daily in their entire system during 2017 - 2019 as seen in Figure 2 below that was excerpted from page 5 of their 2018-19 Winter Supply Plan. The same information also appears on page 46 of their report where it lists the transport carrier. NYSEG has 873,000 electricity customers and 259,000 natural gas customers in an 18,000 square mile area of central, eastern, and western New York so to increase its trucked natural gas volume by 250% is significant, even though it accounts for only 1/2 of one percent of total volume delivered.

**Figure 2**

NYSEG RG&E July 16, 2018

**Table 1: Total System Firm Peak Day Capacity (DT)**

Company: NYSEG
Service Area: NYSEG TOTAL
Submission Date: July 16, 2018
Version #: 1

| New York State Electric & Gas | 2017-18 Winter | 2018-19 Winter | Design Peak Day Demand [1] |
|---|---|---|---|
| TOTAL | | | |
| Flowing Supplies | 220,465 | 220,657 | |
| Storage Withdrawals | 205,560 | 205,560 | |
| Winter Peaking Service * | 0 | 0 | |
| Renewable Gas** | 0 | 0 | |
| LNG | 0 | 0 | |
| CNG | 1,050 | 1,050 | |
| Cogen Supplies | 0 | 0 | |
| Local Production [2] | 6,180 | 5,466 | |
| Recallable Capacity (AMAs, etc.) | 0 | 0 | |
| Marketer Provided Supplies [3]: | 0 | 0 | |
| Mandatory Retail Access Capacity | 57,095 | 57,095 | |
| Grandfathered Retail Access Capacity | 6,596 | 6,596 | |
| Non- Mandatory Firm Capacity | 0 | 0 | |
| Other Customer Capacity [4] | 62,083 | 62,083 | |
| | | | |
| Peak Day Totals | 559,029 | 558,507 | 512,437 |
| | Peak Day Design Temp: | | -10 |

It does not take a great deal of foresight to understand that this is a potential accident waiting to happen. A truck of a similar type flipped near Binghamton in September, 2019, in 69 degree temperatures with no precipitation at the time, at the junction of Interstates 81 and 88 that required the evacuation of 80 people and released 25% of the trucks methane into the atmosphere. That is a less densely populated area than Lansing. The article at the following URL documents this incident:

https://spectrumlocalnews.com/nys/central-ny/news/2019/09/23/tractor-trailer-crash-on-i-88-prompts-evacuation-of-nearby-homes

The issue of transporting large additional amounts of flammable materials in the Lansing area at that time of year is also personal to me as I have a daughter that is a Cornell student that frequents the mall in Lansing. Tompkins County roads can get extremely icy during the winter months.

Beyond the transport hazard, if the goal of the people pursuing the Gas Moratorium is to reduce GHG (methane) emissions (which it will not accomplish as will be documented later), how is burning large amounts of diesel fuel that is chemically identical to Number 2 (#2) home heating oil and has a $CO2_e$ of over 7.5 pounds per mile considered an environmental improvement over pipelines?

If the heat pump option is chosen, the 1080 Therms per hour shortfall (100,000 BTU/Therm) equals 2000 heat pumps with a heating capacity of 54,000 BTU. That size heat pump will heat a 1500 - 2000 square foot home. NYSERDA has tested Mitsubishi Split System Air Source Heat pumps, which one on-line reviewer referred to as the Porsche of heat pumps, and has ascertained that they will operate during winter with a COP (coefficient of performance) of 2.5, although they lose about 10% - 15% of their efficiency on the zero degree days experienced in the Ithaca area. A higher COP indicates a higher efficiency and results in less energy usage per unit of thermal energy delivered to the home or building. The heat pump review is at the following URL and the Mitsubishi unit is #4 on the list. **https://asm-air.com/heat-pump/top-10-heat-pump-brands-best-heat-pump/**

Other manufacturers claim higher COP's but they don't work that way in the field at New York State's winter temperatures. Most have COP's lower than the Mitsubishi Heat Pumps and they will not work as well at the low temperatures in Central New York. The equipment costs, excluding installation and accessories, for the 54000 BTU Mitsubishi heat pumps are approximately $ 9750 per location. Extrapolated over 2000 heat pumps, that totals to $19,500,000 in just equipment costs. Installed costs could range between $30 million and $40 million for the 2000 heat pumps, or between $ 2700 and $ 3700 per person for every resident of Lansing just to compensate for the RFP shortfall (Appendix G). Ground Source heat pumps would use less energy but would be much more expensive to install, with the heat exchange vertical wells or horizontal field possibly costing as much as the heat pump equipment before any equipment was even purchased, so the cost could be almost double for that option.

There are plans for an 18 Megawatt (MW) Solar Array on the property of the recently closed coal fired electrical generating plant on Cayuga Lake. When new, the expected annual energy output of the 18 MW solar array, calculated using NREL's PVwatt tool, would be 21.67 GWh. However, only 3.3 GWh (15% of array output) would be generated during the months of December through February when the heat pumps would be operating at their peak load. Figuring a COP of 2.5, the 3.3 GWh would keep the 2000 heat pumps operating for approximately the equivalent of 9 days (216 hours), assuming that it could be distributed throughout the 24 hour day which would require large amounts of installed energy storage. The entire annual energy output of the array would operate the heat pumps for 2 months, perhaps slightly longer if the duty cycle was reduced because of warmer weather. The balance of the time, the heat pumps would be operating on fossil fuel generation, and not at the state's current energy mix, an issue that will be examined on page 9. That is the problem with the electrification of thermal loads and renewables. The thermal loads are so relatively large and the efficiencies of the existing gas equipment that they would replace are so high that the heat pumps will outstrip the ability to add renewable generation to keep up with the increased load. The additional fossil fuel generation needed to run these thermal electric loads will actually increase GHG footprint.

But while the annual energy equivalents would yield two months of operation, the reality is that the solar array will offset only 216 mid-winter hours during daylight when the array is new. The 18 megawatt array is projected to cost approximately $26 million and has been in the planning stages since at least 2017. So for a total investment of between approximately $ 33 million and $ 43 million (heat pumps plus 15% of the array cost) , Lansing will have additional electric heat that operates for nine days on renewables and the balance of the winter on increased fossil fuel generation during the times when the renewable generation is not available. Even using the higher efficiency heat pumps, the increased fossil fuel generation will be on the order of 5% higher to support the electrification of those thermal loads, resulting in no significant decrease in natural gas or fossil fuel usage. If less expensive heat pumps are used, the fossil fuel usage will be even higher. As the solar array ages, the output will drop and the numbers will get worse. After ten years, a 10% to 15% drop in energy output can be expected and further deterioration of energy output will occur until the array needs replacing after approximately 25 years. The entire time, barring the installation of even more renewables, fossil fuel generation will be increasing to compensate for the additional load.

If the trucked in gas option is used, fossil fuel usage will increase by the amount of diesel fuel needed for transport plus the increased natural gas losses during transportation that have been documented. Greenhouse gas levels will increase even more than that because of the higher carbon footprints of diesel fuel and NOx relative to natural gas. What this shows is that you can block pipeline construction and spend large amounts of money to support alternative forms of electric heating plus renewable generation, but it will not have any significant effect on fossil fuel usage and in all likelihood, it will increase fossil fuel usage and greenhouse gas levels. Similarly, the annual energy output of the 18 Megawatt and 11 Megawatt solar arrays being built in Dryden will be more than offset by the additional loads of the heat pumps in Lansing, if that option is implemented, and the electrified thermal loads of newer buildings in Ithaca with the 775 housing units that were mentioned in Tompkins County Energy Assessment of March, 2017. The Tompkins County report can be found at the following URL:

http://tompkinscountyny.gov/files2/planning/Energy-greenhouse/TC%20Energy%20Focus%20Area%20%20Phase%20II%20Report%20FINAL%205-1-17%20V1.pdf

Unfortunately, the Tompkins County Report reads more as an advertisement for heat pumps than as a reliable engineering document. There are several errors in it which I will document here. First, it discusses carbon emissions and energy usage on page 4 with the following statement:

> *f) Carbon emissions: Even without accounting for methane emissions associated with natural gas production, transmission and distribution, using the current electricity generation mix in NY State an electric air source heat pump decreases emissions 66 percent compared to a natural gas furnace. Including even modest estimates of methane leakage increases the CO2 equivalent emissions from a natural gas furnace by a factor of two to three times.*

The paragraph above uses a false assumption to calculate the source of the heat pumps energy. New York State's current electrical generation mix includes four nuclear plants on three sites. One of them, Indian Point, will close by 2022 and is being partially replaced by combined cycle natural gas generating plants with a 200 MW shortfall still to be resolved. Plans for a 1200 MW Meadowlands generating plant in New Jersey that would deliver power to New York City were recently blocked by the Governor there. New York State also has the largest Hydroelectric generation capacity East of the Mississippi River, number three in the entire United States behind Washington and Oregon. The following URL documents U.S. hydropower capacities:

**https://www.eia.gov/energyexplained/hydropower/where-hydropower-is-generated.php**

However, it will not be renewable generation, nuclear, or the Hydro plant at Niagara Falls supporting the heat pumps, which is what the Tompkins County report is implying. What the Tompkins County Report and many similar reports ignore is that winter and summer base electric demand are both higher than New York State's 13 Megawatts of non-carbon producing generation (Appendix F). As a result, any additional electric load will require increased use of fossil fuel generation equivalent to the heat pumps electric demand. Using NYSERDA's suggested COP of 2.5 for a Mitsubishi heat pump (the most efficient one) operating in the field, the air source heat pumps operate with a slightly higher carbon footprint than 95% efficient gas combustion equipment. From a total energy perspective, solar panels and other renewables won't change that fact because the rate of heat pump installation in Tompkins County is, or will be, higher with this RFP than the rate of renewables installation in terms of electric load versus new renewable energy output. Further, the solar panels generate the least of their energy during the heating season.

Second, in paragraph "f" above it associates heat pumps with a reduction in methane emissions from natural gas production by saying that "*an electric air source heat pump decreases emissions 66 percent compared to a natural gas furnace. Including even modest estimates of methane leakage increases the CO2 equivalent emissions from a natural gas furnace by a factor of two to three times*".

The previous statement implies that switching to heat pumps will avoid that methane leakage. However, on page 9 of the same document it states the following when trying to say that heat pumps are better because of rising gas prices:

> *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.*

This contradicts the claim that heat pumps will reduce methane emissions because if the gas is liquefied and exported, even if it isn't used in Tompkins County it will still be fracked and methane leakage will still occur if it isn't addressed at the source. The report uses a 20 year horizon, acknowledging long term fracking. That is especially true now that the EPA has approved the gas export terminal in New Jersey. Further, heat pumps will do nothing to stop methane emissions from leaking pipes in the streets. If there is one customer on a service, the service will need to be pressurized and if it leaks, methane will escape. The political peril of disconnecting gas customers was seen just last month during the National Grid fiasco on Long Island, and those customers weren't even active but were just trying to reconnect. The document is trying to have it both ways and that is fundamentally misleading to a non-technical reader. The use of gas combustion equipment and the global methane leakage issue are mutually exclusive and heat pumps will do nothing to reduce methane leak rates, as tacitly admitted to by the Tompkins County Report. The same logic that applies to Tompkins County applies to the entire state. New York can stop using natural gas, but Pennsylvania is not going to stop fracking and destroy employment for 60,000 workers in their natural gas industry and other related industries supported by gas.

Further, on page 20, the report refers to 14% and 19% methane leakage rates. Extensive reading of the literature has revealed no documents that refer to 14% or 19% leakage rates. The EPA lists them at 1.4%. The Environmental Defense Fund (EDF) listed them at 2.3% in 2018 and the worst case estimates of anyone were approximately 8%, with half of that being in the local distribution systems, but that number has never been verified. In addition, the reports with the higher estimates were published after the release of the Tompkins County Report and would not have been available to the authors in March, 2017. Penn State released a study of the Marcellus Shale area of Pennsylvania in November, 2017 that showed leakage rates in the range of 0.4% (link below). Nowhere does the Tompkins County report state where a 19% leakage rate was documented and all of the links in the report were searched. In fact, the link in the Tompkins County Report on page 18 which refers to a 2015 article for the American Chemical Society states that methane leaks are in the range of 0.4% (1697 Gg of 420,906 Gg), similar to the Penn State Study and less than the EPA estimates of 1.4%. Having checked the 2014 IPCC report mentioned in the table of the Tompkins County study, it does not reference a 19% leakage rate for methane anywhere in the document. It does state that methane may contribute 19% of the total Global Warming Potential, however that methane will be from all sources including agriculture, biomass burning, and methane seeps, with about 23% of the 19% from fossil fuel extraction worldwide, or about 4.3% of total GWP (Appendix E). That is a very different meaning than a 19% leakage rate. Another link to the 2014 Tompkins County Energy and greenhouse gas emissions report makes no reference to any percentage relative to methane, other than to say the GWP potential of methane should be adjusted from the figures in the Kyoto protocol. So there is a large disconnect between what the authors of the Tompkins County Report were documenting and what was in their own references. The Penn State study is at the following URL:

**https://eidclimate.org/new-study-finds-low-methane-leakage-rates-marcellus-shale/**

Overlooked in the discussion of greenhouse gases are the refrigerants used in heat pumps. Appendix E shows the relative Global Warming Potential (GWP) of various gases. Even the best refrigerants used in air conditioners and heat pumps have GWP's 27 times higher than methane. The worst have GWP's almost 600 times higher than methane. While the self contained factory units have low leakage, the split systems, such as the Mitsubishi units, will have more field installed pipe connections and will be more prone to refrigerant leakage. The following link is to an article that discusses refrigerant leaks in air conditioning/heat pump systems. While the article also makes the identical error as the Tompkins County report regarding the source of the electrical generation, which reduces their estimates of the carbon footprint of heat pumps by half, it ascertains that only a 10% leakage rate from a heat pump will eliminate any benefit to using them. In actuality, if the true generation sources supporting the heat pumps are used, a 10% refrigerant leak on the Mitsubishi Split System heat Pumps will result in them having a carbon footprint over 50% higher than a gas combustion system. Even at a 1% leak rate for refrigerants, they have a higher emissions level than gas combustion systems. While this issue has not received major attention, as heat pumps proliferate the issue will become apparent, just as it did decades ago when refrigerants caused the hole in the ozone layer. The article is at the following URL:

**https://www.buildinggreen.com/feature/cost-comfort-climate-change-and-refrigerants**

In fact, a new study led by a Columbia University geophysicist has concluded that CFC's, the now outlawed refrigerants, have contributed to half of Artic ice melt. A link to the article is at the following URL:

https://www.chemistryworld.com/news/cfcs-responsible-for-half-of-arctic-sea-ice-loss/4011037.article

While new heat pumps and air conditioners use different refrigerants now, they still all have very high GWP's and leakage of those gases will have the same effect as the CFC's. The gas will be 10% as harmful but if there are ten times as many heat pumps using the gas with a proportional rate of leakage, the net effect on climate change and the Arctic will be identical to the more harmful refrigerant. Unfortunately, it seems that we never realize the negative impacts of a particular substance until their concentrations reach high enough levels that their global impact can be seen, and by then it is too late. This is another factor that has to be taken into account when considering the trade offs between gas combustion and heat pumps.

Third, the Tompkins County report states on page 9 that heat pumps are less expensive to operate, excluding demand charges. Nowhere does it explain how it arrived at that conclusion. It doesn't state what commodity prices were used to calculate that result. In addition, many of the buildings in the airport area where the report says that the gas constraints are the greatest are also commercial facilities and many would be subject to electric demand charges, but the report glosses over that fact. For those readers unfamiliar with commercial utility billing, commercial customers are not just billed for usage (KWh) the way that residential customers are. Commercial utility customers are billed less per KWh for usage but they are also billed a demand charge (KW), usually based upon their peak usage during two 15 minute periods during the month to charge for their load on the utility system. So if the heat pumps were on for only 30 minutes of a month, they would impact the demand and drive the bill up disproportionately above what a residential user would pay for the same heat pump. It wouldn't even matter if they didn't turn on again for the rest of the entire month beyond the 30 minutes. The one zero degree day in May, 2019 (Appendix A) would affect the utility bill for the entire month and the demand charge related to the heat pump would be the same as in January.

Also, regarding the commodity prices mentioned in the report, gas prices have remained relatively stable over the past five years, actually lower than in 2015 and trading in the lower end of the last 52 week period. Documenting this, the 10 year natural gas commodity price graph is included at the end of the document (Appendix B). Production also continued to rise into 2018, increasing by 12% in 2018 versus 2017, contradicting

the statements in the Tompkins County Report that imply dropping production rates on page 9. Graph and table are included at the end of the document (Appendix C).

However, the greatest issue of all is that the Tompkins County report, written in March, 2017, documented on page 16 a need for an additional 2.1 million BTU per hour for moderate growth and 6.5 million BTU per hour for the "aggressive load projections". Just 33 months later, NYSEG is trying to figure out how to offset 120 million BTU per hour during times of peak load, between nineteen to sixty times as much as predicted in the report. People looking at renewables with Rose Colored Glasses are doing an incredible disservice to the state, whether it is the Stanford/Cornell document of 2013 whose predictions went off the rails within five years or the Tompkins County report whose predictions went off the rails in an even shorter time span. This large energy shortage is an issue that will proliferate across the state if these gas moratoriums persist or expand.

As an early adopter, I made major investments in renewable technologies at both my manufacturing business and my home before it was "fashionable". They were significant enough that both the N.Y. Times and the Wall Street Journal took notice and the projects were initiated over twenty years ago when the return on investment was longer than it is now and the obstacles to installing the technologies were much higher as municipalities and utilities didn't have the means to permit them or the tariffs didn't account for them. I spent months of my time in tariff battles with the utilities to successfully interconnect multiple sources of efficient generation at the same location, being the first in the state to do so. Consolidated Edison has a renewable interconnection method named after my company. The use of grid connected solar and high efficiency generation there currently accounts for 85% to 90% of the electric energy used onsite, resulting in an average overall energy efficiency of 80%, more than twice as efficient as electricity produced through fossil fuel generation. This type of solution has been available for over 10 years because of the tariff modification. The non-renewable part takes up relatively little space, generates large amounts of energy, and unlike renewables, can be easily implemented in densely populated areas. In addition, I have donated several days of my time, gratis, to the Department of Public Services to aid them is reducing energy losses on the utility system. I have a belief in the promise of renewable energy and I want to see renewables installed, but their capabilities should not be oversold.

One such example of an oversell is an article that misrepresents the facts stating, " Three-Quarters of New US Generating Capacity in 2020 Will Be Renewable, EIA Says", and can be found at the following URL:

https://www.greentechmedia.com/articles/read/eia-forecasts-wind-solar-will-break-records-for-new-u-s-generation-in-2020

The headline and article, while technically true, are very misleading. While it's great that renewables are being installed at a record rate, it only talks about Peak Power Capacity (GW - gigawatts). But to understand the issue, we need to discuss energy (GWh - gigawatt hours) and to do that, the duty cycle of the generation has to be factored in. The article says that:

> *According to EIA data released Tuesday, wind and solar will make up 32 of the 42 gigawatts of new capacity additions expected to start commercial operation in 2020, respectively,* ***dwarfing*** *the 9.3 gigawatts of natural-gas-fired plants to come online this year.*

However, as an exercise let's imagine the 18.5 GW of wind, the 13.5 GW of Solar, and the 9.3 GW of gas generation mentioned in the article being installed in New York State and compare the outcomes. In New York, the average duty cycles of the three types of generation mentioned in the article are as follows. Including offshore sources wind is 30%, solar is 12%, and natural gas is greater than 90%. To calculate the energy, Power is multiplied by time. 365 days x 24 hours x Power x duty cycle = Energy (GWh).

