# Role of Hydrogen in the "New York State Climate Action Council Draft Scoping Plan"

**July 1, 2022**

**Executive Summary:** The New York Geothermal Energy Organization (NY-GEO) – that we are a member of - has been a notable advocate to reduce greenhouse gas (GHG) emissions in support of the Climate Leadership and Community Protection Act (CLCPA). Of particular interest to our organization is the planned phaseout of fossil fuels for heating buildings and homes.

In reviewing the "New York State Climate Action Council Draft Scoping Plan, dated December 30, 2021, both NY-GEO and Thomas Geothermal Engineering LLC (TGE) are in full agreement that our building stock needs to pursue a strategy of both reducing heating and cooling loads while electrifying both heating and the production of Domestic Hot Water (DHW) using heat pumps.

Heat pumps are both highly efficient and a mature technology in use for more than four decades. They are the best and least expensive choice in providing both space and water heating in buildings with commercial off-the-shelf units widely available today.

However, we disagree with pursuing the substitution of hydrogen for methane, the main component of natural gas (NG) – into the existing NG grid network, either in blends of up to 20% or in its entirety. There will be many and substantive issues in upgrading the aging gas grid network to eliminate potential leaks and the cost of manufactured green hydrogen will greatly outpace NG with few environmental benefits.

Green hydrogen, unlike methane formed by free natural processes, is manufactured using electricity that will directly compete with other all-electric, emissions-free technologies, such as heat pumps and electric vehicles (EVs). It will also consume dollars in research and implementation costs that would be better disbursed elsewhere.

No doubt the NG industry has fueled and helped grow our economy since the nineteenth century, but the consequences of continued use are very detrimental to the goals of the CLCPA and its use must be incrementally and substantially phased out by 2050.

There are limited industrial and commercial uses for hydrogen that need either a flame or high temperatures that only burning a gas can attain. The Climate Action Council (CAC) should focus only on cases where hydrogen gas is the only viable alternative choice in the relative near-term while research and development continues.

We believe pursuing a strategy of substituting hydrogen for methane to provide heat energy in our buildings and homes will be expensive, fraught with health and deployment issues and counterproductive as it is out of compliance with the CLCPA requirements to cut greenhouse gas emissions.

There are some specific industrial and commercial uses for hydrogen as a substitute for NG; however, producing, storing and distributing hydrogen poses substantive and costly issues. Since hydrogen is the only known alternative in these uses, we believe the CAC should focus on those and not transportation and heating uses.

**Producing Hydrogen:** The only hydrogen gas that makes climate sense is "green hydrogen," produced using an electrolyzer that separates water into hydrogen and oxygen gases. This process is typically about 75% efficient and produces considerably less energy than the electricity it consumes to produce it! Making hydrogen with electricity to combust as a heating fuel (with less than 100% efficiency) will be very costly to consumers, and if burned in air like NG is today, will produce deleterious oxides of nitrogen.

Hydrogen production will also be competing with other large consumers of electricity, like transportation and heat pumps, at a time when fossil fuel power generation is being retired and new green electricity from solar and wind farms will be coming on line.

The only plausible, financially prudent strategy to pursue would be to manufacture hydrogen only with cheap excess electricity. This will be highly variable in availability and quantity. In general, solar photovoltaic (PV) production of electricity can be up to 75% lower from December to February when we'll need the most electricity for building and home heating with heat pumps. And we'll still need to service peak cooling loads in the summer months. This strategy would push hydrogen production mostly to the shoulder seasons where neither heating or cooling will be needed much – principally in April, May, and October. Consequently, this hydrogen for all uses will need to be stored safely somewhere for perhaps six months or more.

**Volatility:** Hydrogen is known to be explosive. This tendency also raises concerns about safety should a hydrogen-based device spring a leak, particularly inside a building or home.

**Storing and distributing hydrogen:** The reserves of naturally occurring NG can be safely left stored in the earth. There is also manmade storage to balance seasonal supply and demand within the gas grid.

Hydrogen gas will also have to be stored after manufacturing in order to meet fluctuating consumer hydrogen demand. It has been suggested that large quantities can be stored either in manmade tanks or in naturally occurring salt caverns. In the case of New York State these caverns are located in the Finger Lakes region, far from the greatest demand centers downstate in New York City, and Long Island. This will require large new pipelines.

Replacing NG with hydrogen or hydrogen/NG blends for building space and water heating needs presents a myriad of technical, distribution, and health issues associated with simply using small of amounts of hydrogen in natural gas "blends," while the benefits are small.

Some have proposed upgrading our current NG gas grid, which contains a large quantity of steel piping prone to leaking, to larger diameter high density polyethylene (HDPE) plastic piping that is less likely to leak. The larger diameter will accommodate the need to pass almost 3.3 times the volume of hydrogen as NG for the same amount of available energy. Even small ratios of hydrogen to NG in blends will also require new leak proof piping.

In short, the use of hydrogen—even in blends—will require substantial investments in distribution, storage, new transmission pipelines and building piping. It may mean replacing almost the entire gas grid network of today—a very large construction undertaking. We question the value of those investments, particularly with low percentage blends that will produce only about 7% improvement in emissions.

