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February 25, 2022

Delegate Dana Stein

Taylor House Office Building, Room 251
6 Bladen St., Annapolis, MD 21401

Subject: **Myths About Building Electrification**

Delegate Stein,

I am a past Chair of the Board for the Maryland Chapter of the US Green Building Council, Chair of the AIA Baltimore Committee on the Environment, and I have long attended the Maryland Green Building Council meetings that are open to the public. I am a Principal at FSi, with 37 employees—we are mechanical and electrical engineers with a strong focus in green and net zero building. As you can see in my signature line below, I am a licensed mechanical engineer, a licensed fire protection engineer, and a certified commissioning professional. I can count myself among only a handful of people in the country with this broad set of certifications to understand, design, and operate building mechanical equipment.

At your request, I am writing a letter to address some misconceptions around building electrification. As you'll see, each of these is a persistent myth because it contains a kernel of truth, but is not the whole picture. Buildings can electrify now, for less money, and within grid constraints. Particularly for new construction, continuing to allow natural gas buildings is a disservice to consumers and a downright waste of taxpayer funding.

Myth: "too expensive":

Heat Pumps at their most basic form are just the same thing as commercial air conditioners, with an extra valve to reverse refrigerant flow (aka the reversing valve). They have a very nominal cost over a traditional furnace and AC unit, and are often cost neutral or cost negative when the total system installation including gas service and piping is included.

The Interagency Commission on School Construction has the data on this, all three net zero schools in Maryland were built at the same cost as other traditional schools, in their bid year. IAC released a report showing the total cost of building the schools averaged 3% more, including the substantial cost of solar panels, and simple math using $2 per watt and the area of the solar arrays shows that means net zero ready schools (everything except solar panels) can be built for less than traditional schools.

For all electric projects without a requirement to be net zero ready, in our own practice we have seen many projects save overall cost by omitting natural gas service, which more than covers the small incremental cost of heat pumps. Compelling alternatives now exist for all former natural gas uses. We have chefs asking for all electric kitchens, laundry staff praising electric washing equipment, and maintenance personnel praising heat pumps for comfort and maintainability. It can be done, at the same cost, right now. Requiring high performance buildings only decreases the size and cost of the HVAC as other systems are improved. See the attached data on net zero school costs.

In existing buildings, several bills in session address the cost of replacing existing gas systems using Empower Maryland funds, and assistance to the most impacted low-income populations. Cost for existing building switchover is not a reasonable argument to anyone who has read those bills.

Myth: "grid can't handle it":

Pepco release a report last year showing the grid would need to grow 1.4% to 1.7% over the next 30 years (to 2050) to handle all new and existing buildings AND all transportation energy: (https://edocket.dcpsc.org/apis/api/filing/download?attachId=140553&guidFileName=1211ecc8-254d-4fc1-9143-10c8442e3fbc.pdf) It offered a handy retrospective that in some points in the grid history, the growth rate has approached 10%. This can be done now, at a low cost to the consumer, if properly directed.

Additionally, we know that the natural gas infrastructure in this country is rapidly aging and failing, releasing methane with its ~30x the global warming potential of CO2 into the air. The Rocky Mountain institute has a report out showing most gas infrastructure we install now will be abandoned after 2035 due to rising costs: https://rmi.org/insight/clean-energy-portfolios-pipelines-and-plants/ Allowing our schools, public buildings, and other tax payer funded projects to install natural gas is a waste of state money over the life of the building. Allowing private buildings to install natural gas now is a disservice to owners and occupants.

Myth: "heat pumps don't work in the cold"

In cold weather climates, there has long been a perception that heat pumps don't work when it's cold, which is no longer true. There are multiple brands of Variable Refrigerant Flow (VRF) systems that work at full capacity down to 5 degrees Fahrenheit, with a few notable brands that work down to -15 degrees F. The lowest recorded temperature at Deep Creek in western MD was -5 degrees in the last 20 years, and the closest available ASHRAE weather data for far western MD, for Morgantown, WV, has a design temperature of 7.4 degrees F, with a 5 year return extreme temperature of -3.6 degrees F. (http://ashrae-meteo.info/v2.0/index.php?lat=39.64&lng=-79.92&place=%27%27&wmo=724176&ashrae_version=2013) These temperatures are well within the engineering range of modern commercial heat pumps. Heat pumps are available in a wide variety of configurations, are just as flexible for use as natural gas equipment, and are at a similar price point when the cost of natural gas service is included in the cost calculation.