For the gas generation: $365_{days} \times 24_{hours} \times 9.3_{GW} \times .90_{duty\ cycle}$ = 73,321 GWh
For the wind generation: $365_{days} \times 24_{hours} \times 18.5_{GW} \times .30_{duty\ cycle}$ = 48,618 GWh
For the solar generation: $365_{days} \times 24_{hours} \times 13.5_{GW} \times .12_{duty\ cycle}$ = 14,191 GWh

Total wind and solar = 62,809 GWh or 14% **less** energy than the 9.3 GW of Gas generation.

So an article that stated that renewable generation installation was ***dwarfing*** the additional fossil fuel generation was misleading in that the renewables installed actually generated 14% less energy than the additional fossil fuel generation over the course of a year. If the wind farm was in West Texas, it would raise the wind output by 50% so that the renewables exceed the gas generation by about 15%, but it is nowhere near "***dwarfing"***, even under ideal circumstances. It isn't 75% of new generating capacity as the article claims. Depending on where it is located, it is between 43% and 58% of new capacity when looking at how much work can actually be done with the generated output. Also, if the 32 Gigawatts of installed renewables was sufficient to solve the problem, why was there a need to install the additional fossil fuel generation? Utilities are not investing in these facilities to waste money. Compounding the energy problem, there are wind farms in Iowa and the United Kingdom that are being replaced after 12 - 15 years because their capacity has degraded by 50% or more. Solar arrays last 25 years and need to be replaced. There are fossil fuel plants still operating at rated capacity that were built in 1970, fifty years ago. I am not advocating keeping the fossil fuel plants but articles such as the one above and the Tompkins County report are raising false expectations. Facts can be sobering.

I don't have any negative predisposition towards heat pumps, as I have owned three working ground source heat pumps for the past 16 years, and I am not in favor of fossil fuels, but I am a pragmatist. I am ambivalent on both except as it pertains to the math and engineering aspects of the issues. I am fundamentally against overselling the capabilities of a technology. It is dangerous and irresponsible. Methane is a problem, but it is a problem that will not be solved at the local level beyond repairing any leaking pipes in the streets. Overlooked in much of the discussion is that a lot of the methane venting and flaring is actually occurring in the oil industry and less is occurring in the gas industry and the environmental movement is conflating the two. When they drill for oil, gas is a waste byproduct. When they drill for gas, the gas is the product and the source of their revenue stream. A study by the American Geosciences Institute of seven oil and gas producing areas in the United States found higher methane emissions in mainly oil producing areas than in mainly gas producing areas.

**https://www.americangeosciences.org/geoscience-currents/methane-emissions-oil-and-gas-industry**

Additionally, engineering reports or articles that distort or misrepresent facts do not help the public discourse and worse, they mislead or provide false expectations to government policy makers and a public that doesn't have an engineering background. Having to truck in natural gas to offset a lack of pipeline capacity is a public safety hazard and greatly increases the carbon footprint and cost associated with the commodity. The moratoriums don't alleviate the need for gas or even reduce the usage, they just raise the carbon footprint and costs associated with it. With gas in place, the 39 megawatts of solar energy being added in Tompkins County could have been used to offset the 33% efficient utility grid, including the coal plant that just closed, or the 22% efficient internal combustion engines through powering electric vehicles (EV's). Instead, in the big picture the energy being produced will offset the 95% combustion efficiencies of gas equipment, which is not the most efficient use of resources and will not reduce carbon footprint. Germany has experienced this for more than 30 years. Ignoring historical data and math puts us all in peril. (Appendix J)

If a Town of 11,000 people can have a problem like this after only 30 months, where will Westchester, with over 980,000 people, be in 30 months? The County is undergoing explosive growth. It doesn't have the empty spaces of Tompkins County to install 18 megawatt solar arrays and that wouldn't help with thermal load on that scale even if there was space. The Town of Greenburgh, in Westchester, just turned down the permits for a 10

megawatt solar array. Highly trafficked roads will not support increased truck transportation of CNG and the NIMBY (Not In My Back Yard) effect will block storage sites and the transportation of CNG for years, if not permanently. One of the options that the state has offered to Westchester, acknowledging in advance that there will be a shortage, is funding for the construction of natural gas storage sites and compressor plants that would be used to offset peak loads. If the populace is against a passive solar array that just sits there and sunbathes, what chance is there that a community will approve a natural gas storage site with increased heavy vehicle traffic covered with "FLAMMABLE GAS 2" placards on them traversing the local roads? Beyond that, the TRIP Report from September, 2019 found that 13% of the road bridges in the Hudson Valley are rated as Poor or Structurally Deficient. Many of those are in Westchester or on Interstate-87. Truck transport of natural gas in the quantities needed to support this plan would greatly increase traffic of a hazardous product in heavy vehicles across some of them. If Lansing would need 15 trucks daily for an area with 11,000 people, how many would be required to support a county with almost 1 million people. Common sense solutions have to be applied to these problems that actually have a chance of succeeding. The ones that have been proposed are not viable solutions on many levels. The following is a URL to a 1994 N.Y. Times article that documents what can happen if a fuel truck explodes in a densely populated area of Westchester, so the trepidation is not a theoretical "*What If*" exercise. **https://www.nytimes.com/1994/07/28/nyregion/explosion-on-i-287-the-overview-tanker-crashes-in-a-fiery-blast-in-westchester.html**

New Rochelle, alone, is adding over 6500 residential units at present, over 300,000 feet of commercial/retail space and over 500 hotel rooms with notice of a new 28 story building appearing in the papers almost every week. Seven development projects on the New Rochelle website in March, 2019 has now increased to thirty two projects nine months later, as seen in the link below. Another 28 floor residential tower was announced last week, going before the City Council in late January, and another 28 floor residential tower was announced this week for a block where there are two other large projects already under construction or nearing completion. The increase in New Rochelle's population over the next seven years will be more than the entire current population of Lansing. Yonkers and White Plains are not far behind in their rates of expansion. Documentation of New Rochelle's explosive growth appears in Appendix M with a list of planned and recently completed projects and can also be found at the following URL:

**https://www.ideallynewrochelle.com/grow-here/development-map/#filters%5B%5D=residential&filters%5B%5D=commercial&filters%5B%5D=mixed-use**

As seen from the Lansing experience with the previously documented numbers there and New York State's proposed "moon shot" solutions to Westchester's current energy problem in lieu of realistic ones, this expansion cannot be well supported with thermal electrification, especially with the closing of Indian Point Energy Center (IPEC) occurring over the next two years. Compounding the problem is that the prices of electricity in the downstate area make air source heat pumps an extremely unattractive option, with at least twice the operating costs and negative atmospheric carbon effects, when compared to natural gas. In an area with some of the highest living costs and highest property taxes in the nation, doubling heating costs is going to make housing even less affordable. The downstate area is short 200 megawatts of generation as a result of the Indian Point (IPEC) closure, based on existing loads, even with the construction of the Cricket Valley Energy Center and the CPV Valley Energy Center, with protesters climbing the exhausts of those in an attempt to shut them down. The two new combined cycle fossil fuel plants replacing IPEC, while more efficient than New York's existing fossil fuel inventory, will still add approximately 4 million metric tons of $CO2_e$ annually to New York's GHG inventory. Also, New York State has one of the older inventories of fossil fuel plants in the country that will need replacing in the not very distant future. Many could be replaced with renewable generation, but not if the winter electric load is radically increased by adding heat pumps requiring increased fossil fuel generation. A better use of renewable generation would be to offset the energy output of the Queens generating plant mentioned in the following URL:

**https://www.motherjones.com/environment/2018/12/power-plant-explosion-casts-new-light-on-new-yorks-addiction-to-dirty-fuel/**

The generating plant in the article is burning No. 6 fuel oil and renewable generation should be used to replace it and other power plants like it, as opposed to the 95% efficient onsite natural gas combustion that burns far more cleanly. Switching from No. 6 oil to natural gas reduces $PM_{2.5}$ emissions by about 96%, $SO_2$ by over 99% and NOx by about 75%. In terms of global warming potential, switching from No. 6 oil to No. 2 heating oil reduces heat-trapping $CO_2$ emissions by about 7%, and natural gas reduces $CO_2$ emissions by about 30% compared to No. 6 oil and replacing it with renewable generation would reduce it by 100% to zero emissions. The following URL documents these facts: **https://www.edf.org/sites/default/files/10071_EDF_BottomBarrel_Ch3.pdf**

Consider the following scenario. New York State has set a goal to install 9 Gigawatts of offshore wind turbines by 2035. With a duty cycle similar to the wind farm at Block Island, Rhode Island of 46%, that would provide an amount of annual energy approximately equivalent to a 4.2 Gigawatt Fossil Fuel or Nuclear Power Plant. In terms of $CO2_e$ reduction, approximately 2 Gigawatts will offset the loss of Carbon free energy resulting from the closure of the Indian Point Nuclear Power Plant, leaving 2.2 equivalent Gigawatts of generation to be applied to reducing carbon footprint elsewhere. How much $CO2_e$ reduction can be achieved?

Keeping in mind that there are 29.3 Kilowatt Hours in 1 Therm (100,000 BTU) and assuming a 93% efficient energy delivery system, if that 4.2 Gigawatts (4,200,000 Kilowatts - KW) is applied to replacing the 95% efficient onsite gas combustion equipment with heat pumps with a COP of 2.5, the following gas combustion can be replaced:

$$4{,}200{,}000_{KW} \times 365_{days} \times 24_{hours} \times 2.5_{cop} \times 0.93_{Delivery\ Efficiency} / 29.3_{KWh/therm} =$$

91,980 Gigawatt Hours (GWh) of electricity or in its thermal equivalent, it equals

3,139,099,659 therms of natural gas combustion reduced annually.

Each therm of onsite Natural Gas Combustion releases 12.32 pounds of $CO_2$ (accounts for 95% combustion efficiency), so the net reduction of $CO_2$ emissions from applying the 9 GW wind farm to onsite gas combustion will be 19,336,853 tons of $CO_2$. While the 91,980 GWh may seem like a lot of energy and it is, it is only about 36% of New York States total of approximately 250,000 GWh of annual onsite gas combustion and does not include onsite oil combustion or onsite radiant electric heat that both have a higher $CO_2$ footprint. Using fifteen years of wind turbine installation to offset less than 40% of New York's one year on-site combustion, that extrapolates to over 30 years to offset all of it without doing anything to reduce power plant emissions, onsite oil combustion, or accounting for additional EV loads. That also doesn't take into account the amount of labor that would be needed to electrify all of the thermal loads and remove all of the existing gas equipment. It also doesn't factor in the fact that a lot of onsite combustion, especially in larger, older residential buildings, are steam boilers that don't convert well to electrification. Those factors result in full electrification taking much longer than 30 years. Based upon conversations with knowledgeable contractors, it could take 60 to 90 years or more for that to occur.

If instead, the gas pipelines are built and 95% efficient gas furnaces are installed, then the 4.2 GW of remaining generation from the wind farm can be applied to generating plants like the one in the link above that burn Number 6 (#6) oil or other fossil fuel generation and it will offset 4.2 GW of generation. That would offset 36,790 GWh, or approximately 50% of N.Y. State's fossil fuel generation on-line after the closure of Indian Point in 2022, excluding the increase in grid load that will occur because of electric vehicles, shown in Appendix F, Table I-11b. As fossil fuel generation is approximately 33% efficient, that 4.2 GW of wind will offset 12.6 GW of fuel usage. For every GW of power delivered, 3 GW of fuel are burned. Looking at Appendix F, Table II-1B, there are far more than 2 GW of oil based generation and seven times that capacity in fossil fuel plants in New York State. #6 Fuel Oil combustion releases 16.7 pounds per therm. Using the same math as above:

$12{,}600{,}000_{KW} \times 365_{days} \times 24_{hours} / 29.3_{KWh/therm} = 3{,}767{,}098{,}976$ Therms of oil combustion reduced

At 16.7 pounds of $CO_2$ per therm, that is a reduction of 31,394,135 Tons of $CO_2$, 1.62 times more carbon reduction than with replacing onsite gas combustion. That does not even include massive reductions in NOx from not burning fuel oil that has 12 times the GWP of methane and 298 times the GWP of $CO_2$. In fact, the NOx levels in the combustion of #6 and #2 Fuel Oils are so high that these plants release between 1.5 and 2 times more greenhouse gases than onsite natural gas combustion. The math is in Appendix L.

If the fossil fuel plant is burning #2 Fuel Oil, at 15.9 pounds of $CO_2$ per therm, the savings will be 30,303,861 tons of $CO_2$, 1.55 times as much as replacing the onsite natural gas combustion.

If the fossil fuel plant was burning natural gas as a fuel source, at 11.7 pounds of $CO_2$ per therm, the savings will be 22,259,069 tons of $CO_2$, 1.17 times as much as replacing the onsite natural gas combustion. Consolidating the math, the following table in Figure 3 shows the potential $CO2_e$ reductions below 2020 levels, including $CO_2$ and NOx, from the 9GW wind farm energy not applied to replacing the non carbon-producing energy of the 2 GW Indian Point Nuclear Plant. It amounts to the savings of applying the remaining 2.2 GW balance of the 4.2 GW equivalent renewable output. We can either use the renewable generation to convert onsite combustion to heat pumps or we can use it to replace fossil fuel generation. The expected installation of 15 GW of Solar Arrays by 2035 will offset the equivalent of an additional 1.8 GW of fossil fuel generation. Even with that, there will not be enough renewable generation available to replace all of the non-carbon producing generation, so a choice has to be made between replacing onsite combustion and replacing less efficient fossil fuel generation.

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Figure 3 Potential Annual $CO2_e$ reductions below New York State 2020 Levels using 9 GW of Renewable Generation

| Combustion Type | $CO_2$ Reduction tons* | NOx Reduction $CO2_e$ tons* | Total $CO2_e$ Reduction tons* | % Reduction Over Onsite Gas Combustion |
|---|---|---|---|---|
| **Onsite Gas Combustion to Heat Pumps** | **10,129,310** | **3,362,894** | **13,492,205** | |
| **#6 Fuel Oil Generating Plant** | **16,445,330** | **10,781,558** | **27,226,889** | **202 %** |
| **#2 Fuel Oil Generating Plant** | **15,874,207** | **4,242,613** | **20,116,821** | **149 %** |
| **Natural Gas Generating Plant** | **11,660,068** | **4,076,235** | **15,736,304** | **117 %** |

*** To convert Tons to Metric Tons, divide by 1.102**

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So the net benefit of leaving onsite gas combustion in place is a much larger $CO2_e$ reduction enabled by applying the renewable generation to the fossil fuel generation. That will also reduce Sulfur Oxide emissions by thousands of tons annually that have been extensively linked to asthma. In addition, local gas supplies enable the use of smaller Combined Heat and Power Systems (CHP) that nearly double the energy efficiency where they are used. They can be installed quickly and take up minimal space when compared to solar panels and wind farms, minimizing NIMBY issues and allowing for rapid reduction of $CO2_e$ levels where they are installed.

Using the same math as above, a second 9 GW wind farm, not having to compensate for the lost carbon free generation of Indian Point, could replace the balance of the fossil fuel generation in N.Y. State with a minimum of a 17% carbon reduction improvement over replacing onsite combustion. That again excludes the added utility grid load of the electric vehicles.

Appendix N shows the potential 30 year greenhouse gas reductions with and without local gas supplies and shows how the moratoriums will reduce the rate of GHG reduction, and in many cases will raise GHG levels. It includes Ground Source Heat pumps that are actually a good method to reduce GHG emissions but they are very expensive to install and there isn't sufficient labor available to implement that in any significant way in the near future. Without local gas pipelines, perhaps a 30% - 35% reduction in GHG emissions is possible. With local gas supplies, that can be raised to 50%.

Research and implementation of carbon sequestration technology that can reduce $CO_2$ emissions from fossil fuel generating plants, thereby reducing GHG footprints of onsite combustion, have shown promise. However, as can be seen in a 2018 article at the following URL, "The Inconvenient Truth About Carbon Capture", its wide scale implementation is many decades away.

https://www.washingtonpost.com/news/theworldpost/wp/2018/05/31/carbon-capture/

The models used to calculate the 30 year $CO_2$ reductions assume that the state can overcome the headwinds that installation of renewable generation is facing in New York, including major energy storage issues, NIMBY'ism and the Jones Act, dating to the 1920's. The Jones Act states that all shipping within U.S. waters must be done on U.S. built ships. Currently, there are only 55 of the 60 ships available to install 1.7 GW of offshore wind for the entire East coast. New York will need 18 GW, more than ten times that amount to just offset its fossil fuel generation, not including EV's. Ships take years to build so this problem is a major obstacle. The article at the following URL documents these issues:

**https://www.offshorewind.biz**

Evidence of the NIMBY effect has been visible both on Long Island, where wealthy, supposedly environmentally friendly landowners in the Hamptons have been blocking an underground (invisible after it is installed) cable to bring power onshore from the Atlantic Wind Farm. It has also been apparent upstate where seven counties along Lake Erie and Lake Ontario voted in 2011 to block Project GLOW, Great Lakes Offshore Wind, because it would interfere with their views of the lakes. Wind speeds in New York State on land will only generate 33% of the energy of offshore wind resulting in much higher costs for that option, so offshore wind is a necessity if large scale renewable generation is to ever be a reality. The article at the following URL documents just one of the many issues that the installation of renewables will face in the coming years, although a list of links documenting similar situations would fill many pages and cover locales from Maine to Oregon. The objections range from the locations of the generation to the siting of transmission lines and storage, among others.

