Testimony of the New York Geothermal Energy Organization (NY-GEO) at the Public Service Commission public hearing on the National Grid Rate Case 17-E-0238 and 17-G-0239 in Buffalo, NY

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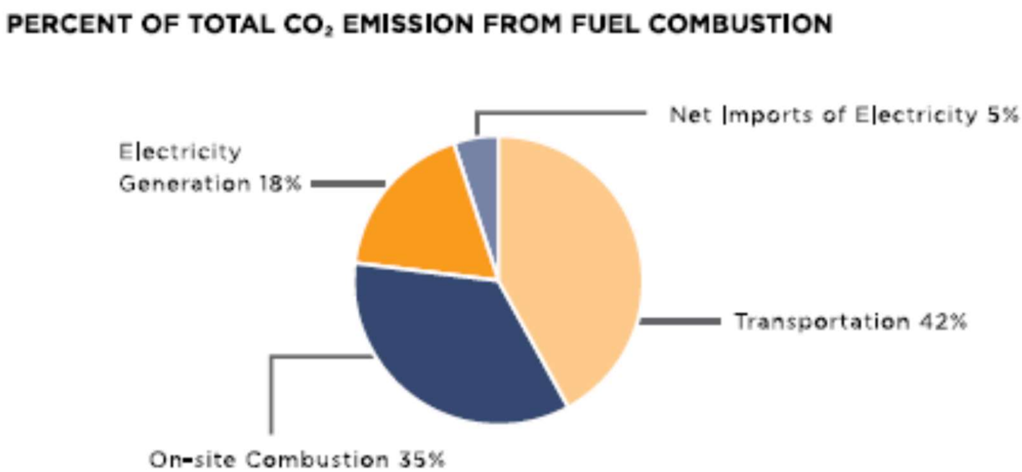
This rate case is being carried out in the context of Governor Cuomo's Reforming the Energy Vision (REV) initiative and an adopted State Energy Plan (SEP). One of the main thrusts of REV is creating space in the market and the regulatory structure for the rapid adoption of clean energy technology. The State Energy Plan has a specific target of a 40% reduction in greenhouse gas (GHG) emissions from 1990 levels by 2030. The chart below can help us understand the context in which those reductions will need to take place. It is taken from Volume 2 Technical Appendix to the SEP, titled "Impacts and Considerations", page 11:

Figure 1 | 2011 Carbon Dioxide (CO_2) Emissions from Fuel Combustion by End Use Sector



Further data in this appendix show the vast majority of the 35% contributed by on-site combustion comes from heating our homes and businesses, with a relatively minor amount coming from fuel burning in idustrial processes.

On page 10 of this Technical Appendix it is noted "The great preponderance of New York's GHG emissions came from fuel combustion, with CO2 constituting the majority of these emissions."

And

"For both the residential and commercial sectors, emissions from fuel combustion on-site were greater than those associated with electricity generation or power imported from outside the State."

New York's efforts to reduce greenhouse gases, as well as the media and public focus on this effort, have centered on moving power generation from coal, oil and Ngas to renewable sources such as solar hydro and wind. However to reach the 40% goal it is crucial that the heating and transportation sectors begin an immediate and rapid transition away from fossil fuels.

Electric generation – It is essential that our electric supply continues to be cleaned up and decarbonized. It offers an attractive target for emissions reductions because much of the supply comes from large generating facilities that can be relatively easily regulated or replaced. A clean electricity supply is also a fundamental underpinning to cleaning up the transportation and heating sectors as electric vehicles and elctric heat pumps are far and away the most promising technologies to replace burning fossil fuels in these sectors. Both technologies are key to what is being termed "beneficial electrification". They are far more clean and efficient than internal combustion engines and fossil fuel furnaces and boilers. As the electricity supply becomes cleaner, their effieciency multipies the impact of lowered emissions from electricaal generation.

Transportation – At 42% this is New York's current largest source of GHG emissions. While fuel cell, hydrogen and bio liquid vehicles are being explored, by far the strongest alternative to fossil powered vehicles are electric vehicles. While this testimony will focus on ground source heat pumps (GSHP), it is also important to consider EVs and their impact on this case, as the Public Service Commission begins to explore and implement fuel neutrality and the active consideration of fuel switching technologies.

Heating – The path to the 40% goal and how emission reductions need to play out between New York's three major sources has not yet been set. But, as the source of approximately one-third of New York's GHG emissions, the heating sector must become a major focus if the 40% goal is the be reached.

