**Role of Hydrogen in the Building Heating**

**Summary:**

In reviewing the Climate Action Council Draft Scoping Plan, dated December 30, 2021, I am in full agreement that a strategy for our building stock needs to be of both reducing heating and cooling loads while also electrifying heating, cooling 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.

However, I disagree with pursuing the substitution of hydrogen for methane, the main component of natural gas (NG). NG is delivered in great quantities via an expansive pipe network to homes and business across the state for heating and hot water purposes.

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.

There are some applications for hydrogen that should and/or need to be contemplated, but these should be limited to processes where electricity does not offer a solution.

Substituting hydrogen for methane to provide heat energy in our buildings and homes will be very inefficient and expensive. It will consume about 5 times more electricity than heat pumps, delaying carbon neutrality and will therefore be counterproductive to the Climate Leadership and Community Protection Act requirements to cut greenhouse gas emissions.

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**Producing Hydrogen:** The only hydrogen gas that makes climate sense is “green hydrogen,” which is produced using electrolysis that separates water into hydrogen and oxygen gases. This process is typically about 75% efficient and produces less energy than the electricity it consumes to produce it! Using this hydrogen to heat buildings and homes instead of heat pumps would result in an effective COP of less than 0.75 compared to heat pumps which can produce the same heat with a COP of 4. The end result is that the heat pumps will be more than 5X as effective at heating than using Hydrogen derived from electricity.

Hydrogen production will also be competing with transportation for electricity. 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 wasteful consumption of electricity for hydrogen production is simply a burden that our very limited renewable power generation cannot bear.

**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. Similar to NG leaks and explosion hazards, this is a risk that we no longer need to tackle in homes and buildings.

**Storing and distributing hydrogen:**  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

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.

**H2 is *not* Clean Burning:** Hydrogen burns hotter than NG. Therefore retrofitting of existing boilers and stoves will be required. Burning hydrogen with air instead of Oxygen 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.

Hydrogen can be combusted cleanly with pure oxygen. This produces only water as a byproduct. To accomplish this would require 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.

**General use in buildings.** 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 would become available or what such a conversion would cost. If they are converted, the combustion will be less than 100% efficiency; the end-to-end efficiency of a hydrogen-based heating system is virtually guaranteed to be at least 25% less efficient than electric solutions.

Additionally, replacing NG with NG/hydrogen blends for buildings requires the replacement of all the existing steel NG piping. Pipe sizing will not match the requirements of hydrogen and the pipe also be subject to leaking. 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. This does not appear feasible or practical. And the GHG emission issues remain unresolved.

**Heat Pumps not Pipelines.** In the HVAC sector, providing heat using a mature technology like heat pumps will be five 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 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.

I 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.

**Value Proposition:** We need to pursue alternatives that will cost the least and produce the best available, reliable and resilient service to consumers. This means choosing the easiest, lowest investments in grid upgrades, energy storage and new green energy sources. That should start with the least consumption of non-polluting electricity in the most efficient ways. I