**https://www.wind-watch.org/news/2011/03/23/new-york-counties-opposed-to-glow/**

If these issues are not overcome, renewable installation will be severely curtailed. Storage also presents a major issue. The sun doesn't always shine and the wind doesn't always blow. Texas, where wind energy has been hugely incentivized by the state, now generates approximately 25% of its energy from wind turbines. Often, in the middle of the night when electric usage drops, the electric rates are negative and they are giving power away because they have too much. That dynamic has forced some fossil fuel plants to close, which seems like a good idea at first glance. However, in August 2019, the wind energy was extremely low during a heat wave that greatly increased air conditioning load. The result was that they came very close to running out of electricity and the utility prices spiked so high that market controls activated, as can be read at the following URL:

**https://www.bloomberg.com/news/articles/2019-08-13/texas-power-prices-briefly-surpass-9-000-amid-searing-heat**

The Texas Utility Grid is "Islanded" and they have limited options for importing electricity from out of state to compensate for situations like that. Without sufficient storage in place to transfer energy from times when renewables are abundant to times of paucity, situations as occurred in Texas will proliferate on a fully renewable

grid. It is not easy to site large scale pumped storage as Consolidated Edison found out in the 1960's - 1970's with their Storm King project. The history of the proposed pumped storage facility is documented at the following URL: **http://library.marist.edu/archives/mehp/scenicdecision.html**

Batteries on electric vehicles and stationary battery storage offers other options, but the lifetime of the hardware could be an issue. Tesla currently warranties their batteries for eight years. Assuming they may last longer than that, will storage infrastructure have to be replaced every 10 years? Are there sufficient raw materials to build enough batteries to accomplish that on such a large scale? In May, 2019, Elon Musk was predicting that they would run out of battery material. The article is at the following URL:

**https://www.reuters.com/article/us-usa-lithium-electric-tesla-exclusive/exclusive-tesla-expects-global-shortage-of-electric-vehicle-battery-minerals-sources-idUSKCN1S81QS**

The following link to an article in the N.Y. Times documents some of the major issues that will be encountered when looking for solutions to the storage problem. The problems range from neighbors that object to anything in their vicinity to technological issues that minimize efficiency, decrease storage life, and increase cost. Regarding battery storage, there are estimates that stored electricity using Lithium batteries will be 1.7 times as expensive as stored electricity using a pumped storage system. As detailed in the article, pumped storage can be difficult to site, even when the generating plant and the reservoir already exist.

https://www.nytimes.com/interactive/2018/07/24/business/energy-environment/hoover-dam-renewable-energy.html

Additionally, if car owners are asked to use their electric cars as part of a larger storage network, how will they be compensated for the energy losses that occur during charging and discharging? Those could amount to approximately 20% of the total so the car owner will pay $ 1.00 to charge the car and would only get back $.80 when it was sent back to the utility. Further, charging and discharging of car batteries decreases battery life. Using the car batteries to support the utility system will require more frequent charging and discharging. How would vehicle owners be compensated for increased "wear and tear" on the batteries? How would the utilities control the energy flow from 5 million point sources of power to prevent overages and shortages on the utility system, while simultaneously ensuring that car owners didn't run out of power halfway to where they are going because the utility sucked their battery dry in order to keep another customer's air conditioner running? These are all major technical hurdles that have to be solved if a fully renewable utility grid is to be realized and they are not simple problems. Further compounding the issue is the expectation of the utility customers that the power will just be there when they flip the switch. When it isn't, you see the political fallout from the blackout in Times Square in July, 2019.

Modern society needs energy if it is to continue to exist and remain functional. Lack of access to sufficient energy supplies or expensive energy as a result of shortages can be seen in the effect on the quality of life in Eastern Europe after the fall of the Soviet Union when the Eastern European countries had severely constrained economies due to a lack of available energy resources. (Appendix H)

New York will not have an external entity, such as Russia, manipulating its energy supplies for political gain but as seen there, a lack of access to energy will have economic and social impacts, regardless of the cause. That is the extreme case and while I wouldn't expect New York State to deteriorate to the degree where it resembles 1990's Eastern Europe, certain muted effects will become apparent if there is not sufficient access to energy. If businesses or people leave because of a lack of access to sufficient energy supplies or because of expensive energy coupled with high taxes needed to support environmental initiatives that are not effective, that will negatively affect the state's tax base and the long term health of New York. That has become a more urgent consideration in light of New York State's most recent budget announced in December, 2019 that has a $ 6.1 billion deficit. Compounding that, New York was one of nine states with a net loss of population in 2018 and is

expected to lose at least one seat in the House of Representatives after the 2020 census, as can be seen at the following URL:

**https://www.pressconnects.com/story/news/local/2019/04/18/population-loss-plagues-new-york/3482885002/**

While people may be against fossil fuels, the experience in Lansing shows that blocking a pipeline will actually increase gas usage while simultaneously burdening the municipality or the state with enormous additional costs if it chooses to subsidize the transition. Either way, the additional costs will be passed on to the taxpayers or ratepayers with absolutely no improvement, or at best a very minimal improvement in greenhouse gas levels. The math shows that the gas pipelines are a less expensive solution with a higher rate of Greenhouse Gas reduction than other options when considering the current realities of available resources.

It is going to take much longer to install sufficient renewable generation than what people believe. This is documented in Appendix K. Therefore, compromises are going to have to be made as seen in the example above, documented in Figure 3. We need the installation of renewables but the costs of the technology, Federal Regulations, NIMBY'ism, and sociopolitical constraints are going to limit the rate of installation below what is needed to support the growth that is occurring in the New York metropolitan area. All of the fossil fuel loads cannot be replaced simultaneously so the least efficient should be addressed first to implement the fastest reduction of greenhouse gases. A lack of access to natural gas, in many cases, is going to induce builders to use less environmentally friendly and more expensive alternatives as is already happening in Westchester. #2 fuel oil has been chosen at some of the new buildings as a backup to natural gas. Burning #2 oil has 1.5 times the carbon footprint of natural gas plus the higher NOx emissions previously documented and the increased emissions of the diesel exhaust from the trucks that haul it to the sites.

Based upon the inability of New York State to affect methane emissions beyond its borders, piped natural gas is not a compromise as it relates to onsite combustion. It delivers more clean energy with less societal disruption, lower costs, and a lower carbon footprint than air source heat pumps or trucked natural gas. New York State needs dependable energy sources if it is to remain economically viable and environmentally friendly. In addition, energy shortages or high prices will turn the political climate against the environmental movement and set it back years.

Again, the math shows that Gas Pipeline Moratoriums will not significantly reduce GHG Emissions and may in fact increase them depending on the solutions employed to meet a community's energy needs in lieu of the pipeline. Further, they will cause renewable generation to be used ineffectively resulting in an opportunity cost being imposed on employing more effective methods of greenhouse gas reduction.

New York needs a Better Plan.

# A Better Plan

New York has set a goal of 100% carbon free electricity by 2040. It will never achieve that if it keeps adding wintertime electric load. As seen with the experience of the United Kingdom, a 42% reduction in Carbon footprint is achievable in a relatively short period of time. But the United Kingdom does not have a war on natural gas and does not incentivize installing air source heat pumps. In doing so, they have reduced the rate of electrification of onsite combustion. New York can achieve similar results and it will be far better for the environment and the New York State economy to focus its limited resources, both renewables and financial, in the places where the greatest carbon decreases can be achieved, while simultaneously reducing the costs of the transition.

A better way to achieve New York's goals would be to start installing renewables as quickly as possible and actually determine how fast that can be done before starving areas of needed energy, the result of which will actually drive up both costs and $CO2_e$. Based on a mathematical analysis of fossil fuel loads and New York's renewable generation installation rate that was done and is displayed in Appendix K, it will be at least 90 years until there are sufficient renewables to offset the fossil fuel load. Even if the installation rate doubles, it will still take over 45 years and that will take a Herculean effort and enormous monetary investments. A confirmed plan for adding sufficient energy storage should also be developed simultaneously, including engineering a system, standardizing it across all vehicles, and testing it as a method for using electric vehicles as point sources of energy to support the utility grid. Without sufficient storage, the system will collapse.

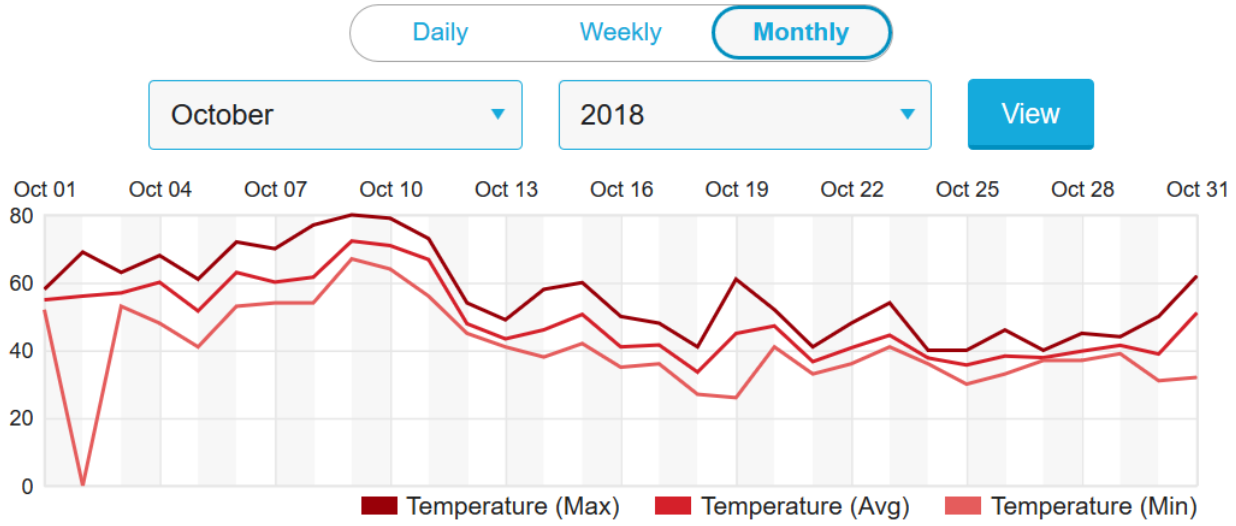
By reducing the amortization period for new gas infrastructure to 40 years, it will allow a shorter term investment for the service so that there will not be resistance to the conversion to electrification by the gas companies when sufficient renewables are available, which will have a minimal affect on rates. Methane leaks in the gas infrastructure below the streets should also be repaired.

The renewable generation that is installed should be applied to the least efficient fossil fuel generation first as shown on page 13 to 15, and then progress down the list until all of it has been replaced . This will reduce greenhouse gas emissions the most rapidly and will also be the least expensive option, so it will simultaneously benefit the New York State economy and the environment. As this plan will be increasing the generation efficiency of the utility system, it will also have the effect of making the electric vehicles that are charged from the system more efficient and will further reduce GHG emissions from internal combustion vehicles that are actually the worst sources of $CO2_e$. The conversion to electric vehicles will add load while the renewable generation is reducing it, leading to a longer period to remove all of the fossil fuel generation. Despite that fact, the benefit of not burning gasoline in a 22% efficient engine more than offsets that in terms of $CO2_e$ reduction. When the state has confirmed the installation rate of renewable generation, replaced inefficient fossil fuel generation, and overcome the currently existing obstacles to renewable generation installation, it can develop a sensible plan for converting areas in blocks to electric based heat. This will allow entire areas to be disconnected together so that the local gas services can be deactivated, thus reducing methane leaks, while keeping the lights on.

Natural Gas prices continue at historically low levels. If the Federal Government can find a way to compromise, a $.01/therm surcharge could be applied to natural gas and those funds could be used exclusively to repair methane leaks across the U.S. system. At the 35 trillion cubic feet produced in 2018, that would yield $3.5 billion per year to fix methane leaks and would be less than a 1% increase on the average U.S. $1.05/therm natural gas bill for an end user.

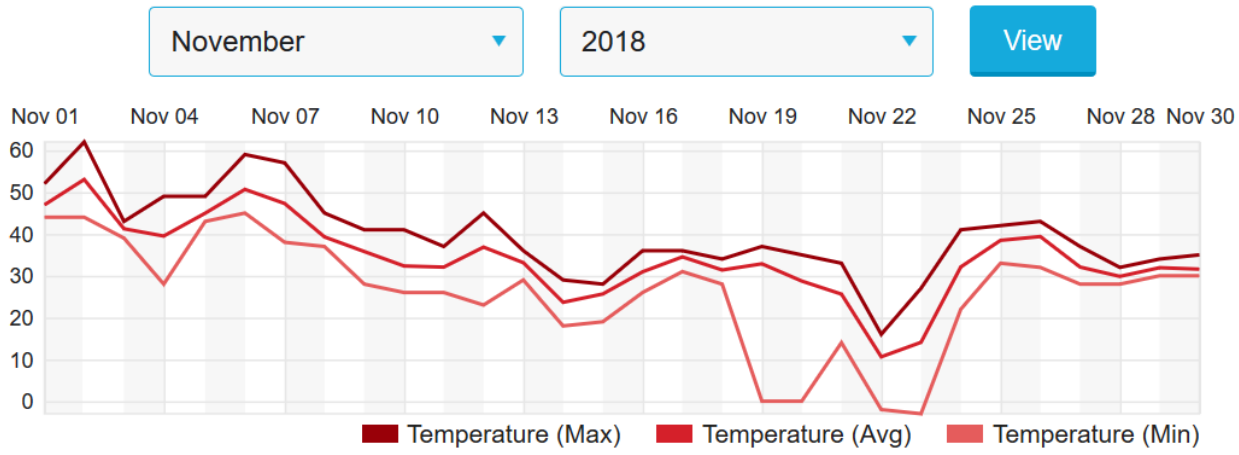
There are solutions to climate change problems but gas moratoriums should not be the focus and they are not the solution. The moratoriums create more problems than they solve. Instead, the current focus should be on replacing older 33% efficient fossil fuel generating plants with renewable energy, on replacing 22% efficient internal combustion vehicles with electric vehicles, and on adding storage to support that system. That can only be accomplished and afforded if access to the 95% efficient onsite natural gas combustion is supported, and that can only be done with sufficient access to the commodity.

**APPENDIX A - Ithaca Temperature Data - October, 2018 - May, 2019** (Weather Underground wunderground.com)



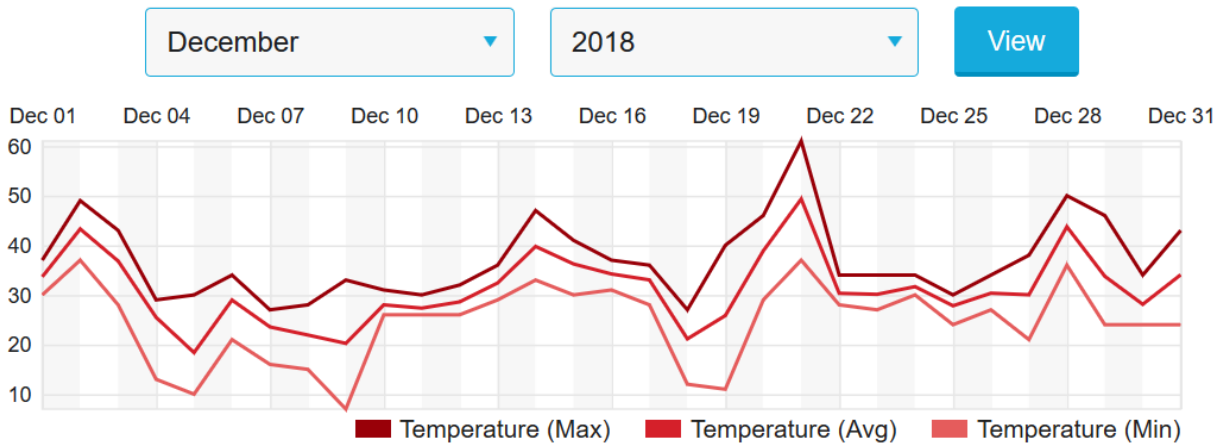

# Summary

| Temperature (° F) | Max | Average | Min |
|---|---|---|---|
| Max Temperature | 80 | 56.55 | 40 |
| Avg Temperature | 72.28 | 48.8 | 33.56 |
| Min Temperature | 67 | 40.58 | 0 |



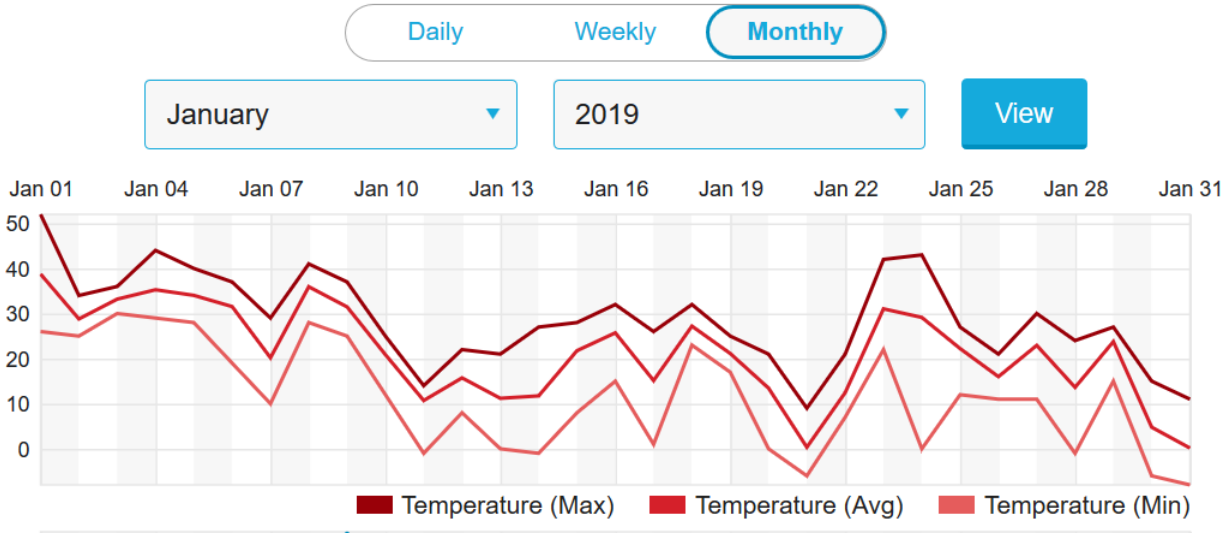

# Summary

| Temperature (° F) | Max | Average | Min |
|---|---|---|---|
| Max Temperature | 62 | 39.7 | 16 |
| Avg Temperature | 53.03 | 34.22 | 10.62 |
| Min Temperature | 45 | 26.13 | -3 |



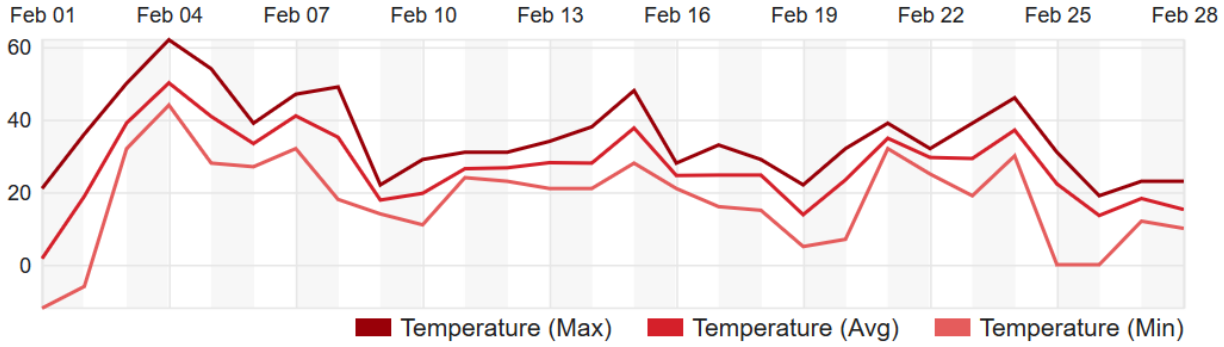

# Summary

| Temperature (° F) | Max | Average | Min |
|---|---|---|---|
| Max Temperature | 61 | 37.13 | 27 |
| Avg Temperature | 49.33 | 31.2 | 18.38 |
| Min Temperature | 37 | 24.52 | 7 |