Certainly advances in insulating New York's buildings will play a big role, but that can take us only so far. The transition from fossil fuel heating to renewable heating is currently on New York's agenda, but it must become an urgent matter if we are to succeed in reaching the 40% target. Massive swaths of New York's building stock will need to become net zero and heating with fossil fuels will need to be phased out if the 40% by 2030 and 80% by 2050 are to be reached. The only question is one of timing.

Europe has been a leader in climate initiatives and addressing carbon initiatives. Three European examples in the heating sector could be instructive for New York:

- Denmark, banned fossil fuel heating in new builds starting in 2013
- Merton, a town in the UK, developed a groundbreaking planning policy [1], which required new developments to generate at least 10% of their energy needs from on-site renewable energy equipment in order to help reduce annual carbon dioxide (CO_2) emissions in the built

[1] http://www.merton.gov.uk/environment/planning/planningpolicy/mertonrule.htm accessed 2016 03 17

environment. The rule applied to all types of buildings, not just homes. Merton Council developed the rule and adopted it in 2003. Since then the Mayor of London and many councils have implemented it, and it has become part of national planning guidance.

- On January 1, 2016, rules went into effect in Germany, under which "Heating systems that use fossil fuels - even condensing boilers - will have a hard time complying"[2i].

Here in New York, no target has been set for heating sector emisson reductions and no glide path for the heating sector has been established. However in NYSERDA's Renewable Heating and Cooling Policy Framework (p4), issued in February of this year, a beginning discussion of mandates was introduced with the following language:

"The nature of RH&C (Renewable Heating & Cooling) as an emerging market in New York State places constraints on the extent to which mandates are a viable policy option at this stage. However, there is an opportunity to integrate RH&C into building and energy mandates for public buildings, new construction, and renovation. Concepts presented for consideration include:

- Integrate RH&C into the Build Smart NY initiative.
- Integrate RH&C technologies into New York State's Stretch Code for new construction and existing building retrofits.
- Support a transition to a net-zero building requirement for new construction and renovation."

A more fleshed out glide path for the heating sector has been outlined by the organization Physicians, Scientists, and Engineers for Healthy Energy, (PSE) and is presented in slide form as *Energy Transformation Framework for New York State* at https://www.psehealthyenergy.org/our-work/publications/archive/energy-transformation-framework-for-new-york-state/. The PSE research places a far stronger emphasis on methane climate impact emissions in a way that NY-GEO understands to be more accurate and advanced than New York's current framework.

PSE estimates that more than 168,000 New York homes will need to be converted from fossil fuel heating systems to electric ones in an average year from now until 2030 for the residential sector to attain a 40% reduction in GHG emissions by this sector. That works out to 14,000 conversions statewide per month and 460 conversions per day.

In this context it is important for New York's utilities to rapidly gain experience with geothermal heat pumps to learn how to integrate them with their systems and how to interact with customers as they make this transition.

NY-GEO has registered as a party in the National Grid rate case 17-0087. When we did so, we stated the following as our interest in the case and as areas where we could help establish a more complete record in the case while contributing to a result that more fairly serves the public interest:

- NIMO's proposal for an Electric Heat initiative,

[2] http://www.sunwindenergy.com/new-buildings-germany-now-required-to-use-renewable-energy-heating accessed 2017 08 01

- The impact of this case on beneficial electrification,
- The role heat pumps can play in meeting the needs of underserved and low income customers; and
- The recognition of the grid value of geothermal heat pump installations

1. NIMO's proposal for an Electric Heat Initiative

In NiMo's Book 7 for this case, page 128, there was a proposal for an Electric Heat Initiative.

"*The Electric Heat initiative (EHI) would encourage customers to convert to efficient electric heating technologies when replacing older, less efficient and more carbon-intensive heating equipment. The main focus of the program would be on replacing oil heating equipment. The program is intended to accelerate the adoption of cost-effective, low-carbon heating technologies, especially ground and air-source heat pumps. It is estimated that the initiative would result in an average savings of two tons of carbon per home per year. Based on an assumed 15 year heating equipment life, this would yield 30 lifetime tons of carbon savings per converted home, supporting the State's carbon reduction goals. The initiative would involve rebates to customers to convert to electric heat alternatives, community-based outreach and education efforts to promote least-cost procurement, and contractor training to boost awareness of electric heat technology. Additionally, financing and incentive partnerships with other agencies (e.g., NYSERDA) would be explored to maximize the impact of the program, while minimizing costs."*