Of course, there are also ground source (aka geothermal) systems, which are not outside temperature dependent at all, but we must acknowledge that these systems have a cost premium not present in other heat pump systems, with a long payback. Ground source is not required for any climate in Maryland.

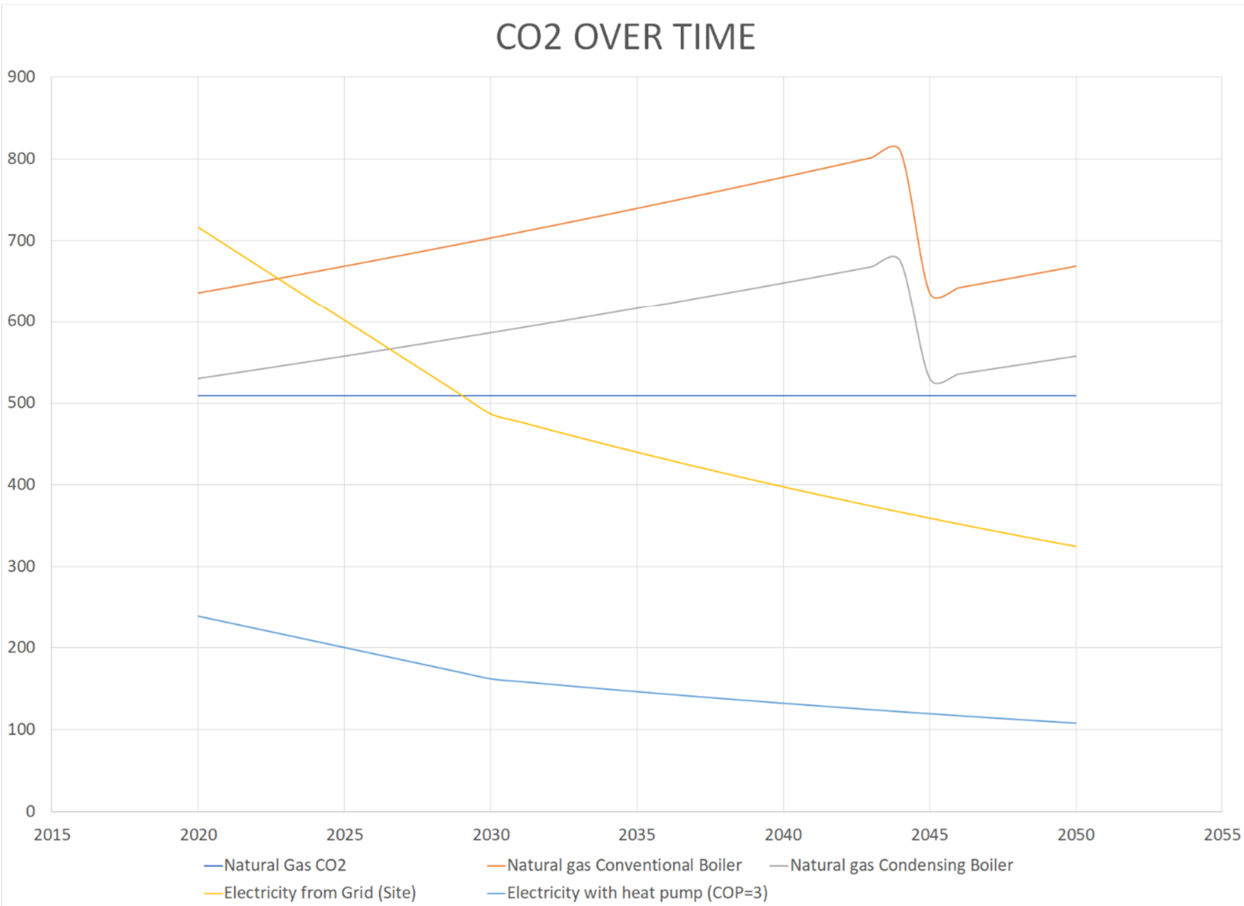
Myth: "grid electric emits more carbon than gas"