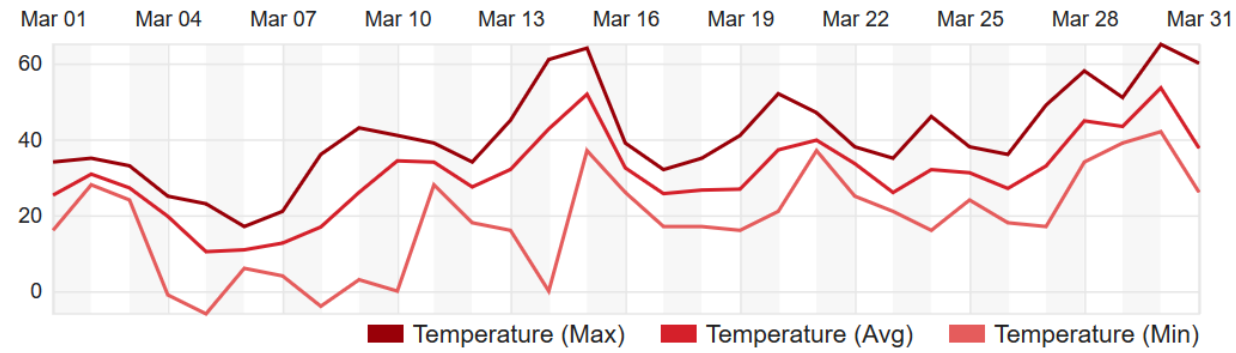

| Temperature (° F) | Max | Average | Min |
|---|---|---|---|
| Max Temperature | 52 | 28.81 | 9 |
| Avg Temperature | 38.75 | 21.3 | 0.16 |
| Min Temperature | 30 | 11.58 | -8 |

February 2019 View



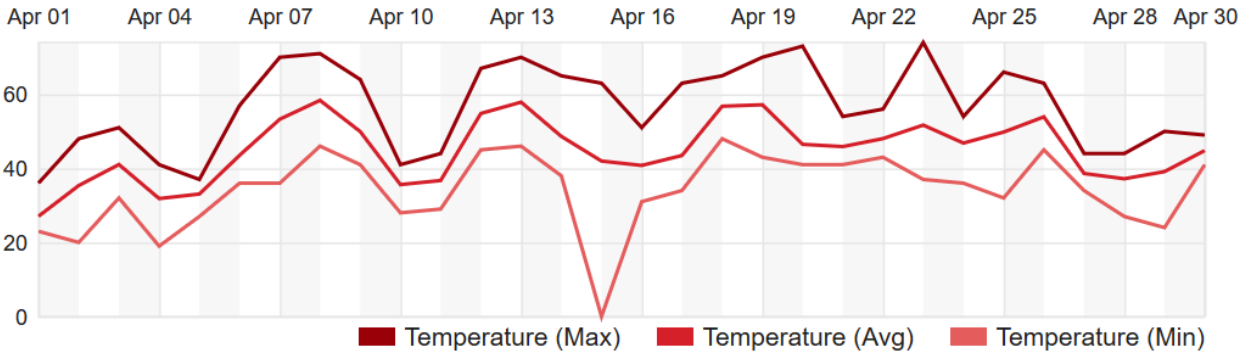

| Temperature (° F) | Max | Average | Min |
|---|---|---|---|
| Max Temperature | 62 | 35.25 | 19 |
| Avg Temperature | 50.12 | 27 | 1.68 |
| Min Temperature | 44 | 17.75 | -12 |

March 2019 View



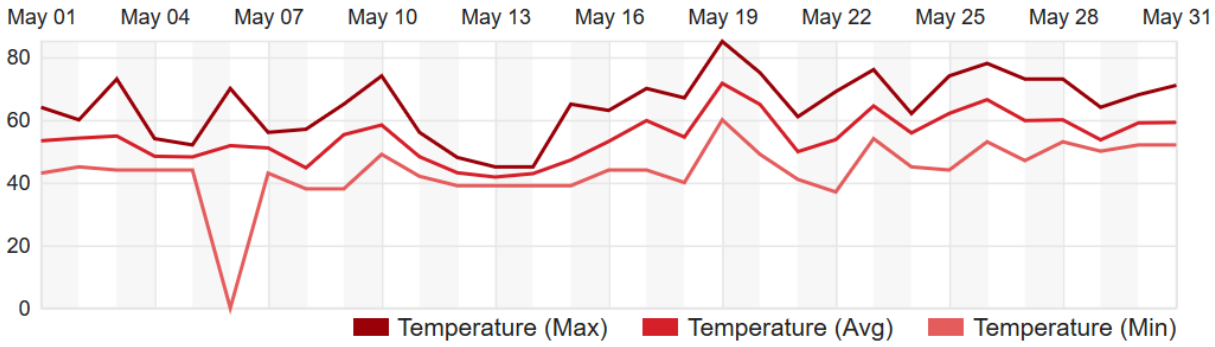

| Temperature (° F) | Max | Average | Min |
|---|---|---|---|
| Max Temperature | 65 | 41.06 | 17 |
| Avg Temperature | 53.52 | 30.73 | 10.38 |
| Min Temperature | 42 | 18.23 | -6 |

April 2019 View




| Temperature (° F) | Max | Average | Min |
|---|---|---|---|
| Max Temperature | 74 | 56.7 | 36 |
| Avg Temperature | 58.37 | 44.99 | 27.06 |
| Min Temperature | 48 | 34.1 | 0 |

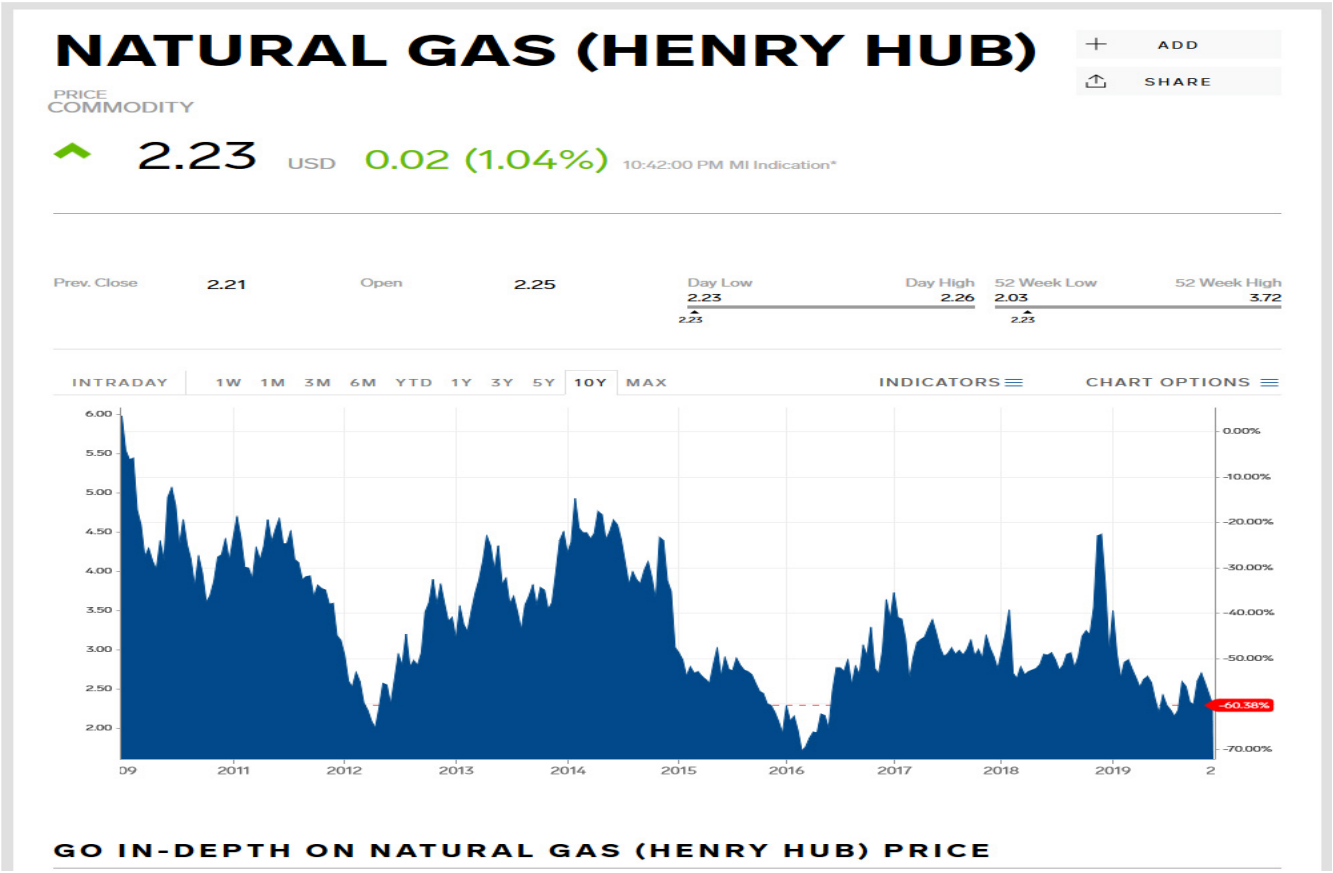
May 2019 View




# Summary

| Temperature (° F) | Max | Average | Min |
|---|---|---|---|
| Max Temperature | 85 | 64.94 | 45 |
| Avg Temperature | 71.64 | 54.55 | 41.76 |
| Min Temperature | 60 | 43.58 | 0 |

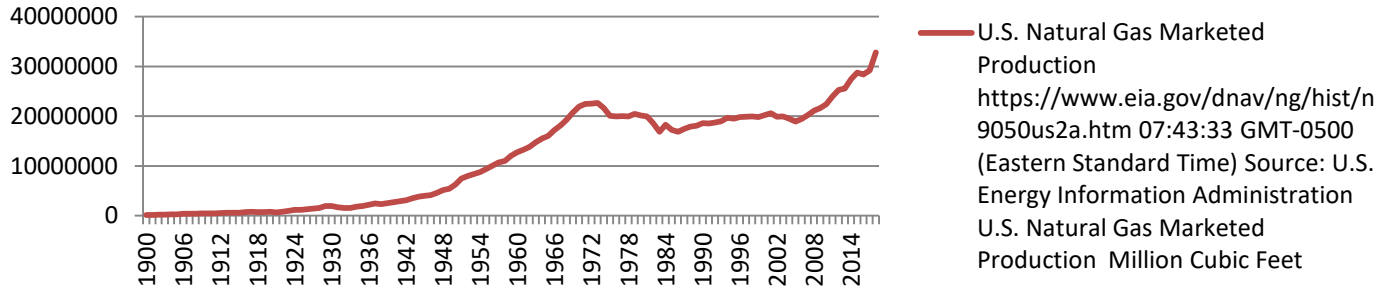
**APPENDIX B - Natural Gas Prices through November, 2019**




**$/million Cubic Feet**

**APPENDIX C - U.S. Natural Gas Production through December, 2018**

# U.S. Natural Gas Marketed Production https://www.eia.gov/dnav/ng/hist/n9050us2a.htm 07:43:33 GMT-0500 (Eastern Standard Time) Source: U.S. Energy Information Administration U.S. Natural Gas Marketed Production Million Cubic Feet




eia Source: U.S. Energy Information Administration

This series is available through the EIA open data API and can be downloaded to Excel or embedded as an interactive chart or map on your website.

**U.S. Natural Gas Marketed Production (Million Cubic Feet)**

| Decade | Year-0 | Year-1 | Year-2 | Year-3 | Year-4 | Year-5 | Year-6 | Year-7 | Year-8 | Year-9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1900's | 128,000 | 180,000 | 206,000 | 239,000 | 257,000 | 320,000 | 389,000 | 407,000 | 402,000 | 481,000 |
| 1910's | 509,000 | 513,000 | 562,000 | 582,000 | 592,000 | 629,000 | 753,000 | 795,000 | 721,000 | 746,000 |
| 1920's | 812,000 | 674,000 | 776,000 | 1,025,000 | 1,162,000 | 1,210,000 | 1,336,000 | 1,471,000 | 1,596,000 | 1,952,000 |
| 1930's | 1,978,911 | 1,721,902 | 1,593,798 | 1,596,673 | 1,815,796 | 1,968,963 | 2,225,477 | 2,473,483 | 2,358,201 | 2,538,383 |
| 1940's | 2,733,819 | 2,893,525 | 3,145,694 | 3,515,531 | 3,815,024 | 4,042,002 | 4,152,762 | 4,582,173 | 5,148,020 | 5,419,736 |
| 1950's | 6,282,060 | 7,457,359 | 8,013,457 | 8,396,916 | 8,742,546 | 9,405,351 | 10,081,923 | 10,680,258 | 11,030,248 | 12,046,115 |
| 1960's | 12,771,038 | 13,254,025 | 13,876,622 | 14,746,663 | 15,546,592 | 16,039,753 | 17,206,628 | 18,171,325 | 19,322,400 | 20,698,240 |
| 1970's | 21,920,642 | 22,493,012 | 22,531,698 | 22,647,549 | 21,600,522 | 20,108,661 | 19,952,438 | 20,025,463 | 19,974,033 | 20,471,260 |
| 1980's | 20,179,724 | 19,955,823 | 18,582,001 | 16,884,095 | 18,304,340 | 17,270,223 | 16,858,675 | 17,432,901 | 17,918,465 | 18,095,147 |
| 1990's | 18,593,792 | 18,532,439 | 18,711,808 | 18,981,915 | 19,709,525 | 19,506,474 | 19,812,241 | 19,866,093 | 19,961,348 | 19,804,848 |
| 2000's | 20,197,511 | 20,570,295 | 19,884,780 | 19,974,360 | 19,517,491 | 18,927,095 | 19,409,674 | 20,196,346 | 21,112,053 | 21,647,936 |
| 2010's | 22,381,873 | 24,036,352 | 25,283,278 | 25,562,232 | 27,497,754 | 28,772,044 | 28,400,049 | 29,203,550 | 32,823,295 | |

- = No Data Reported; -- = Not Applicable; NA = Not Available; W = Withheld to avoid disclosure of individual company data.

**APPENDIX D - National Grid RFP**

NYSEG

**December 4, 2019**

**Re: Invitation to Participate in a Solicitation for Reliability Services**

Dear Bidder:

New York State Electric & Gas ("NYSEG"), a subsidiary of AVANGRID, is issuing this Request for Proposal ("RFP") to qualified parties ("Bidders") with the capability to develop and deliver innovative solutions to address gas reliability in the Tompkins County region of the NYSEG service territory. NYSEG is issuing this RFP in search of Non-Pipe Alternative ("NPA") solutions to defer or avoid a planned natural gas pipeline construction in the Lansing, New York area.

Highlights of this opportunity include:

- *Resource Need*:

| | |
|---|---|
| **Goal** | To improve system endpoint pressure toward a 70% Maximum Allowable Operating Pressure ("MAOP") in order to mitigate service reliability concerns in the Lansing area. |
| **Identified Need** | A reduction (or addition) of approximately 120 Mcfh[1] in the defined Lansing moratorium area. |
| **Term** | 10 Years (11/01/2021-10/31/2031) |

- *Eligible Resource Types:* Resources may be in the form of any or all of the following resource types:
  - Incremental natural gas energy efficiency resources,
  - Incremental natural gas demand response resources,
  - Fuel substitutions (subject to net carbon reduction evaluation) including electric/geothermal heat pumps and/or other forms of "beneficial electrification,"
  - Introduction of RNG, CNG, LNG to the extent allowed by local, State and Federal laws and regulations[2], and
  - Other resources which meet all the requirements of this RFP

[1] NYSEG will consider both proposals which are below 120 Mcfh and make a material contribution to reaching the desired 70% MAOP, as well as proposals which are above 120 Mcfh which may provide additional system improvement above that which is specifically requested in this RFP.

[2] If RNG, CNG or LNG is proposed, Bidder will be required to meet applicable tap agreement requirements, gas quality requirements, gas supply agreements and gas storage requirements. RNG Bidders may take ownership of RINS credits generated and should include details of their plan to monetize these credits in their Proposal.

*Preliminary Schedule:*

| RFP Milestone | Expected Completion Date[3] |
|---|---|
| December 4, 2019 | Issue RFP |
| January 10, 2020 | Pre-bid conference |
| January 17, 2020 | Last day for Bidders to indicate collaboration interest |
| February 14, 2020 | Bidder questions due |
| February 21, 2020 | NYSEG responses to questions due |
| February 21, 2020 | Last Day for Bidder Response Template training requests[4] |
| March 6, 2020 | RFP responses due |
| End-April 2020 | RFP Evaluations Complete |
| Mid-May 2020 | File Petition with PSC[5] |
| November 2021 (or sooner) | Anticipated resource in-service date |

Resources are expected to begin to be implemented by November 2021 or sooner, but the complete schedule for implementation will depend on the proposals received. As part of the RFP response analysis, NYSEG will model the proposals received and decide if there is a benefit to implementing a staged delivery of solutions.

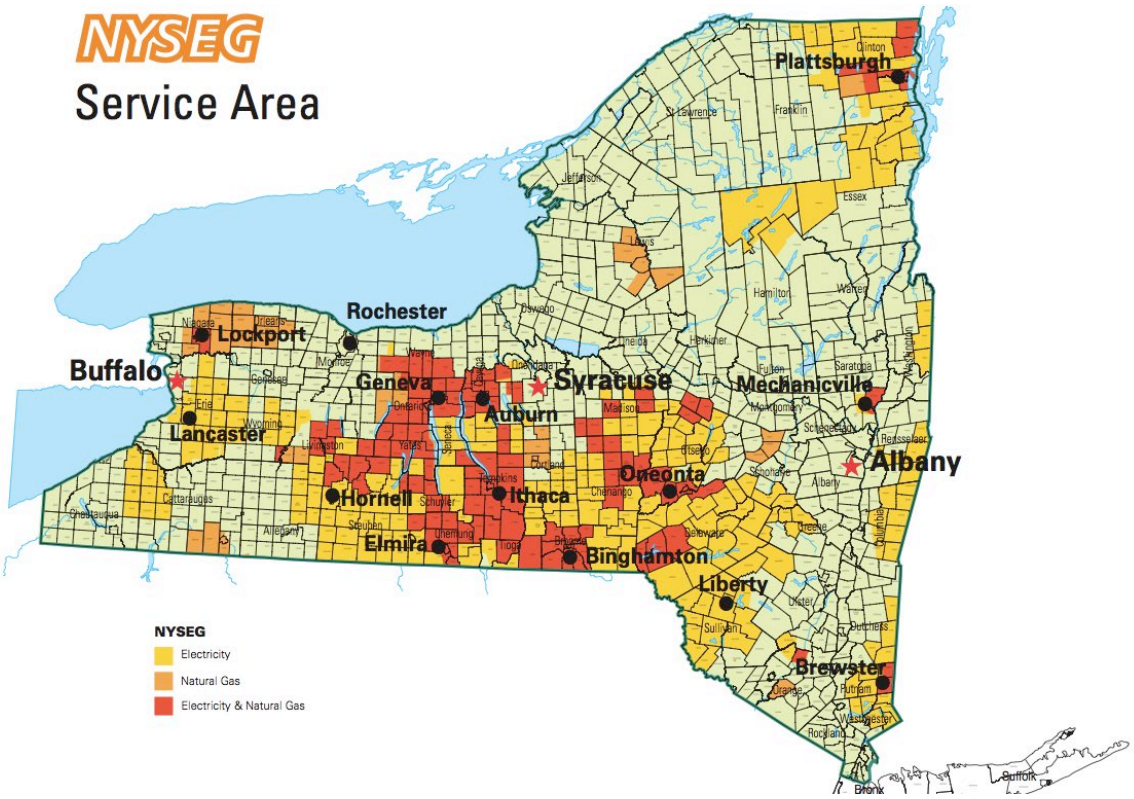
Certain data will be provided to Respondents upon execution of the Confidentiality Agreement (Attachment D) and a Data Security Rider (Attachment F). In addition, the Confidentiality Agreement can be used should the Developer wish to submit its response to the RFP as confidential matter.