NY-GEO supports the thrust of this initiative and proposes that it be greatly expanded and adopted. It is our understanding that the initiative is currently on hold based on pushback to the increased rates proposed in the case. It is our contention that a properly designed initiative would actually benefit ratepayers. A full-on Electric Heat Initiative could lower rates in the following primary ways, among many others:

A. Lowering peak summer demand
B. Increasing winter system utilization
C. Increasing return on distribution system assets

A. Lowering peak summer demand

Summer peak demand in New York is very expensive for New York ratepayers. New York's peak electrical demand comes on the hottest days of summer, when normal electrical use is compounded by the demands of air conditioning. During these periods, as demand soars, supply must rise to meet it. Generating plants that are normally idle because they are too dirty or too expensive to operate are placed in service and begin generating power. The price of power is set in an auction where the power sources are lined up by from lowest cost to highest. At times of peak demand, some of the higher cost power sources need to be used, and the price that all power sources receive is the price the higher cost source has bid. Prices to consumers during this period can be extremely expensive.

According to the Draft Generic Environmental Impact Statement for the REV and Clean Energy Fund:

“,,,if the 100 hours of greatest peak demand were flattened, long-term avoided capacity and energy savings would range between $1 billion and $2 billion per year.”

The New York Independent System Operator publishes a Gold Book each year that documents, summarizes and forecasts electrical load information for New York. The 2017 Gold Book notes a 2017 projected peak demand of 33,178 MW with a possible peak of 35,487 MW if we reach the 90th percentile of extreme weather. On an average day, the demand in New York state might be half that.

It is very expensive to build, maintain and operate plants which are idle for much or most of the year.

According to the Draft Generic Environmental Impact Statement for the REV and Clean Energy Fund:
“,,,if the 100 hours of greatest peak demand were flattened, long-term avoided capacity and energy savings would range between $1 billion and $2 billion per year.”

On the hottest days of summer, Ground Source Heat Pumps (GSHPs) are vastly more efficient than conventional air conditioning systems. In the summer, GSHPs extract the heat from inside a building and transfer it to the cool soil below the ground where it is readily absorbed. GSHPs also use some of the heat from the building to produce hot water for use within the building. In contrast, air conditioners exhaust the heat to the hot outside air surrounding the building requiring far more power to effectively cool a building.

There is no standard number used for kW peak savings for a typical geothermal heat pump, but some examples can be noted.

- PSEG-LI offers a rebate for GSHP installations based on peak demand savings. PSEG’s 2018 planning projection is that geothermal system peak savings tier 1 GSHP systems (less efficient geothermal systems with an Energy Efficiency Ratio EER of >=19) will be .3887 kW per ton. For a typical home using a 4 ton system, the peak savings will be 1.55 kW. For Tier 2, for more efficient systems with an EER greater than 25, the projected peak savings are .5403 kW per ton, or 2.16 kW for a 4 ton system.
- In 2016 NYGEO prepared an analysis of the investment value of a solar installation and a geothermal installation for a typical new built 2800 square foot single family house in Albany, NY (see Appendix A). We projected a 1.75 kW peak demand reduction based on the circumstances of this home.
- The Benefit Cost Analysis (BCA) tool submitted as part of this proceeding uses an EER of 23.44 for geothermal systems. While NY-GEO believes this is a seriously understated number for the state of installations in New York, it is still almost twice as efficient at peak as the roughly equivalent air source system given a 12.7 EER in the BCA tool

While there would be program costs to an aggressive EHI, reduced peak demand would be one of three countervailing cost reductions which NY-GEO believes could lead to a rate neutral program.

B. Increasing winter system utilization

As noted above, average electricity use in New York State is somewhere near half of peak use, leaving expensive generating plants idle much or most of the year. GSHPs reduce energy use in the winter by eliminating fossil fuel burning and replacing with it significantly less energy used in the form of electricity used to power the system pumps. For every kW used to power the pumps, approximtely 4 units of heat energy are suppllied to the building.

As efficient as they are, GSHP systems do use the bulk of their required electricity in the winter when most of New York is using far less than peak capacity. This means that GSHP can increase system utilization, returning more revenue to utilities on the same fixed assets, resutling in lower costs for all rate payers.