**Burning Hydrogen**: If the oxygen produced via electrolysis can subsequently be used to combust the hydrogen cleanly, without creating the NOx gases that are so deleterious to respiratory health and the environment, this could be a potential benefit in those specific applications where burning is necessary. It would require two separate collection, storage, and distribution mechanisms. Conversely, combusting hydrogen more easily in air like we currently do with methane, we will create those oxides of nitrogen—a poor trade-off.

**H2 is *not* Clean Burning in Air:** Hydrogen burns at a much higher temperature than NG (4000°F for hydrogen vs 3500°F for NG). This will require close attention to the metals used in delivering and combusting. It also means that simply burning hydrogen in the air will unfortunately also produce the various oxides of nitrogen as a byproduct we are trying to avoid with NG; these are deleterious to one's health and the environment. Its benefit over NG in terms of emissions fades away.

The potential silver lining is if hydrogen is combusted with oxygen. This produces only water as a byproduct. This would mean yet a separate storage and distribution system for oxygen, or the location of the electrolyzer and its storage tanks near the point of combustion. While the US Department of Energy (DOE) has funded research in this area for commercial products, it seems highly unlikely that such a system could be designed at a reasonable cost for residential use in the near-term or be widely available before 2030.

**General use in buildings.** Replacing NG with hydrogen or hydrogen/NG blends for building space and water heating needs presents a myriad of technical, distribution, and health issues associated with simply using small of amounts of hydrogen in natural gas "blends," while the benefits are small.

There are no hydrogen fuel equipment offerings on the market today for the HVAC (Heating, Ventilating, and Air Conditioning) trade to specify and install; this, in particular, includes hydrogen-based cooling products. There are also no manufacturer certified conversion kits for existing deployed NG furnaces and boilers; there are thousands and thousands of models/makes that would need to be addressed. It is not clear if and when such units or conversion kits would become available or what such a conversion would cost. If they are converted, the combustion will be less than 100% efficient; the end-to-end efficiency of a hydrogen-based heating system is virtually guaranteed to be at least 25% less efficient than electric resistance elements that we've tried hard to eliminate.

What's been ignored in the discussion of simply replacing NG with NG/hydrogen blends for buildings is the need to replace all the existing inside steel NG piping, which is not sized for hydrogen, and that is also subject to leaking with numerous threaded fittings. We'd have to upgrade existing building stock containing NG-rated piping as well as upgrade the gas grid. In addition, all buildings on that grid branch would have to be simultaneously converted as well. This does not appear feasible or practical. And the GHG emission issues remain unresolved.

**Other HVAC Concerns:** Having multiple avenues of heating homes and buildings will also create uncertainty in the HVAC trades. We know of no commercially available hydrogen-compatible furnaces or boilers, or certified conversion kits for existing NG systems on the market today. HVAC businesses will need to make large investments in equipment, training, and their workforce to meet the challenge but will be rightfully reluctant to do so if the playing field might change.  There must be a clear pathway to heating electrification in the near-term with an eye to breakthrough innovation in the future.

**Heat Pumps not Pipelines.** In the HVAC sector, providing heat using a mature technology like heat pumps will be almost four times more efficient than using hydrogen-fueled furnaces and boilers; with future improvements the gap between heat pumps and hydrogen furnaces/boilers will grow in efficiency to 9 times or more.  Even with today's GSHPs, we can achieve 100% heating capacity in a cold climate at 3.5 times more efficiency than hydrogen without supplemental heat being required.

While GSHPs and multi-source heat pumps will also require new HDPE pipe to be buried, those can be done incrementally and do not require entire neighborhoods to be converted simultaneously, even with community heating systems.  They are safer because there is no risk of explosion with heat pumps.

GSHPs, already in use in forwarding-thinking households and countries, are the EPA's technology of choice for space and water heating.  Heat pumps multiply the electricity consumed by harvesting heat from the air and/or ground and other potential sources.  Ground source heat pumps (GSHPs) can yield the equivalent of 3 to 5 times the energy for every unit of energy it uses.  With advanced multi-source heat pumps, this efficiency factor is expected to be 7 or more in the future.

In addition, the geothermal loops have not been considered or evaluated as a source of thermal storage. They are a two-for-one deal by providing the ambient heat in winter and storing the excess heat in summer for winter consumption. Assessing their contribution as a source of thermal storge to reducing heating demand would be very beneficial.

In the best-case scenario, hydrogen will always be at least several times more expensive to purchase than the NG that some intend it to replace.  We do not believe consumers will want to switch to a fuel that is virtually guaranteed to cost more and still involve the burning of fuel and its concomitant pollution and GHGs.

Specific industrial and commercial uses for hydrogen, produced cleanly and onsite, may be the only feasible use for hydrogen gas in NYS. Bottom line, pursuing hydrogen will divert attention and funding from a proven technology–heat pumps–towards a technology still in its infancy in pursuit of clean heating and cooling.