To indicate your desire to participate in this RFP opportunity, please respond via e-mail to lansingnpa@avangrid.com at your earliest convenience. Upon NYSEG's receipt of a respondent's interest, NYSEG will provide the respondent with details regarding the RFP pre-bid teleconference which is scheduled for **January 10, 2020**.

Sincerely,

Mike DeAngelo
Manager, Non-Wires Alternatives
AVANGRID

[3] NYSEG reserves the right to adjust the schedule; adjustments outside of date ranges provided will be distributed via email to interested Bidders.
[4] Bidders have until February 21, 2020 to request one-on-one training on the Bidder Response Template which is a requirement for bid responses to this RFP.
[5] NYSEG will utilize a Benefit Cost Analysis ("BCA") process to evaluate Responses/Proposals. Although the details of project BCA results will not be made public in order to protect the confidentiality of the Bidders, if a petition is filed with the NY PSC it will include high level BCA results (costs and benefits).


NYSEG
Service Area
Plattsburgh
Rochester
Lockport
Buffalo
Geneva
Syracuse
Auburn
Mechanicville
Lancaster
Albany
Oneonta
Hornell
Ithaca
Elmira
Binghamton
Liberty
Brewster
NYSEG
Electricity
Natural Gas
Electricity & Natural Gas

**APPENDIX E - Greenhouse Gas Global Warming Potential and Fuel Carbon Footprints**

**Fuel Oil Carbon Footprint https://www3.epa.gov/ttn/chief/ap42/ch01/bgdocs/b01s03.pdf**

**Table 6. Default $CO_2$ Emission Factors for Liquid Fuels**
**Quality Rating: B**

| Fuel Type | %C[a] | Density[b] (lb/gal) | Emission Factor (lb/1000 gal) |
|---|---|---|---|
| No. 1 (kerosene) | 86.25 | 6.88 | 21,500 |
| No. 2 | 87.25 | 7.05 | 22,300 |
| Low Sulfur No. 6 | 87.26 | 7.88 | 25,000 |
| High Sulfur No. 6 | 85.14 | 7.88 | 24,400 |

[a]An average of the values of fuel samples in References 6-7.
[b]References 6 and 8.

1 Gallon of #6 Fuel Oil = 150,000 BTU = 1.5 Therms, 1 Gallon of #2 Fuel Oil = 140,000 BTU = 1.4 Therms

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**NITROGEN OXIDE EMISSIONS - FUEL OIL**

https://www3.epa.gov/ttnchie1/ap42/ch01/final/c01s03.pdf

Table 1.3-8. EMISSION FACTORS FOR NITROUS OXIDE ($N_2O$), POLYCYCLIC ORGANIC MATTER (POM), AND FORMALDEHYDE (HCOH) FROM FUEL OIL COMBUSTION[a]

EMISSION FACTOR RATING: E

| Firing Configuration (SCC) | Emission Factor (lb/$10^3$ gal) | | |
|---|---|---|---|
| | $N_2O$[b] | POM[c] | HCOH[c] |
| Utility/industrial/commercial boilers | | | |
| No. 6 oil fired (1-01-004-01, 1-02-004-01, 1-03-004-01) | 0.53 | 0.0011 - 0.0013[d] | 0.024 - 0.061 |
| Distillate oil fired (1-01-005-01, 1-02-005-01, 1-03-005-01) | 0.26 | 0.0033[e] | 0.035 - 0.061 |
| Residential furnaces (A2104004/A2104011) | 0.05 | ND | ND |

[a] To convert from lb/$10^3$ gal to kg/$10^3$ L, multiply by 0.12. SCC = Source Classification Code. ND = no data.
[b] References 45-46. EMISSION FACTOR RATING = B.
[c] References 29-32.
[d] Particulate and gaseous POM.
[e] Particulate POM only.

**NITROGEN OXIDE EMISSIONS - NATURAL GAS**

https://www3.epa.gov/ttnchie1/ap42/ch01/final/c01s04.pdf

In Large Boilers such as in a Generating Plant, 100 - 280 Pounds/Million SCF, Average of 140 Pounds/Million SCF used in calculations in Appendix L.

Smaller Boilers, such as in a home will have NOx Emissions 1/3 of the large boilers on average as seen below.

Table 1.4-1. EMISSION FACTORS FOR NITROGEN OXIDES ($NO_x$) AND CARBON MONOXIDE (CO) FROM NATURAL GAS COMBUSTION[a]

| Combustor Type (MMBtu/hr Heat Input) [SCC] | $NO_x$[b] | | CO | |
|---|---|---|---|---|
| | Emission Factor ($lb/10^6$ scf) | Emission Factor Rating | Emission Factor ($lb/10^6$ scf) | Emission Factor Rating |
| Large Wall-Fired Boilers (>100) [1-01-006-01, 1-02-006-01, 1-03-006-01] | | | | |
| Uncontrolled (Pre-NSPS)[c] | 280 | A | 84 | B |
| Uncontrolled (Post-NSPS)[c] | 190 | A | 84 | B |
| Controlled - Low $NO_x$ burners | 140 | A | 84 | B |
| Controlled - Flue gas recirculation | 100 | D | 84 | B |
| Small Boilers (<100) [1-01-006-02, 1-02-006-02, 1-03-006-02, 1-03-006-03] | | | | |
| Uncontrolled | 100 | B | 84 | B |
| Controlled - Low $NO_x$ burners | 50 | D | 84 | B |
| Controlled - Low $NO_x$ burners/Flue gas recirculation | 32 | C | 84 | B |
| Tangential-Fired Boilers (All Sizes) [1-01-006-04] | | | | |
| Uncontrolled | 170 | A | 24 | C |
| Controlled - Flue gas recirculation | 76 | D | 98 | D |
| Residential Furnaces (<0.3) [No SCC] | | | | |
| Uncontrolled | 94 | B | 40 | B |

[a] Reference 11. Units are in pounds of pollutant per million standard cubic feet of natural gas fired. To convert from $lb/10^6$ scf to $kg/10^6$ $m^3$, multiply by 16. Emission factors are based on an average natural gas higher heating value of 1,020 Btu/scf. To convert from $lb/10^6$ scf to lb/MMBtu, divide by 1,020. The emission factors in this table may be converted to other natural gas heating values by multiplying the given emission factor by the ratio of the specified heating value to this average heating value. SCC = Source Classification Code. ND = no data. NA = not applicable.

[b] Expressed as $NO_2$. For large and small wall fired boilers with SNCR control, apply a 24 percent reduction to the appropriate $NO_x$ emission factor. For tangential-fired boilers with SNCR control, apply a 13 percent reduction to the appropriate $NO_x$ emission factor.

[c] NSPS=New Source Performance Standard as defined in 40 CFR 60 Subparts D and Db. Post-NSPS units are boilers with greater than 250 MMBtu/hr of heat input that commenced construction modification, or reconstruction after August 17, 1971, and units with heat input capacities between 100 and 250 MMBtu/hr that commenced construction modification, or reconstruction after June 19, 1984.

## Exhaust gas composition according to various sources [ edit ]

**Diesel engine exhaust composition**

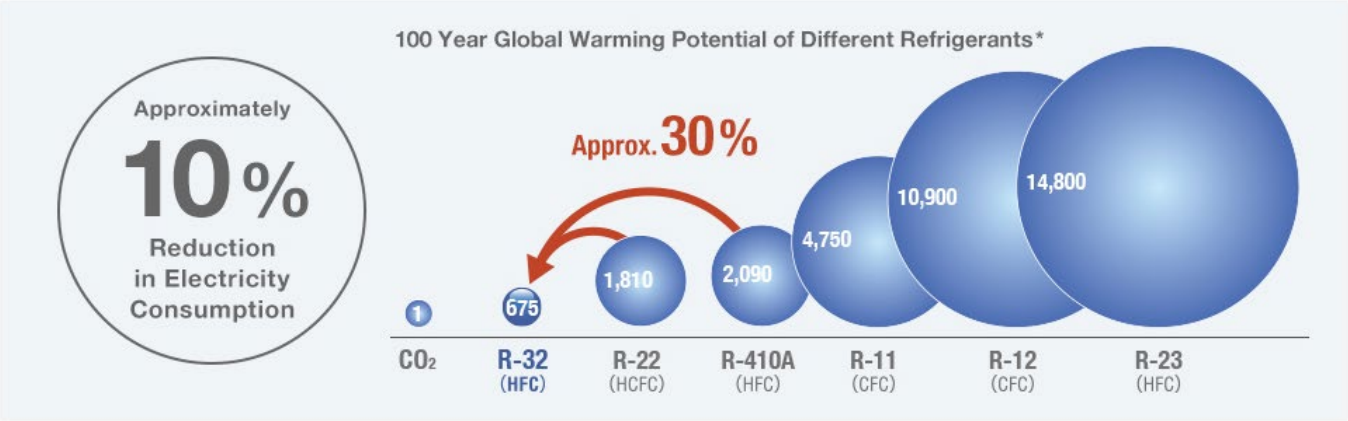
| | Average Diesel engine exhaust composition (Reif 2014)[17] | Average Diesel engine exhaust composition (Merker, Teichmann, 2014)[18] | Diesel's first engine exhaust composition (Hartenstein, 1895)[19] | Diesel engine exhaust composition (Khair, Majewski, 2006)[20] | Diesel engine exhaust composition (various sources) |
|---|---|---|---|---|---|
| **Species** | **Mass percentage** | **Volume percentage** | **Volume percentage** | **(Volume?) percentage** | |
| **Nitrogen ($N_2$)** | 75.2 % | 72.1 % | - | ~67 % | - |
| **Oxygen ($O_2$)** | 15 % | 0.7 % | 0.5 % | ~9 % | - |
| **Carbon dioxide ($CO_2$)** | 7.1 % | 12.3 % | 12.5 % | ~12 % | - |
| **Water ($H_2O$)** | 2.6 % | 13.8 % | - | ~11 % | - |
| **Carbon monoxide (CO)** | 0.043 % | 0.09 % | 0.1 % | - | 100–500 ppm[21] |
| **Nitrogen oxide ($NO_x$)** | 0.034 % | 0.13 % | - | - | 50–1000 ppm[22] |
| **Hydrocarbons (HC)** | 0.005 % | 0.09 % | - | - | - |
| **Aldehyde** | 0.001 % | n/a | - | - | - |
| **Particulate matter (sulfate + solid substances)** | 0.008 % | 0.0008 % | - | - | 1–30 $mg \cdot m^{-3}$[23] |

Using Reif 2014, NOx= 0.034% $CO_2$= 7.1% yields the following: 0.034 x 298 GWP = 10.03 / 7.1 = 1.41 times as much $CO2_e$ from NOx as from $CO_2$ in Diesel Emissions. https://en.wikipedia.org/wiki/Diesel_exhaust

Emissions of greenhouse gases are typically expressed in a common metric so that their impacts can be directly compared. The international standard is to express greenhouse gases in units of carbon dioxide equivalent, commonly written as $CO2_e$. For a given amount of a greenhouse gas, multiplying the amount of gas times the global warming potential (GWP) for that gas results in the amount of greenhouse gas in terms of $CO2_e$.

For refrigerants, such as those used in air conditioners and heat pumps, the equivalents are as follows. Even R-32, which is the best available, has a GWP that is 27 times higher than methane. R-23 has a GWP that is almost 600 times higher than methane.

**( https://www.daikin.com/corporate/why_daikin/benefits/r-32/ )**

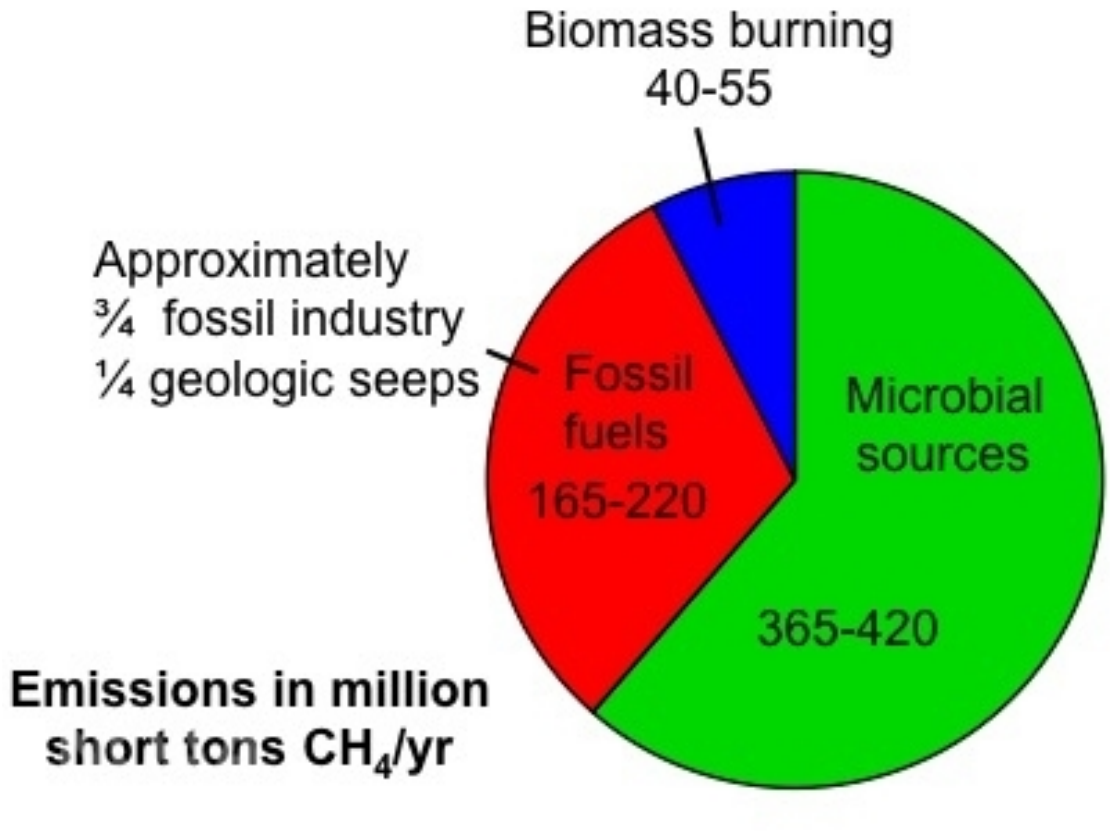



For automotive-related gases, these global warming potentials are:

| **Greenhouse Gas** | **Abbreviation** | **GWP[5]** |
|---|---|---|
| Carbon Dioxide | CO2 | 1 |
| Methane | CH4 | 25 |
| Nitrogen Oxide (NOx) | N2O | 298 |

(**https://www.nrc.gov/docs/ML1408/ML14087A259.pdf**)

**Methane Sources**




Fossil Fuels account for approximately 30% - 31% of Annual Methane emissions with 75% of that related to the industry, or approximately 23% of all methane emissions.

The UN IPCC Report of 2014 states that methane may account for 19% of total GWP.

The calculation results in the following:

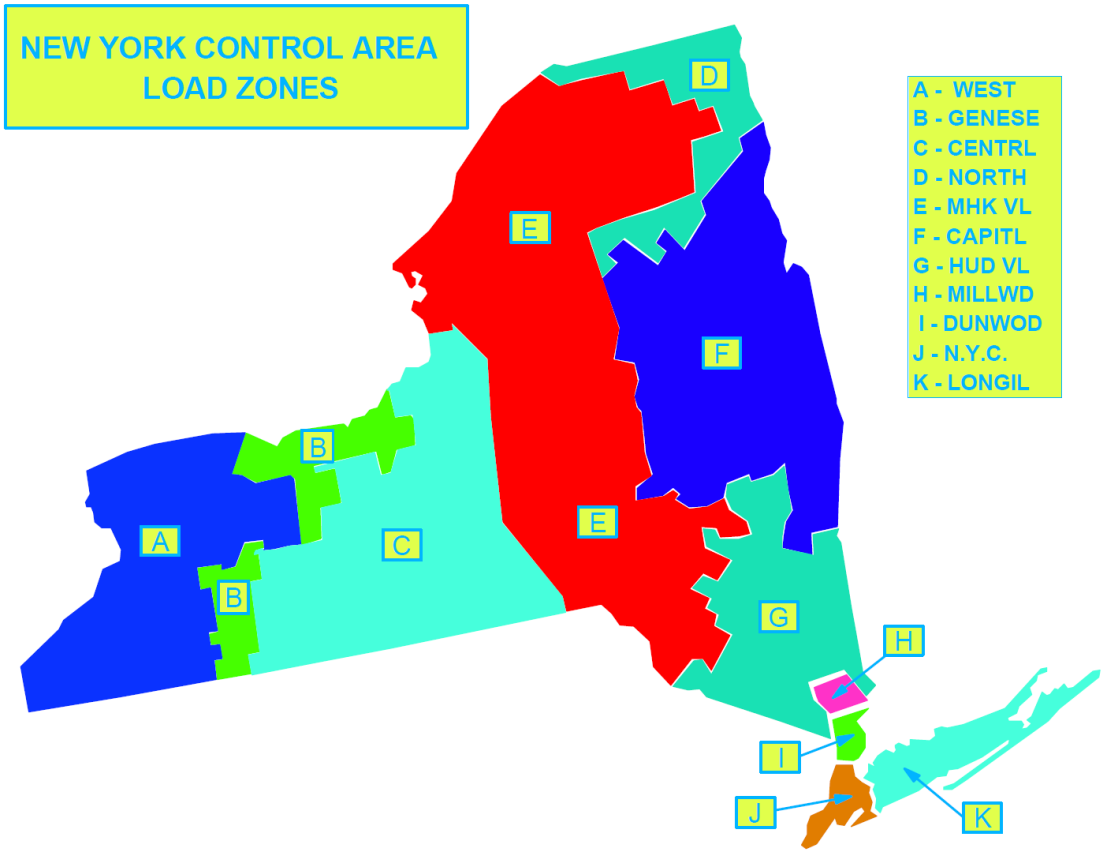
23% of 19% = 4.37%

so it can be estimated that the methane from the fossil fuel industry accounts for 4.37% of total GWP. That does not include $CO_2$ and NOx emissions that result from the burning of fossil fuels.