Greg Hale is Senior Advisor to the NY Chairman of Energy & Finance in the Office of the Governor. In 2014, Mr. Hale gave a plenary address to NY-GEO's annual conference. In his address he noted thata system utilization, or the average electrical demand versus peak demand has been steadily eroding. It had been at 59%, was then currently at 54% and was projected to dip to 51% by 2025. Mr Hale stated that "merely increasing the system load factor from 55% to 56% would produce potential gross benefits of $150 million to $219 million per year."

The degree to which GSHP installations increase winter system utilization is a second countervailing cost reduction which NY-GEO believes could lead to a rate neutral or rate positive Electric Heat program

C. Increasing return on distribution system assets

There is a great deal of overlap between the benefits of system utilization and this point and this could be seen as a subset of system utilization , but it is worth examining for the clairity of the example and the large potential benefit that could be monetized.

NY-GEO member and geothermal consultant Bob Wyman made the following argument on the Renewable Thermal Alliance's web blog this year https://basecamp.com/1793784/projects/12528285/messages/65553161 .

Should Geothermal Customers Continue Subsidizing Fossil Fuel Heating Customers ? (Policy Question)

Posted by Bob Wyman on Jan 12

- By reducing demand for fossil fuels, GHP reduces fossil fuel prices. (Obvious.)
- By increasing demand for electricity, GHP reduces electric rates and subsidizes users of fossil fueled heating systems. (Not so obvious.)

The electric rate you pay is made up of at least two components (in most areas):

1. A "supply" charge to pay for the cost of generating what you consume.
2. A "delivery" charge, which pays your share of the grid's fixed costs for transmission and distribution equipment.

In many areas of the country, the delivery charge is about 50% of the per/kWh electric rate. When a home converts from fossil fuel to heat pumps, it will pay more for electricity since it will be consuming more. This makes sense. You use more, you pay more. But, given today's rate structures, a GHP home will not only pay higher electricity supply charges than a fossil fueled home, it will also pay higher delivery charges. This doesn't make sense. A GHP's system's increased electricity demand is mostly off-peak and thus does not require additional grid capacity or fixed costs. In fact, GHP homes, because they reduce peak demand through more efficient cooling, actually reduce demand for grid capacity. So, if GHP systems don't increase the grid's fixed costs, why are GHP users required to pay more for those fixed costs?

If a home is fossil fueled today, the design of electric rates ensures that it already pays what regulators consider a "fair" share of the grid's fixed costs. But, that same home, if it converts to GHP in the future, will pay that not only that same "fair share" of the costs but also an additional "unfair share" for every additional kWh of increased demand. These excess delivery payments put downward pressure on all ratepayers' delivery rates in future years since the higher the number of kWhs sold, the larger the number of units over which the grid's fixed costs can be spread. In more formal terms, GHP installations have a "Rate Impact Metric (RIM)" which is greater than 1. Note: Electric component efficiency improvements or onsite electrical generation typically have a RIM of less than 1 -- they require an increase in demand charges since they reduce kWh sold. Thus, GHP subsidizes electricity rates of all ratepayers -- even those who use fossil fuels exclusively. Is this fair?

A fossil fueled home in the Northeast that today spends $3,000 per year on heating oil might, as a result of converting to a geothermal heat pump, see an increase in its annual electrical bill of about $1,800. While this is a nice, 40%, reduction in the home's annual energy bill, it is an increase of about $900 per year in the amount that the homeowner must pay for the "fixed costs" of the electricity grid -- even though converting to GHP does not increase those fixed costs. If the homeowner was only required to pay for the actual costs of their additional electrical consumption, the annual electric bill would increase by only $900 (assuming that delivery charges are 50% of total kWh prices). In this case, the "fair" reduction in energy costs would be 70% per year. (A much more compelling Operating Expese reduction.)

Continued subsidy of fossil fuel heating systems by GHP systems inevitably reduces the desirability of installing these systems -- as is the case whenever a system produces a "public good" or "positive externality" whose value can't be captured by the party who pays for that good. The cost of GHP's subsidy of fossil fuels works as a "Low-Carbon Tax" which increases the cost of the low-carbon solution and thus discourages its use just as a "Carbon Tax" might discourage the use of fossil fuels. In part, this "Low-Carbon Tax" subsidy explains why GHP installations have been so limited that ratepayers and policy makers have simply not yet noticed the downward pressure that GHP installations put on everyone's electric rates. However, that impact is unquestionable and it will grow more obvious as industry installation volumes increase.