This gets thrown out all the time, and it is true that our current grid emissions are nearly the same as natural gas emissions on a per unit energy basis. There is a big caveat--this misses that natural gas equipment is only 80% efficient for a code minimum furnace or boiler. Comparing electric resistance (like a tea kettle) to natural gas, and including efficiency, they're essentially at par for carbon emissions, but as we hit our 2030 60% target and net zero carbon by 2045 in our electric grid (as proposed in the climate bill), the electric resistance carbon emissions continue to improve while the natural gas only decreases in efficiency over time, emitting more and more carbon until the end-of-life equipment replacement.

Heat pumps, with their 3x less energy use already emit ~3x less carbon than natural gas on aa per unit energy basis. The energy code mostly requires the use of heat pumps in modern commercial buildings and can be amended to limit electric resistance except in a few key circumstances, and to entirely prohibit the use of natural gas. This is an easy change for the energy code, and is my recommended pathway to direct building electrification. The technology already exists to use heat pumps for building heating and water heating, and other states like New York and Washington already have an all-electric energy code requiring heat pumps.

(continued) Myth: "grid electric emits more carbon than gas"

Here is a graph I made showing lbs. CO_2/MWH and years, using EPA data specific to our grid, really demonstrating that heat pumps are superior and just get better over time. Note that this uses what's currently in legislation, not the revised 60% by 2030 and 0% by 2045 carbon emission targets, which will only accelerate the improvement:



Myth: "gas equipment will work in a power outage":

There is a persistent idea that gas equipment can work without electric power. There are some very select cases, mostly older equipment, where this is true. Think of direct venting fireplaces and wall heaters, and very old natural draft boilers. These are notable because these appliances direct vent the combustion products into the space, significantly increasing indoor air pollutants and risks for asthma and other issues, and when malfunctioning create tremendous carbon monoxide risk. They have pilot lights that continuously waste energy year-round. Modern gas appliances have glow plug ignitors and safety valves, which will not allow gas flow without proof of ignition. Modern boilers have forced air induction fans and controls, both of which require power to operate. Hot water boilers have electric pumps for system operations. House furnaces have fans and safety valves and controls, all of which require power. Even modern gas stoves have glow plugs and electronic ignition for the oven and cooktop.

Notably, home scale generators are sometimes powered using utility natural gas, and for this one case, they are both safe (when outdoors) and effective. However, the vast majority of homeowners do not have generators, and they can continue to maintain gas service to those generators. I understand there is nothing in the current bills preventing gas usage beyond building HVAC and domestic water heating. If or when gas service becomes too costly, those generators can be replaced with a battery backup in homes that choose to want backup power systems. There is no current requirement forcing any homeowner to buy backup power systems and only a small handful of commercial buildings are required to have backup power systems (hospitals, emergency operations, hazardous occupancies, non-ambulatory care, etc. As a firm, we have designed some of the first emergency operations buildings with battery backup instead of backup generator in the country. Again, the current legislation seems to only address building heating and cooling, and generators are perfectly acceptable.

Myth: "Maryland will be the first to require an all electric energy code":

Seattle beat the pack and was first to require all new building and major retrofit projects to electrify using heat pumps specifically for building heating and service water (domestic) water heating, in the 2018 code cycle. The 2021 Washington State Energy Code, adopted in 2023, will bring the rest of Washington State along. New York City has done the same beginning in 2023, six municipalities in California are already all electric, and Washington DC adopted Appendix Z to the International Energy Conservation Code, allowing a pathway for net zero buildings (which are combustion free) to have preferential code treatment.

All electric energy codes exist already with great examples of thoughtful ways to electrify buildings while allowing targeted exemptions for industrial and process uses. Maryland will be with the leaders in building electrification, but certainly not the first. Note that the 2024 code cycle would be the first available opportunity for an all-electric code adoption in Maryland, which won't apply until 2026, so there are several years for the industry to adjust. The equipment already exists, this is just a matter of political will.