**https://e360.yale.edu/assets/site/NOAA_MethanebySource.jpeg**

**APPENDIX F - Information from NYISO Gold Book 2019 Follows**

Tompkins County is in Zone C. Westchester County includes Zones H & I



## Table II-1b: Summary of Changes in Winter Capacity Since 2018 – MW

| Generator Fuel Types | 2018/19 Capacity | Deactivations | Additions & Uprates | Reclassi-fications | Ratings Changes | 2019/20 Capacity |
|---|---|---|---|---|---|---|
| Gas | 4,100 | | | | -69 | 4,031 |
| Oil | 2,876 | | | | -37 | 2,839 |
| Gas & Oil | 20,313 | -284 | 886 | | -2 | 20,913 |
| Coal | 1,001 | -158 | | | 1 | 844 |
| Nuclear | 5,425 | | | | 5 | 5,430 |
| Pumped Storage | 1,410 | | | | -1 | 1,409 |
| Hydro | 4,223 | | | | 1 | 4,224 |
| Wind | 1,739 | | | | 0 | 1,739 |
| Other | 381 | -20 | | | 1 | 362 |
| Total | 41,468 | -462 | 886 | 0 | -101 | 41,791 |

**28290 MW Fossil Fuel** **13,178 MW Non-Fossil Fuel (Will be reduced to 11,200 MW Non-Fossil Fuel when Indian Point Closes by 2022 )**

2019 Load & Capacity Data Report

## Table V-2b: NYCA Load and Capacity Schedule – Winter Capability Period

| ***WINTER CAPABILITY*** | **2018/19** (from 2018 *Gold Book*) | **MW** 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 | 2028/29 | 2029/30 | **Totals** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Steam Turbine (Oil) | 825.5 | 827.0 | 827.0 | 827.0 | 827.0 | 827.0 | 827.0 | 827.0 | 827.0 | 827.0 | 827.0 | 827.0 | |
| Steam Turbine (Oil & Gas) | 8,489.3 | 8,445.5 | 8,445.5 | 8,445.5 | 8,445.5 | 8,445.5 | 8,445.5 | 8,445.5 | 8,445.5 | 8,445.5 | 8,445.5 | 8,445.5 | |
| Steam Turbine (Gas) | 1,540.5 | 1,548.9 | 1,548.9 | 1,548.9 | 1,548.9 | 1,548.9 | 1,548.9 | 1,548.9 | 1,548.9 | 1,548.9 | 1,548.9 | 1,548.9 | |
| Steam Turbine (Coal) | 1,000.7 | 843.5 | 843.5 | 843.5 | 843.5 | 843.5 | 843.5 | 843.5 | 843.5 | 843.5 | 843.5 | 843.5 | |
| Combined Cycle (Oil & Gas) | 8,919.6 | 9,707.6 | 9,707.6 | 10,839.6 | 10,839.6 | 10,839.6 | 10,839.6 | 10,839.6 | 10,839.6 | 10,839.6 | 10,839.6 | 10,839.6 | |
| Combined Cycle (Gas) | 1,805.6 | 1,730.7 | 1,730.7 | 1,730.7 | 1,730.7 | 1,730.7 | 1,730.7 | 1,730.7 | 1,730.7 | 1,730.7 | 1,730.7 | 1,730.7 | |
| Jet Engine (Oil) | 806.4 | 795.4 | 795.4 | 795.4 | 795.4 | 795.4 | 795.4 | 795.4 | 795.4 | 795.4 | 795.4 | 795.4 | |
| Jet Engine (Oil & Gas) | 1,656.7 | 1,511.2 | 1,511.2 | 1,511.2 | 1,511.2 | 1,511.2 | 1,511.2 | 1,511.2 | 1,511.2 | 1,511.2 | 1,511.2 | 1,511.2 | |
| Jet Engine (Gas) | 58.4 | 58.6 | 58.6 | 58.6 | 58.6 | 58.6 | 58.6 | 58.6 | 58.6 | 58.6 | 58.6 | 58.6 | |
| Combustion Turbine (Oil) | 1,219.9 | 1,194.3 | 1,194.3 | 1,194.3 | 1,194.3 | 1,194.3 | 1,194.3 | 1,194.3 | 1,194.3 | 1,194.3 | 1,194.3 | 1,194.3 | |
| Combustion Turbine (Oil & Gas) | 1,218.7 | 1,219.5 | 1,219.5 | 1,219.5 | 1,219.5 | 1,219.5 | 1,257.9 | 1,257.9 | 1,257.9 | 1,257.9 | 1,257.9 | 1,257.9 | |
| Combustion Turbine (Gas) | 695.9 | 692.7 | 692.7 | 692.7 | 692.7 | 692.7 | 692.7 | 692.7 | 692.7 | 692.7 | 692.7 | 692.7 | |
| Internal Combustion (Oil) | 24.6 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | |
| Internal Combustion (Oil & Gas) | 28.3 | 28.9 | 28.9 | 28.9 | 28.9 | 28.9 | 28.9 | 28.9 | 28.9 | 28.9 | 28.9 | 28.9 | |
| Internal Combustion (Gas) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Pumped Storage Hydro | 1,409.9 | 1,408.7 | 1,408.7 | 1,408.7 | 1,408.7 | 1,408.7 | 1,408.7 | 1,408.7 | 1,408.7 | 1,408.7 | 1,408.7 | 1,408.7 | |
| Steam (PWR Nuclear) | 2,645.0 | 2,647.5 | 2,647.5 | 1,621.6 | 581.7 | 581.7 | 581.7 | 581.7 | 581.7 | 581.7 | 581.7 | 581.7 | |
| Steam (BWR Nuclear) | 2,780.2 | 2,782.5 | 2,782.5 | 2,782.5 | 2,782.5 | 2,782.5 | 2,782.5 | 2,782.5 | 2,782.5 | 2,782.5 | 2,782.5 | 2,782.5 | |
| Conventional Hydro (5) | 4,223.1 | 4,224.0 | 4,224.0 | 4,224.0 | 4,224.0 | 4,224.0 | 4,224.0 | 4,224.0 | 4,224.0 | 4,224.0 | 4,224.0 | 4,224.0 | |
| Internal Combustion (Methane) (5) | 107.3 | 107.3 | 107.3 | 107.3 | 107.3 | 107.3 | 107.3 | 107.3 | 107.3 | 107.3 | 107.3 | 107.3 | |
| Steam Turbine (Wood) (5) | 20.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Steam Turbine (Refuse) (5) | 221.7 | 223.6 | 223.6 | 223.6 | 246.1 | 246.1 | 246.1 | 246.1 | 246.1 | 246.1 | 246.1 | 246.1 | |
| Wind (5) (6) | 1,739.2 | 1,739.2 | 1,739.2 | 2,766.4 | 2,766.4 | 2,766.4 | 2,766.4 | 2,766.4 | 2,766.4 | 2,766.4 | 2,766.4 | 2,766.4 | |
| Solar (5) (8) | 31.5 | 31.5 | 31.5 | 31.5 | 31.5 | 31.5 | 31.5 | 31.5 | 31.5 | 31.5 | 31.5 | 31.5 | |
| EXISTING GENERATING FACILITIES | 41,468.3 | 41,790.4 | 41,790.4 | 42,923.7 | 41,906.3 | 41,906.3 | 41,944.7 | 41,944.7 | 41,944.7 | 41,944.7 | 41,944.7 | 41,944.7 | |
| Special Case Resources - SCR (3) | 884.4 | 853.0 | 853.0 | 853.0 | 853.0 | 853.0 | 853.0 | 853.0 | 853.0 | 853.0 | 853.0 | 853.0 | |
| Additions and Re-rates (2) | 832.8 | 0.0 | 2,159.2 | 22.5 | 0.0 | 584.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2,765.7 |
| Noticed Deactivations (9) | -485.5 | 0.0 | -1,025.9 | -1,039.9 | 0.0 | -545.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -2,611.4 |
| NYCA RESOURCE CAPABILITY | 42,700.0 | 42,643.4 | 43,776.7 | 42,759.3 | 42,759.3 | 42,797.7 | 42,797.7 | 42,797.7 | 42,797.7 | 42,797.7 | 42,797.7 | 42,797.7 | |
| Net Capacity Purchases (1) (7) | 1,482.4 | 678.0 | 1,219.2 | 1,233.1 | 1,236.9 | 1,375.0 | 1,375.0 | 1,375.0 | 1,375.0 | 1,375.0 | 1,375.0 | 1,375.0 | |
| TOTAL RESOURCE CAPABILITY | 44,182.4 | 43,321.4 | 44,995.9 | 43,992.4 | 43,996.2 | 44,172.7 | 44,172.7 | 44,172.7 | 44,172.7 | 44,172.7 | 44,172.7 | 44,172.7 | |
| ***BASE FORECAST*** | | | | | | | | | | | | | |
| Peak Demand Forecast | | 24,123.0 | 23,745.0 | 23,457.0 | 23,415.0 | 23,381.0 | 23,340.0 | 23,297.0 | 23,281.0 | 23,307.0 | 23,436.0 | 23,550.0 | |
| Installed Reserve | | 19,198.4 | 21,250.9 | 20,535.4 | 20,581.2 | 20,791.7 | 20,832.7 | 20,875.7 | 20,891.7 | 20,865.7 | 20,736.7 | 20,622.7 | |
| Installed Reserve Percent (4) | | 79.6 | 89.5 | 87.5 | 87.9 | 88.9 | 89.3 | 89.6 | 89.7 | 89.5 | 88.5 | 87.6 | |

# Table I-11b: Electric Vehicle Peak Usage Forecast

*Reflects Total Cumulative Impacts*

**Total Increase in Coincident Summer Peak Demand by Zone - MW**

| Year | A | B | C | D | E | F | G | H | I | J | K | NYCA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2019 | 2 | 2 | 2 | 0 | 1 | 2 | 2 | 1 | 1 | 5 | 6 | 24 |
| 2020 | 3 | 3 | 3 | 0 | 1 | 4 | 4 | 2 | 2 | 10 | 8 | 40 |
| 2021 | 3 | 3 | 4 | 0 | 2 | 5 | 5 | 3 | 3 | 13 | 10 | 51 |
| 2022 | 5 | 5 | 5 | 0 | 2 | 7 | 6 | 3 | 4 | 18 | 13 | 68 |
| 2023 | 6 | 6 | 6 | 1 | 3 | 9 | 8 | 5 | 5 | 25 | 16 | 90 |
| 2024 | 7 | 8 | 8 | 1 | 3 | 11 | 10 | 6 | 7 | 33 | 19 | 113 |
| 2025 | 9 | 10 | 10 | 1 | 4 | 15 | 14 | 8 | 9 | 43 | 21 | 144 |
| 2026 | 12 | 13 | 13 | 1 | 6 | 19 | 18 | 10 | 12 | 57 | 25 | 186 |
| 2027 | 16 | 16 | 17 | 2 | 7 | 25 | 23 | 13 | 15 | 73 | 29 | 236 |
| 2028 | 19 | 20 | 21 | 2 | 9 | 31 | 28 | 16 | 18 | 92 | 34 | 290 |
| 2029 | 23 | 24 | 25 | 2 | 12 | 37 | 34 | 19 | 22 | 111 | 38 | 347 |
| 2030 | 28 | 29 | 30 | 3 | 14 | 43 | 40 | 22 | 25 | 133 | 43 | 410 |
| 2031 | 32 | 33 | 35 | 3 | 17 | 50 | 46 | 26 | 28 | 156 | 48 | 474 |
| 2032 | 38 | 39 | 41 | 4 | 20 | 59 | 54 | 30 | 33 | 185 | 54 | 557 |
| 2033 | 45 | 45 | 48 | 5 | 24 | 68 | 62 | 34 | 37 | 215 | 60 | 643 |
| 2034 | 52 | 51 | 57 | 6 | 29 | 78 | 71 | 39 | 42 | 250 | 67 | 742 |
| 2035 | 61 | 59 | 66 | 6 | 35 | 90 | 81 | 44 | 47 | 289 | 74 | 852 |
| 2036 | 71 | 67 | 76 | 8 | 42 | 102 | 92 | 50 | 53 | 333 | 82 | 976 |
| 2037 | 82 | 76 | 88 | 9 | 49 | 116 | 104 | 56 | 59 | 381 | 91 | 1,111 |
| 2038 | 94 | 86 | 101 | 10 | 58 | 131 | 117 | 62 | 66 | 435 | 101 | 1,261 |
| 2039 | 108 | 97 | 116 | 12 | 68 | 148 | 132 | 69 | 73 | 495 | 112 | 1,430 |

**Total Increase in Coincident Winter Peak Demand by Zone - MW**

| Year | A | B | C | D | E | F | G | H | I | J | K | NYCA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2019-20 | 3 | 3 | 3 | 0 | 1 | 4 | 4 | 2 | 2 | 9 | 11 | 42 |
| 2020-21 | 5 | 5 | 5 | 1 | 2 | 7 | 6 | 3 | 4 | 16 | 14 | 68 |
| 2021-22 | 6 | 6 | 6 | 1 | 3 | 8 | 8 | 4 | 5 | 21 | 17 | 85 |
| 2022-23 | 8 | 8 | 8 | 1 | 3 | 11 | 10 | 6 | 7 | 29 | 22 | 113 |
| 2023-24 | 10 | 10 | 10 | 1 | 4 | 14 | 13 | 8 | 9 | 39 | 27 | 145 |
| 2024-25 | 12 | 12 | 13 | 1 | 6 | 19 | 17 | 10 | 11 | 51 | 32 | 184 |
| 2025-26 | 16 | 16 | 16 | 2 | 7 | 24 | 22 | 13 | 15 | 67 | 35 | 233 |
| 2026-27 | 20 | 21 | 21 | 2 | 9 | 32 | 29 | 17 | 19 | 89 | 41 | 300 |
| 2027-28 | 25 | 27 | 27 | 3 | 12 | 40 | 37 | 21 | 24 | 114 | 48 | 378 |
| 2028-29 | 31 | 33 | 33 | 3 | 15 | 50 | 46 | 27 | 30 | 143 | 55 | 466 |
| 2029-30 | 37 | 40 | 40 | 4 | 18 | 60 | 55 | 32 | 35 | 173 | 62 | 556 |
| 2030-31 | 44 | 46 | 47 | 5 | 21 | 70 | 64 | 37 | 41 | 205 | 70 | 650 |
| 2031-32 | 51 | 53 | 55 | 5 | 25 | 80 | 73 | 42 | 47 | 242 | 78 | 751 |
| 2032-33 | 59 | 62 | 64 | 6 | 30 | 94 | 85 | 49 | 54 | 285 | 87 | 875 |
| 2033-34 | 69 | 71 | 74 | 7 | 36 | 107 | 97 | 56 | 61 | 332 | 97 | 1,007 |
| 2034-35 | 80 | 81 | 86 | 8 | 43 | 123 | 111 | 63 | 68 | 387 | 107 | 1,157 |
| 2035-36 | 92 | 92 | 99 | 10 | 50 | 140 | 127 | 72 | 77 | 447 | 119 | 1,325 |
| 2036-37 | 106 | 105 | 114 | 11 | 59 | 159 | 143 | 81 | 86 | 515 | 132 | 1,511 |
| 2037-38 | 121 | 118 | 130 | 13 | 69 | 180 | 161 | 90 | 95 | 590 | 145 | 1,712 |
| 2038-39 | 139 | 133 | 148 | 15 | 81 | 202 | 181 | 100 | 105 | 673 | 161 | 1,938 |
| 2039-40 | 158 | 149 | 169 | 17 | 94 | 227 | 202 | 111 | 116 | 767 | 177 | 2,187 |

Note: Electric Vehicle energy coincident peak usage is included in the Baseline Forecast (Tables I-3, 1-4, and 1-5).
The summer coincident peak is assumed to occur during hour beginning 4 PM EDT.
The winter coincident peak is assumed to occur during hour beginning 6 PM EST.

# Table I-11a: Electric Vehicle Energy Usage Forecast

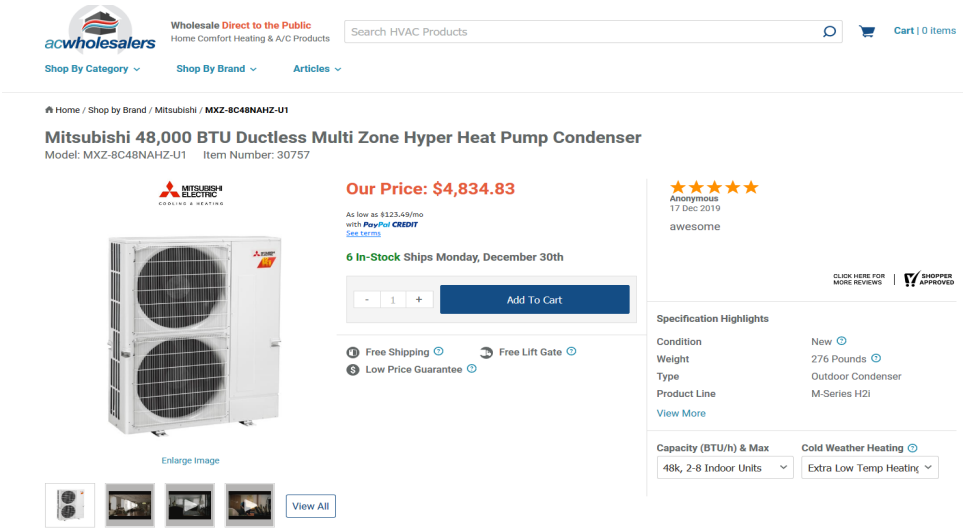
*Reflects Total Cumulative Impacts*

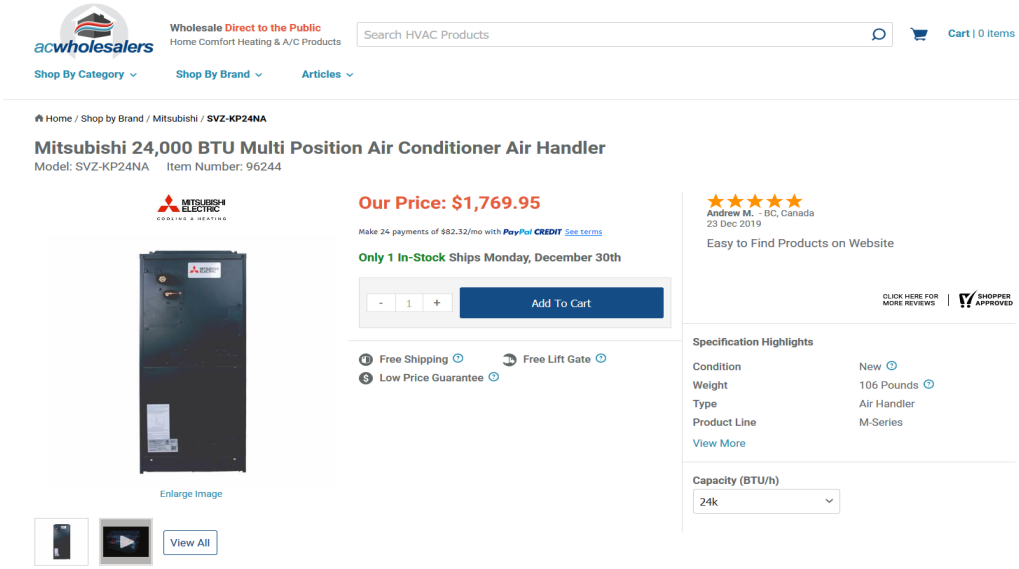
**Total Annual Energy Consumption by Zone - GWh**

| Year | A | B | C | D | E | F | G | H | I | J | K | NYCA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2019 | 14 | 13 | 14 | 2 | 7 | 18 | 17 | 9 | 11 | 38 | 67 | 210 |
| 2020 | 24 | 22 | 24 | 3 | 12 | 32 | 30 | 16 | 19 | 67 | 122 | 371 |
| 2021 | 31 | 28 | 31 | 3 | 15 | 41 | 38 | 20 | 24 | 87 | 212 | 530 |
| 2022 | 41 | 38 | 41 | 4 | 20 | 56 | 51 | 27 | 32 | 120 | 300 | 730 |
| 2023 | 53 | 49 | 54 | 6 | 26 | 73 | 67 | 36 | 42 | 158 | 402 | 966 |
| 2024 | 67 | 63 | 70 | 7 | 33 | 94 | 86 | 46 | 54 | 205 | 518 | 1,243 |
| 2025 | 84 | 81 | 88 | 9 | 41 | 122 | 111 | 60 | 70 | 267 | 655 | 1,588 |
| 2026 | 111 | 107 | 117 | 12 | 56 | 161 | 147 | 79 | 91 | 351 | 796 | 2,028 |
| 2027 | 144 | 138 | 153 | 15 | 74 | 208 | 189 | 101 | 116 | 447 | 948 | 2,533 |
| 2028 | 179 | 172 | 192 | 19 | 94 | 260 | 235 | 126 | 143 | 554 | 1,112 | 3,086 |
| 2029 | 217 | 206 | 232 | 23 | 116 | 311 | 281 | 150 | 168 | 658 | 1,291 | 3,653 |
| 2030 | 252 | 239 | 271 | 26 | 137 | 361 | 326 | 173 | 193 | 762 | 1,486 | 4,226 |
| 2031 | 289 | 274 | 311 | 30 | 158 | 414 | 373 | 199 | 219 | 872 | 1,701 | 4,840 |
| 2032 | 334 | 316 | 361 | 35 | 185 | 479 | 431 | 229 | 251 | 1,005 | 1,939 | 5,565 |
| 2033 | 379 | 358 | 410 | 40 | 212 | 544 | 488 | 260 | 283 | 1,139 | 2,203 | 6,316 |
| 2034 | 430 | 406 | 466 | 45 | 243 | 617 | 553 | 295 | 317 | 1,287 | 2,497 | 7,156 |
| 2035 | 479 | 453 | 521 | 50 | 272 | 690 | 618 | 331 | 353 | 1,439 | 2,825 | 8,031 |
| 2036 | 532 | 504 | 579 | 55 | 304 | 767 | 688 | 369 | 390 | 1,600 | 3,193 | 8,981 |
| 2037 | 584 | 555 | 636 | 61 | 335 | 846 | 759 | 409 | 428 | 1,766 | 3,604 | 9,983 |
| 2038 | 637 | 609 | 696 | 66 | 367 | 928 | 832 | 450 | 468 | 1,940 | 4,064 | 11,057 |
| 2039 | 693 | 665 | 759 | 72 | 400 | 1,014 | 910 | 495 | 510 | 2,122 | 4,479 | 12,119 |

Note: Electric Vehicle energy usage is included in the Baseline Forecast (Table I-2).