Because policy makers generally ignore, or are ignorant of, the existing subsidy, they haven't put much effort into finding ways to eliminate it. Policymakers have instead focused on devising ways to subsidize the GHP industry -- on the assumption that the technology is uneconomic without such subsidies. They haven't yet recognized that a very fundamental reason for GHP's high costs is that GHP systems subsidize fossil fueled systems. Thus, it has not been recognized that **the alternative to subsidizing GHP is to simply stop requiring that GHP systems subsidize fossil fueled systems**. Also, one alternative to a "Carbon Tax" is to end the implicit "Low-Carbon Taxes" that exist today. If purchasers of GHP systems only paid for their own costs and for their own impact on the electric grid, GHP systems would be much cheaper to operate and much more commonly installed."

This distribution subsidy is a 3rd countervailing cost reduction which NY-GEO believes could lead to a rate neutral or rate positive Electric Heat program.

There are numerous other factors that could be taken into account in computing the rate impact of an aggressive Electric Heat initiative. These include:

- Improving fuel diversity: increasing fuel diversity will make customers less vulnerable to price spikes; the estimated total cost to New York customers from the fossil fuel driven price spikes of the winter of 2013-2014 was over $1.0 billion
- Avoided cost of stranded assets as fossil fuels use becomes obsolete
- Demand Response Induced Price Effect on market prices for Ngas and other fossil fuels in winter
- Reduced credit and collection costs from lower operating expenses (electric in summer/fuel in winter
- Increased value of renewable wind generation generation because low cost wind is most effectivley generated and supplied during winter and nigthtime hours when GSHP power demand is greatest

NY-GEO is developing a GSHP Value Stack in conjunction wth the Renewable Thermal Alliance where we are looking at the opportunities for monetization of upwards of 40 values brought by geothermal installations. This value stack may be use use to the PSC as it ponders thi scase

NY-GEO is very interested in taking part in a process to rework and expand the Electric Heat Initiative as well as verifiying and improving the assumptions used in the Benefit Cost Analysis that underlies the Initiative.

The impact of this case on beneficial electrification

This National Grid rate case could be ground breaking as one of the first cases nationally to consider beneficial electrification as part of the proceeding. By comprehensively integrating EVs and heat pumps with other considerations and computations, the parties in this case can set an example for other utilities across New York State and the nation.

In that respect it is important that the result of the case doesn't distort gas costs versus electric costs in NiMO's system. When fossil fuel prices are subsidized in various ways, or when electricity prices are inflated for whatever reason, it makes beneficial electrification more difficult, forestalling the transition to a cleaner economy.

The role heat pumps can play in meeting the needs of underserved and low income customers

One overlooked factor in much energy discussion is the importance of providing for the expansion of air conditioning as climate change advances. AC has often been seen as a luxury but it is quickly becoming a health necessity for large sectors of New York's population. As discussed above geothermal is the most efficient form of full house air conditioning. It will be important, as air conditioning needs are met, to do so in away that minimizes peak demand and has the least impact in contributing to a feedback loop where greenhouse gas emissions are increased to meet needs caused by increased greenhouse gas emissions.

Regarding the rate impact of the Electric Heat Iniitiative, the three main points raised above to describe a rate neutral or rate positive Electric Heat Initiative indicate that an aggressive geothermal heat pump installation campaign could create significant revenue possibilities. Important decisions are waiting to be made as to how much that revenue is used to pay for programming, lower rates and/or to monetize the value that home and building owners create and thus incentivize the installation of more systems.

To the degree that the revenue serves to lower rates it would benefit low income customers.

It is also important to look to the example of the Lockport Housing Authority which recently won the NY-GEO Top Job award for 2017 for converting 72 units of low income housing to geothermal for its tenants, saving money and providing air conditioning for the first time for many of the tenants

On a bigger picture note, it is important to look at the role of stranded assets in raising costs for ratepayers and, in particular, for the low income customers who are most impacted by those rates. New York's best example may be the Shoreham nuclear plant that increased rates for Long Islanders for many years even though they weren't benefiting from an operating generation facility. In a similar way, fossil fuel infrastructure that is being installed today may not have a full life on which rate payers are paying back as pressure builds to reduce greenhouse gases.

The recognition of the grid value of geothermal heat pump installations

This point is covered above as "Increasing return on distribution system assets"- the 3rd factor in creating a rate neutral or rate positive program.