**Hydrogen storage versus Electric Battery or Thermal storage:** A well-known problem we have when moving from fossil fuel power generation that can be virtually throttled at will to meet demand, the primary new green sources of green electric will use solar PV and wind farms. Neither of those sources provide availability at will – they rely on the weather, and the case of solar the number of available daylight hours during a particular season.  As we discussed above, a basic strategy would be to manufacture hydrogen with excess green electricity generation and store for use until a later time.  This approach will be needed for industrial and commercial users that will combust hydrogen to obtain high temperatures as there is no other known alternative.  It is also suggested that converting existing NG power plants to hydrogen would be a way to bring on additional generation to meet peak loads.  And that can theoretically be done, however as mentioned previously in order to avoid unhealthful and polluting oxides of nitrogen, that combustion too must use pure oxygen.  This also means the electrolyzer and its output of hydrogen and oxygen must be stored close to the power generating plant to avoid costly pipelines to be constructed.  Again, Solar PV output peaks during summer months by up to a factor of 4 compared to winter. Projections done over the past several years by the New York Independent System Operators (NYISO) and published in their “Gold Book” show winter peaks may exceed 72 GW should the HVAC sector primarily use Air Source Heat Pumps (ASHPs) – or twice the entire power generation capability available in the state today before plants are retired.

Clearly massive amounts of both hydrogen and oxygen will have to be stored near the power plant. Even presuming that is possible and economically advisable, the overall efficiency of such a scheme would be low. The best NG power plants today operate at only about 67% efficiency; combined with the 75% efficiency of hydrogen production the overall efficiency would be only be about 50%. In other words, half the new green electricity would otherwise be wasted in an attempt to meet peak loads.

Others have similarly suggested electric battery storage to meet short-term high loads. The batteries used in this endeavor will compete with the electrification of transportation for raw materials, much of which is imported into the US. This approach is also expensive, will require maintenance, and replacement of the batteries on a periodic basis. The planned electric battery storage would only provide only a small fraction of the peak loads projected by NYISO.

By and large thermal energy storage has been missing from this discussion. It is the very essence of GSHPs and multi-source heat pumps. Through natural processes – heat from solar radiation, local weather/temperatures, and a small amount of heat still emanating from the earth’s core – charge up the surface of the earth. As currently used today, GSHPs simply deplete that energy during winter months and charge it back up during summer. In the future, multi-source heat pumps will be able to use and recharge the thermal loop almost on a daily basis throughout the year. This would be the thermal analog to either hydrogen or electric battery storage. It would only require a simple of network of pipes buried pipes in the earth. The HDPE pipes used for this purpose are estimated to last more than a century and will require very little maintenance. And of course, the earth will not wear out over time like electric batteries or hydrogen electrolyzer stacks.

The beauty of this strategy is that it also produces the highest HVAC heating and cooling capacities and efficiencies. Unlike the hydrogen and electric battery strategies, this does not rely on dispatchable energy resources that’s the hallmark of today’s thinking. It will, however, reduce the electric loads to an extent that green electric power generation may be able to meet the peak demand.

**Value Proposition:** We believe the CAC needs to pursue alternatives that will cost the least and produce the best available, reliable and resilient service to consumers using mature technologies in the ready today. This means choosing the easiest, lowest cost investments in grid upgrades, energy storage and new green energy sources. That strategy should start with promoting consumption of non-polluting green electricity in the most efficient ways using cost effective high efficiency devices like heat pumps; Light Emitting Diode (LED) lighting is a prime example of progress made in the past decade in that regard. This will, in turn, reduce the size and expense of all the new green infrastructure that will be needed, much of which have to be maintained and periodically replaced.

**References:** The following publicly accessible documents were used in part to produce these comments. They are attached to our submission (listed in alphabetical order – the filenames are slightly different):

1. “Assessing the Viability of Hydrogen Proposals: Considerations for State Utility Regulators and Policymakers”, Energy Innovation Policy & Technology LLC, March 2022
2. “Behind the Meter (BTM) Solar 2020”, New York Independent System Operators, 2021
3. “Blending hydrogen with natural gas is the wrong tool to cut building and power sector emissions”, Energy Innovation Policy & Technology LLC
4. “COP 26 – Widespread use of green hydrogen in heating and cars is not only stupid – it’s practically impossible”, Recharge (NHST Media Group), October 12, 2021
5. “Gas Utilities Are Promoting Hydrogen, But It Could Be A Dead End For Consumers And The Climate”, Energy Innovation Policy & Technology LLC, March 29, 2022
6. “Hydrogen Reality Check: We Need Hydrogen – But Not For Everything”, RMI, June 27, 2022
7. “Hydrogen Vs. Natural Gas For Electric Power Generation”, ISTJ Investor, December 2, 2020
8. “Revealed – What 18 independent studies all concluded about the use of hydrogen for heating”, Recharge (NHST Media Group), June 19, 2022
9. “The Economic Value of Ground Source Heat Pumps for Building Sector Decarbonization”, HRAI Prepared by Dunsky, October 2020