## APPENDIX G - HEAT PUMP COST CALCULATION




**Cost per heat Pump**

| | |
|---|---|
| **$4,834.00** | **Heat Pump with Low Temp Heating** |
| **$716.00** | **5 Unit Branch Box for interior units** |
| **$4,200.00** | **Air Handlers x 2.5** |
| **$9,750.00** | **Total Equipment excluding installation, piping, wiring, other accessories, etc.** |
| **$19,500,000.00** | **Total Equipment cost for equipment only to compensate for 2000 Heat Pumps for the NYSEG RFP, no installation included** |

Cold War Energy pp 401-420 | Cite as

# The Fall of the Soviet Union and the Legacies of Energy Dependencies in Eastern Europe

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Chapter
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## Abstract

Against the background of energy (inter-)dependencies created during the Soviet period between the energy-rich and energy-poor Soviet republics, as well during the Cold War between the Soviet Union and individual European CMEA states, this chapter focuses on the post-Soviet impact of these legacies on each of these two groups of states. In doing so, it focuses not only on the way they affected relations between individual states, but also on their impact on these states' political and economic development after the dissolution of the Communist "bloc" and the breakup of the Soviet Union. These legacies, this chapter argues, go well beyond energy dependency: they affected not only these states' range of energy options, but also Russia's ability to use energy as a foreign policy tool. Most importantly—as shown through the case studies of Ukraine, Belarus, and the Baltic states—the energy legacies of the Soviet era synergized with other characteristics of the transition period and of the external environment at the time of the Soviet/CMEA dissolution to significantly constrain the conditions for political and economic development of these newly-independent states after 1991.

## Keywords

European Union | International Energy Agency | Energy Trade | Energy Export | Soviet Legacy

**APPENDIX J**

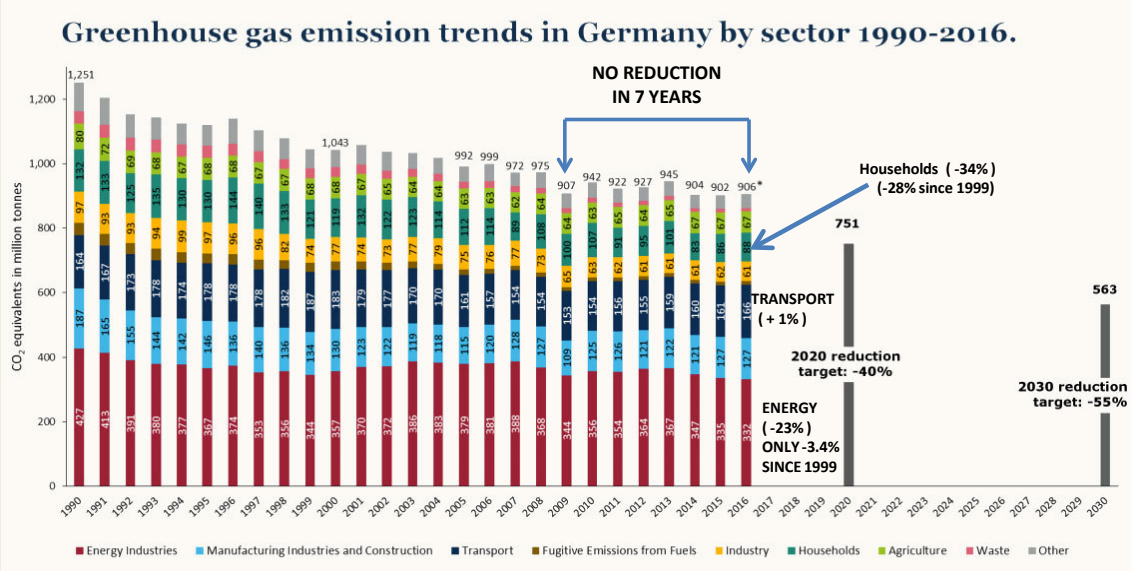
# GERMANY – A CAUTIONARY EXAMPLE

**AFTER 30 YEARS, 30,000 WIND TURBINES INSTALLED, AND SOARING ENERGY COSTS, GERMANY IS MISSING IT'S GHG TARGETS. WHY ?**

**NOT ENOUGH RESOURCES WERE DEVOTED TO REDUCING THE CARBON FOOTPRINT OF TRANSPORTATION AND THE ENERGY INDUSTRY AND TOO MUCH ELECTRIC LOAD WAS ADDED WITHOUT SUFFICIENT RENEWABLE GENERATION TO COMPENSATE FOR THE ADDITIONAL LOAD.**

(Those Accounted for 47% of GHG in 1990 - Reduced by only 16% in 27 years - 1% since 1999 - They Account for 66% of GHG now)

**WITH THE CURRENT NY PLAN, GERMANY'S PAST 30 YEAR HISTORY IS NEW YORK'S FUTURE**




https://e360.yale.edu/features/carbon-crossroads-can-germany-revive-its-stalled-energy-transition

http://www.world-nuclear.org/information-library/country-profiles/countries-g-n/germany.aspx

| | | | | | TWh | | | | | | | TWh | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Nuclear | Wind | Solar | Hydro | Coal | Gas | Biofuels/ Waste | Oil | TOTAL | Total CO2 (Millions of Tons) | Renewables /Nuclear | Fossil/ Other | % Renewable |
| **2016** | 85 | 79 | 38 | 26 | 273 | 82 | 58 | 8 | 649 | 906 | 228 | 421 | 35.1% |
| **2017** | 76 | 107 | 40 | 26 | 252 | 87 | 59 | 8 | 655 | 903.5 | 249 | 406 | 38.0% |
| **Change** | -9 | 28 | 2 | 0 | -21 | 5 | 1 | 0 | 6 | | 21 | -15 | |

The above bar chart and table show German Carbon footprint reductions for 27 years. They have had virtually no reduction in GHG Emissions since 2008 despite 30,000 wind turbines, large amounts of solar power, and the net addition of 21 Terawatt hours of non-carbon producing generation in one year, between 2016 and 2017. Their issue is that they have heavily focused on onsite combustion as can be seen with the 28% GHG reduction in that area since 1999. But that doesn't help with overall GHG reduction because the equipment being replaced is so efficient. They also didn't focus on their vehicle emissions, which are the worst source of GHG emissions, because of a strong automotive lobby in Germany.

## APPENDIX K - RATE OF RENEWABLE GENERATION INSTALLATION IN N.Y. STATE VERSUS TOTAL FOSSIL FUEL LOADS

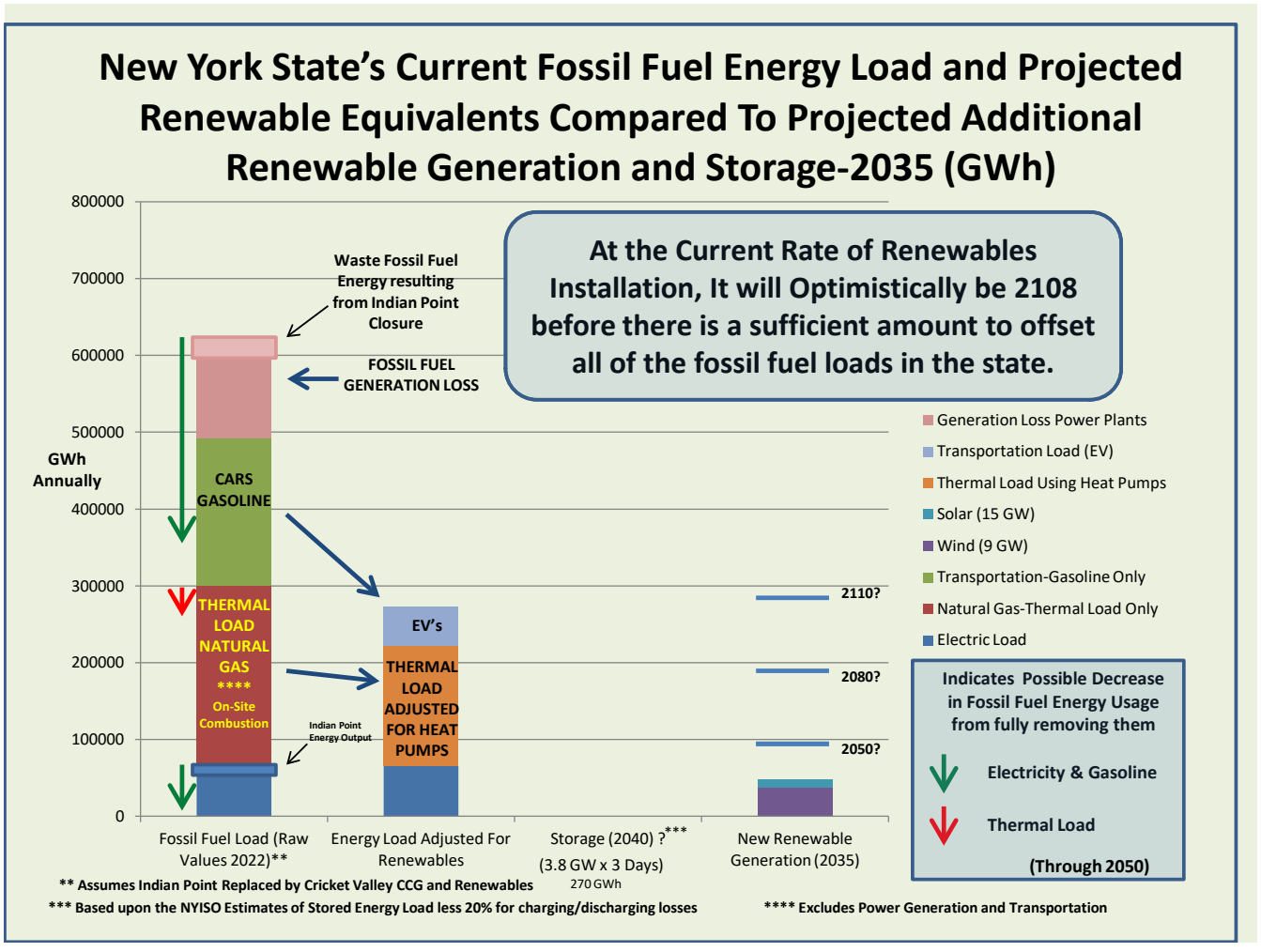
**Left hand bar is total N.Y. State existing fossil fuel usage expressed in GWh Annually**

**Next column is the ideal electric load if everything could be converted to renewables**

**Next column is the storage that will be installed by 2040 according to the NYISO. Without sufficient storage to transfer energy between times of generation and times of use the entire system will break down. What will be available by 2040 will not be nearly enough.**

**Right hand column is the rate of renewable generation installation in N.Y. State, including the planned solar arrays and the 9 GW wind farm in the Atlantic Ocean. It could be another 90 years before there is sufficient renewable generation to offset the current fossil fuel load**

**The green arrows represent the possible fossil fuel reduction by 2050 if the renewables are applied to vehicles and fossil fuel generation. The red arrow represents the reduction if they are applied to onsite combustion.**



## APPENDIX L - $CO2_e$/Greenhouse Gas Calculations (To Calculate CO2e, Multiply quantity of a gas by its GWP - Appendix E)

**Natural Gas - Fuel Oil Comparisons Combustion Equivalents**

| | On-Site Combustion Natural Gas | Power Generation #6 Oil | Power Generation #2 Oil | Power Generation Natural Gas |
|---|---|---|---|---|
| **GW** | 2,200,000.00 | 2,200,000.00 | 2,200,000.00 | 2,200,000.00 |
| **DAYS** | 365.00 | 365.00 | 365.00 | 365.00 |
| **HOURS** | 24.00 | 24.00 | 24.00 | 24.00 |
| **COP/Efficiency** | 2.50 | 0.33 | 0.33 | 0.33 |
| **GWh** | 48,180,000,000.00 | 57,821,782,178 | 58,400,000,000 | 58,400,000,000 |
| **KW/Therm** | 29.30 | 29.3 | 29.3 | 29.3 |
| **Therms** | 1,644,368,600.68 | 1,973,242,321 | 1,993,174,061 | 1,993,174,061 |
| **pounds CO2/Therm** | 12.32 | 16.66666667 | 15.92857143 | 11.7 |
| **Pounds CO2** | 20,258,621,160.41 | 32,887,372,016.67 | 31,748,415,407.12 | 23,320,136,518.77 |
| **Tons CO2** | 10,129,310.58 | 16,443,686.01 | 15,874,207.70 | 11,660,068.26 |
| **Therms/gallon** | | 1.5 | 1.4 | |
| **Gallons** | | 1,315,494,880.67 | 1,423,695,758.17 | |
| **Tons (Nox) per gallon (oil) or Therm (NG)** | 11,284.881 | 36,179.727 | 14,236.958 | 13,678.643 |
| **NOx CO2e Multiplier** | 298.00 | 298.00 | 298.00 | 298.00 |
| **$CO2_e$ (NOx) Tons** | 3,362,894.46 | 10,781,558.70 | 4,242,613.36 | 4,076,235.71 |
| **Tons $CO_2$ + NOx** | 13,492,205.04 | 27,225,244.71 | 20,116,821.06 | 15,736,303.97 |
| **RATIO TO ONSITE COMBUSTION** | | **2.02** | **1.49** | **1.17** |

### Fuel Emissions

| (Tons) | Nat. Gas Onsite | #6 Oil | #2 Oil | Nat. Gas |
|---|---|---|---|---|
| Part | 241.82 | 7,893.76 | 1,423.70 | 293.11 |
| PM10 | 241.82 | 5,130.94 | 768.80 | 293.11 |
| SOx | 48.36 | 104,329.18 | 102,221.36 | 58.62 |
| NOx | 11,284.88 | 36,179.73 | 14,236.96 | 13,678.64 |
| VOC | 225.70 | 743.33 | 242.03 | 273.57 |
| CO | 2,821.22 | 3,289.07 | 3,559.24 | 3,419.66 |
| Lead | 0.00 | 2.76 | 0.28 | 0.00 |
| Total Tons | 14,863.80 | 157,568.76 | 122,452.36 | 18,016.73 |

**https://chpkgas.com/wp-content/uploads//2012/06/Boiler-Emissions-gas-vs-oil_rev103108withCO2.xlsx**

**APPENDIX M - NEW ROCHELLE GROWTH**

**The following clippings document one weeks announced expansion plans in New Rochelle.**

PRINT JOURNALISM: BECAUSE IT STILL MATTERS.
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Cappelli's building, The Standard, is next to the Planned Parenthood site in New Rochelle. *Photo by Peter Katz.*

# Soaring skyline

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## CAPPELLI-RELATED ENTITY PROPOSES NEW ROCHELLE BUILDING

BY PETER KATZ
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The entity 247 North Avenue Associates LLC, which gives its address as being in care of developer Louis Cappelli's Cappelli Organization in White Plains, is seeking approval from New Rochelle to construct a 28-story, mixed-use building at 247 North Ave., a through lot with frontage on LeCount Place that is next to Cappelli's new mixed-use building at 251 North Ave. known as The Standard.

Bruce Berg, an executive vice president with the Cappelli Organization and a member of 247 North Avenue Associates LLC said he anticipates The Standard, a 112-unit, mixed-use building at 251 North Ave. would be opening during the first quarter of 2020.

The planned building at 247 North Ave. would be on a site currently occupied by the Planned Parenthood New Rochelle Center operated by Planned Parenthood Hudson Peconic Inc.

"They put it on the market a couple of months back and we started a dialogue with them," Berg told the New Rochelle Planning Board. "We have structured the deal with them to give them the appropriate amount of time to find and relocate to new headquarters space."

The new building at 247 North Ave. would contain 244 apartments. There would be 28 studios, 144 one-bedroom and 72 two-bedroom units. There would be four levels of parking, including two below grade and two above grade on the second and third floors. Ground-level retail space would front on North Avenue.

"We have two primary garage entrances with one from North Avenue leading to the lower level of the garage and the other entrance

» 247 NORTH AVE. 6

## 28-STORY, 351-UNIT BUILDING PROPOSED FOR NEW ROCHELLE

BY PETER KATZ
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**DEVELOPER MAIN & MEMORIAL ASSEMBLAGE LLC** wants to build a 28-story, mixed-use structure at 525 Main St. in New Rochelle.

The structure also would have frontage on Memorial Highway. The developer has assembled five lots to create a 22,000-square-foot parcel for the project. The building would contain 351 residential units along with 6,000 square feet of retail space. There would be 274 parking spaces provided. And 10% of the units would be affordable.

The city's review process has begun, including an informal presentation to the planning board and the city reportedly has offered several comments that the developer may be planning to accommodate in its plans. The developer's environmental assessment form is under review by the city.

According to attorney Anthony Gioffre III of the White Plains-based law firm Cuddy & Feder, there would be 31 studios, 268 one-bedroom units, 46 two-bedroom units and six three-bedroom units. He said because the project is adjacent to Memorial Plaza, which honors local veterans, the developer reached out to a local veterans group with an offer to redesign the plaza. The developer also recently met with the library board to seek feedback and lis-

» 525 MAIN ST. 6

# IN BRIEF

## Pier 1 Imports stores face potential closing

The Pier 1 Imports store at 1460 Post Road East in Westport, Connecticut, during its last week in business in late October 2016. *Photo by Alexander Soule / Hearst Connecticut Media.*

Eleven regional Pier 1 Imports stores face the prospect of closing after the home furnishings retailer announced plans to shut down up to 450 of its 942 stores.