Appendix A – GHP and Solar Investment Value

February 24, 2016

Re: Comparison of GHP and Solar PV Investment Value

Dear Commissioner Zibelman:

At our January 19th meeting, you asked us to compare the energy return on investment of a typical geothermal heat pump (GHP) installation with that of a typical solar installation before incentives. Below is that comparison developed and reviewed by the NY-GEO board:

A 9 KW solar system in Albany NY would deliver approximately 9,900 KWH of electricity annually, and at $ 3/watt would cost $27,000 to install. Spread out over the assumed lifetime of the system (25 years), the system delivers a renewable KWH for 10.91 cents.

Let's assume a typical new built 2800 square foot single family house in Albany, NY, occupied by 3 people, with a design heat loss of 45,000 BTUs/hour for heating, a design heat gain of 26,400 BTUs/hour, and a daily hot water use of 55 gallons.

Modeled with 10 year average weather data, this house would annually use 83.6 Million BTUs for heating (24,501 KWHs), 9.2 million cooling BTUs for A/C (2,696 KWHs), and 16.2 million BTUs for domestic hot water (4,748 KWHs).

A variable speed geothermal heat pump (GHP) will supply the 24,501 KWH using 5,877 KWh of electricity, meaning that 18,624 KWH are coming free from the ground.

In addition, the system will make 54.7% worth of the domestic hot water, and use 588 KWH for that task, whereas 2,010 KWH comes free from the ground.

In A/C, the GHP system runs at an average EER of 31.6, versus a conventional Energy Star A/C unit (SEER 16) which runs at an average EER of 11.5. Thus the geo system provides the cooling load for 290 KWH instead of 801 KWH, saving 511 KWH annually.

In addition, the geo system will use about 1.25 KW during peak summer demand, versus about 3.00 KW for a high efficiency A/C unit, thus shaving about 1.75 KW of the peak demand.

In summary, the geo system delivers a total of 20,634 KWH of free energy from the ground (and saves an additional 511 KWH for A/C), but also consumes 6,755 KWH annually for doing so, which is also delivered as heat to the house or the domestic hot water (for a total of 27,900 KWH annual delivered and saved energy (A/C mode)), including the free energy from the ground.

The free market average price would be $30,000 (including hot water tanks) to install the geothermal system and it would be in lieu of a conventional HVAC/hot water system (gas furnace, air conditioning and gas hot water heater) costing $12,000. The incremental cost would be $18,000. Thus the 21,145 KWH of free and saved energy annually costs $18,000 additional upfront. Spread out over the assumed lifetime of the system (25 years*), the system delivers a renewable KWH for 3.41 cents, about 2.72 times the ROI over solar.

*In reality the geothermal system will have a far longer effective useful life as the ground loop, which accounts for 1/3 to 1/2 the cost of the system, has a materials warranty of 50 years plus in most cases, and is expected to produce for far longer than that.

Including the costs of operating the system over its 25 year lifespan (6,755 KWH/year x 12 cents/KWH (at current net present value) x 25 years = $20,265) to the $18,000 surcharge for the geo system the 697.5 MWH total energy delivered would cost 5.49 cents per KWH delivered, about 2 times the ROI - over solar.

Of note, the electricity the GHP system consumes is mostly in the off peak hours and in winter when electricity demand is low in NY relative to the summer peak which will result in better grid utilization. The average 1.75 KW peak demand shaving per installation can result in a significant impact on peak demand, forestalling or negating the need for investment in expensive new power plants and grid infrastructure.

The current utility business model is at great risk and will be in need of huge capital investment to solve the storage challenge of other renewable energy, creating extreme upward pressure on the cost per KWH delivered by the utility company. A geothermal program would create downward pressure on the fundamental delivered cost through both peak reduction and better asset utilization, with the ability to use onsite stored energy from the ground at the time the load (capacity) is needed.

The practical goal might be to greatly reduce the energy needed for the house by insulating and installing a geothermal system, and then supplying the remaining energy, at no operating cost, with a solar PV system, resulting in a net zero building.

In summary a geothermal delivers about 2 times as much renewable energy for every dollar of installation and operating costs at current installation rates in NYS when compared to solar PV, without considering incentives. In addition it significantly reduces the peak demand and increases the grid load factor during off peak times.

Thank you for this opportunity to supply you with this information. We look forward to your questions and/or comments.

Sincerely,

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