Pier 1 Imports did not announce which stores it planned to close or what timeline it would pursue in the shuttering of retail operations.

In Fairfield County, Pier 1 Imports has stores in Danbury, Fairfield and Norwalk. In the Westchester-Hudson Valley market, the retailer can be found in Bedford Hills, Middletown, Mohegan Lake, Newburgh, Port Chester, Poughkeepsie, White Plains and Yonkers.

The company has been experiencing financial tumult with sales declines recorded across the last nine fiscal quarters. For the fiscal quarter that ended Nov. 30, Pier 1 Imports announced a $59 million loss, compared with the loss of $50.4 million from a year ago, while net sales fell to $358.4 million from $413.2 million a year ago. Same-store sales fell 11.4% in the most recent fiscal quarter and the company's stock plummeted by more than 40% over the past 12 months.

### CONNECTICUT, NEW YORK EXPERIENCE POPULATION LOSS

Two moving companies issued their annual surveys of states with the greatest inbound and outbound migration – and Connecticut and New York ranked in the top 10 for both companies' lists of states with the greatest levels of outbound migration.

United Van Lines' 2019 National Movers Study ranked New York third and Connecticut fourth among the states with the highest outbound migration activity last year – only New Jersey and Illinois experienced more residents moving out of state.

North American Moving Services' 2019 Migration Report ranked Connecticut eighth and New York 10th among the states that recorded the greatest residential departures in the past year.

The surveys follow a U.S. Census Bureau analysis that found New York and Connecticut losing population in the period between July 2018 and July 2019. New York, the nation's fourth-most populous state, recorded the greatest population decline during this 12-month period with a loss of 76,790 residents. Connecticut ranked fifth among the states with a shrinking population, with 6,233 fewer people at the conclusion of the 12-month period. In contrast, 40 states and the District of Columbia saw population increases.

And where are people moving?

The moving companies pegged Idaho as the top state for inbound migration.

### STATES SEEK SUPREME COURT REVIEW OF AFFORDABLE CARE ACT CASE

New York Attorney General Letitia James and her Connecticut counterpart William Tong have joined other attorneys general in filing a petition asking the U.S. Supreme Court to review last summer's decision by an appeals court that ruled the individual mandate aspect of the Affordable Care Act was unconstitutional.

The lawsuit, Texas v. United States, was filed in February 2018 by 20 Republican state attorneys general and governors and challenged the constitutionality of the individual mandate after the Tax Cuts and Jobs Act of 2017 ended ACA's individual mandate penalty beginning in 2019. The plaintiffs argued the mandate was unconstitutional without the penalty, adding that the ACA also needed to be struck down because the mandate was central to its existence.

The Trump administration backed the effort to strike down the mandate via the case. Last month, the U.S. Court of Appeals for the Fifth Circuit in New Orleans ruled 2-1 that the mandate was unconstitutional, but declined to go further on considering the ACA's overall fate.

"The individual mandate is unconstitutional because it can no longer be read as a tax, and there is no other constitutional provision that justifies this exercise of congressional power," the 5th U.S. Circuit Court of Appeals ruling said. "On the severability question, we remand to the district court to provide additional analysis of the provisions of the ACA as they currently exist."

### PEPSICO UNVEILS NEW MARKETING TAGLINE

PepsiCo has rolled out its first new tagline for its flagship Pepsi brand in more than two decades.

The Purchase-based brand has unveiled "That's What I Like" as the tagline in English- and Spanish-language advertisements and promotions for the Pepsi, Pepsi Zero Sugar and Diet Pepsi lines. The tagline will be introduced in a series of television ads.

*– Phil Hall*

### 247 North Ave. –

coming in on LeCount Place leading to the upper levels of the garage," Berg said.

"The fourth floor of the building is what we will develop as our amenity floor so we'll have an indoor pool, yoga studio, game room, a kitchen and community lounge and an outdoor terrace," Berg said. "We have designed the building in such a way as to not block the views from 251 North so the people who live in 251 North will maintain the views of Long Island Sound."

Berg said there will be 11 residential units per floor on the lower floors.

"When we get up to floors nine through 28, we go down to 10 units," he said.

Berg explained that in designing the building they created a jagged look to add to the visual interest of the building's profile with the edges of the floor plates not being in perfect vertical alignment.

"We have the floor plates going in and out, creating some interesting shapes and it will be very noticeable on the skyline," Berg said.

He described the exterior as largely being a glass curtain wall but with a mix of colors and other materials.

Berg said there would be roll-up doors for the garage entrances.

"We typically set it back one car length so that cars can get off the street while they're waiting to get into the garage," he said. "We'll look at things like high-speed garage doors to allow the entry very quickly."

Berg was asked for details about the indoor swimming pool they're proposing for the project and he noted that in one of their projects in Stamford with RXR Realty they built an indoor pool.

"It's been very well received and a very popular amenity with the crowd that we're typically attracting to the job because they get to use it 12 months of the year as opposed to the outdoor pools which tend to run from the Fourth of July through Labor Day weekend," he said.

Luis Aragon, New Rochelle's commissioner of development, praised Berg and Louis Cappelli for moving ahead with this development in the LeCount Place area after having proposed a $450 million LeCount Place/Anderson Street project in the mid-2000s that would have been called LeCount Square. The financial crisis of 2007-2008 and problems in the housing market intervened. He suggested the construction of the new project outlined by Berg would be a bit like replacing a missing tooth, saying it "is completely going to change the experience downtown and the experience along that street, so I just wanted to say kudos to you guys for not giving up on us and bringing us the missing tooth."

### 525 Main St. –

ten to concerns. He said the library board indicated it would be redesigning its courtyard and the developer feels there would be an opportunity to work with the library on architectural elements.

According to the project's architect, Susan Doban of Brooklyn-based Doban Architects, each side would be treated differently in terms of its finish.

"The side facing Main Street has more, richer brick detailing to relate to the context of Main Street and the side facing Memorial has a prominent base, which is permissible within the zoning because of the depth of the street there and it serves as more of a backdrop in a lot of ways and even a visual extension of the greenery of the plaza," she said.

According to the project's plans, the cellar of the building includes mechanical equipment and parking. The first floor has the lobby entrance and three retail spaces along with a garage entrance. Full valet parking will be offered along with car elevators. There would be some parking spots on the ground level. On the second floor is a single level of parking and car stackers would be placed on floors three and four. The fifth floor is designed to be an amenity


The corner of Main Street and Memorial Highway. *Photo by Peter Katz.*

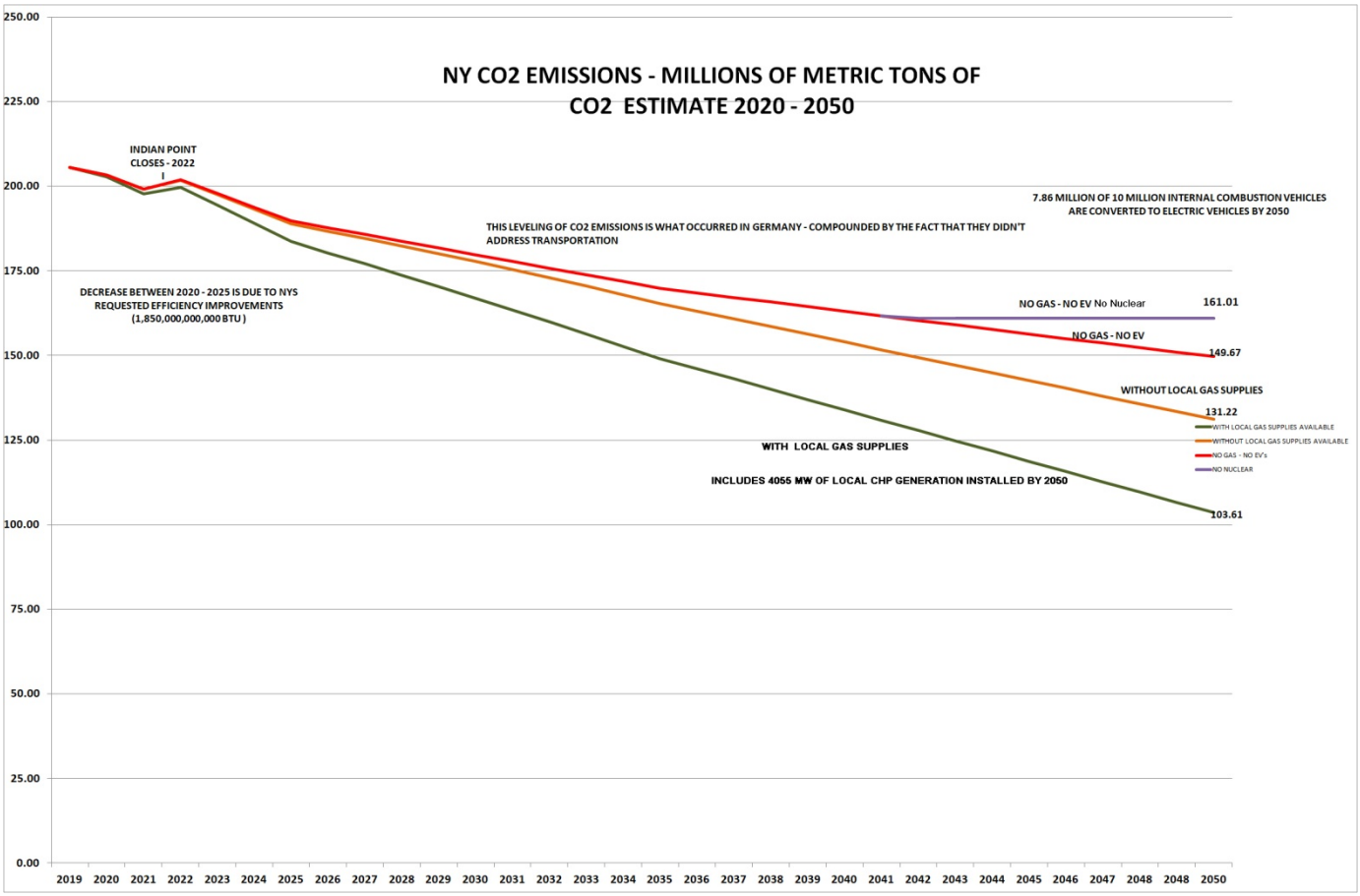
level for residents. Then there is a mezzanine with a swimming pool toward the rear of the site. The plans show the sixth floor would have some outdoor space on what would be a roof over the pool on the fifth floor. There would be a common lounge area. There would be duplexes on the 28th floor.

The developer is expected to make a full presentation to the planning board at its Jan. 28 meeting.

## New Rochelle Development Projects 1/13/2020

| | Project | Units | Commercial /Retail Space (Sq. Feet) | Floors | Hotel Rooms | Notes |
|---|---|---|---|---|---|---|
| 1 | Watermark Point | 72 | | 4 | | 9 Buildings |
| 2 | 2 Hamilton | 56 | 10,500 | 6 | | |
| 3 | The Standard | 112 | 4,000 | 14 | | |
| 4 | The Printhouse | 71 | 3,000 | 6 | | |
| 5 | The Huguenot | 60 | 1,500 | 6 | | |
| 6 | The Grand | 70 | | 6 | | |
| 7 | Prat Landing | 450 | 100,000 | | 200 | 12.5 Acre Project |
| 8 | North Avenue West | 75 | 7,135 | 6 | | |
| 9 | V Hotel | | | 8 | 80 | |
| 10 | New Ro Studios | 73 | | 6 | | |
| 11 | Modera | 334 | | 8 | | Approved 5/28/2019 |
| 12 | Millenia | 110 | | 6 | | |
| 13 | Locust Ave | 303 | | 5 | | Student Housing |
| 14 | Halstead Station | 408 | | 25 | | |
| 15 | Church Division | 742 | 20,260 | 28 | | 2 Towers |
| 16 | 8 Westchester Place | 72 | 6,311 | 7 | | |
| 17 | 64 Centre Ave. | 144 | | 14 | | |
| 18 | 583 North Ave. | 114 | 20,862 | 5 | | |
| 19 | 500 Main Street | 462 | | 26 | | |
| 20 | 45 Harrison Street | 238 | 59,500 | 27 | | |
| 21 | 360 Huguenot Street | 280 | 26,836 | 28 | | |
| 22 | 339 Huguenot Street | 285 | 1,000 | 28 | | |
| 23 | 327 Huguenot Street | 249 | 2,500 | 28 | | |
| 24 | 316 Huguenot Street | 190 | 3,726 | 14 | | |
| 25 | 277 North Avenue | 442 | 15,000 | 23 | | |
| 26 | 26 Garden Street | 187 | 20,000 | 14 | | |
| 27 | 25 Maple Ave. | 184 | | 7 | | |
| 28 | 14 LeCount Place | 553 | | 27 | | |
| 29 | 115 Cedar Street | | | 24 | 225 | |
| 30 | 11 Lawton Street | 596 | 11,055 | 48 | | |
| 31 | 11 Garden Street | 280 | | 20 | | |
| 32 | 10 Commerce Drive | 172 | | 7 | | |
| | 247 North Avenue | 244 | ? | 28 | | Proposed |
| | 525 Main Street | 351 | 6,000 | 28 | | |
| TOTAL | | 7979 | 313185 | | 505 | |

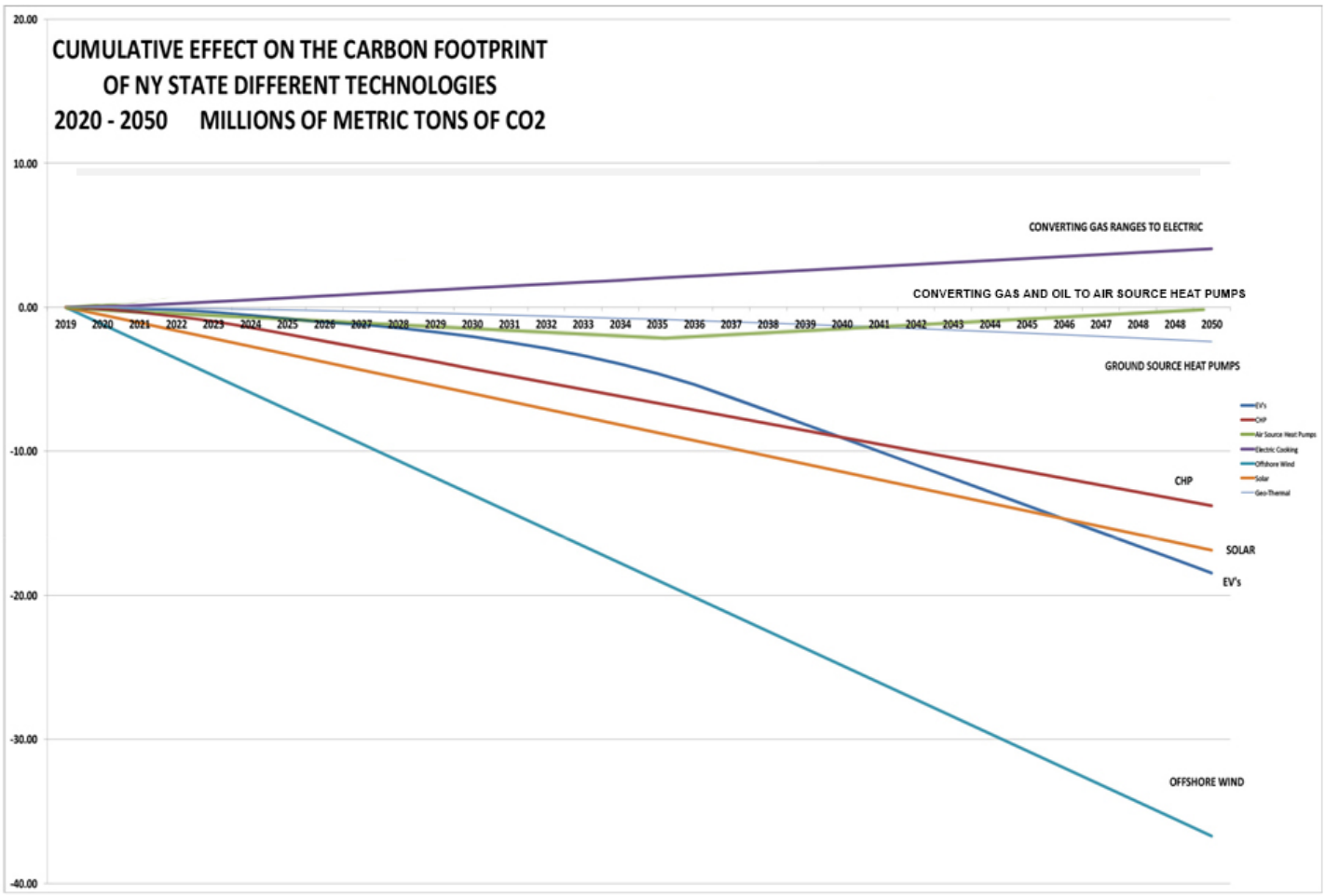
## APPENDIX N - POTENTIAL GREENHOUSE GAS REDUCTIONS 30 YEAR TIME FRAME




**Baseline Level in 2019: 206 Million Metric Tons $CO2_e$**

Revised CO2 Graph - Air Source Heat Pumps COP=2.5

Analysis is below the next graph.




$CO_2$ Graph - Air Source Heat Pumps COP=2.5 - Different Technologies

Air Source Heat Pump curve drops as oil Locations are converted to heat pumps. Starts climbing after oil conversions stop due to completion. Reflects the 2.7% Higher Carbon Footprint when compared to natural gas. Net effect over long term carbon emissions is zero. Higher carbon footprint at gas locations is offset by lower carbon footprint at oil locations. With thermal electrification, GHG levels are still 28 million metric tons higher than if we had the ability to install localized generation (CHP) and it is a far more expensive solution. This also makes the assumption that you can somehow convert the Steam Oil locations to heat pumps and Steam gas locations to heat pumps, which will be extremely difficult so it is overly optimistic on the heat pump final number. It was done by moving the therms of oil and gas to heat pumps. The elbow in the curves on the first graph in 2035 is when the oil conversions have been completed after 15 years. As it is very difficult to ascertain the ratios of the different heating systems (Steam vs No Steam), I didn't distinguish. But it is a flaw in the model that overestimates the reduction from electrification. The bottom line on the graph ("With Local Gas Supplies") does not have this issue as it is technically achievable.

With the local gas supplies available, the improvements will be even greater than what is shown as increased reductions of NOx were not calculated and those reductions are much higher with local Natural Gas Supplies available.

The purple line shows the effect if the State's remaining Nuclear Plants are closed.

As it is impossible to predict the exact rate of installation of the different technologies, a straight line (constant) installation rate was used, except for with the electric vehicles.

Unlike Air Source Heat Pumps, Ground Source Heat Pumps are an effective means of reducing Greenhouse gases. Because the units are shipped self contained from the factory, they don't have the refrigerant issues of split field assembled air source systems. However, for many locations, they are too expensive and the labor force and equipment that is needed to implement them on a wide scale doesn't exist. There are presently 900 certified Air Source Heat Pump installers on the NYSERDA website and only 17 certified geothermal well drillers.