Building Energy Performance Standards (BEPS):

Other jurisdictions, most notably Washington State, Denver, and Washington DC already have a Building Energy Performance Standard in place, addressing the worst performing existing buildings. As written in HB0806, there is a strong push to remove fossil fuels from buildings, but then no energy requirement. This will lead to increased grid demand and a higher cost for all ratepayers in the end. For state buildings, it will also lead to higher energy rates, with the state already spending in excess of $600,000 per day on energy.

Other Amendments:

Specific to House Bill 0806, I have provided input to the Climate Partners Group combined amendments. I strongly encourage you to add an energy efficiency component for both new buildings and the Building Energy Performance Standards addressing existing buildings. There are several good ways to do this modeled by other states, and we encourage additional discussion and amendment to adopt energy efficiency standards.

If there is an additional meeting or additional support you need in this discussion about building electrification, I'm happy to help.

FSi Engineers

Ben Roush, PE, FPE, LEED AP BD+C, ASHRAE BEMP and BEAP, Certified Commissioning Professional

Principal

New Schools in Maryland Must Be Net Zero

What is a "net-zero" school? A net-zero school is a school whose input of energy is equal to or less than its output.

Net-Zero schools have many benefits. Net-zero (NZE) and NZE-ready schools are much cheaper to operate and often are less expensive to build. After payroll, the biggest line item for school districts is operating costs of buildings–most of which is due to energy costs. Looking only at costs, net-zero schools are by far the superior option.Their initial construction costs are lower than or the same as traditional construction, and their operational costs are far less.

NZE schools offer features like "daylighting"--using daylight controls that "know" when to lower the brightness of artificial light– and improved ventilation and air quality, which are known to improve student learning and health. Maryland already encourages school districts to set targets to increase renewable energy, decrease greenhouse gas emissions, and to construct net-zero schools, but has only taken tentative steps toward making its schools net-zero.

There's never been a better time to invest in net-zero schools. Pursuant to the Built to Learn Act, Maryland is investing significantly in new school construction. In 2021, the Interagency Commission on School Construction approved $545 million of state funds for the construction of 23 new schools in Maryland. We should seize the opportunity to make these new schools net-zero.

We owe it to our children and grandchildren to transition our schools to net-zero. The United Nations' Intergovernmental Panel on Climate Change warns that we are still on the trajectory of catastrophic global warming of 2.7 celsius by the century's end. Even if we stopped emitting greenhouse gases today, the gases we have already emitted will linger in the atmosphere for decades and continue to cause global warming. If we are to limit global warming to 1.5 celsius -- the goal set in the Paris Climate Accord -- we need a 50% reduction in greenhouse gas emissions by 2030. ***The 2020s are the only decade we have left to make that target.***[1] And, to be clear, meeting the target of 1.5 celsius of warming is only the best *bad* decision we have--it still promises sea level rise, more powerful storms, devastating wildfires, and sharp species decline. If we don't sufficiently reduce emissions this decade, we will set off a domino effect of escalating disasters.

Schools are "beacon" projects. They educate our children and our communities about both the benefits of and the imperatives for changing to clean, renewable energy, reducing our energy use, and improving health for students and teachers.

Gas delivery rates are expected to increase. The Maryland Commission on Climate Change has projected that gas delivery rates are likely to increase by 2 to 5 times the current rate for consumers left on the gas system[2], making it all the more important that all Maryland schools transition from fossil fuels.

Construction Costs of Newly Constructed Net-Zero Schools In Baltimore and Howard County

Included below are construction costs for three schools and the energy use of Wilde Lake Middle School, which is actually net negative (meaning it produces more energy than it uses). Due to Covid, one-year performance data on Holabird Academy and Graceland is not yet available. Using Montgomery County Public Schools as a baseline (which likely on average has better energy performing schools than much of Maryland), Maryland schools have an average energy use intensity of **54 kBTU** per square foot per year. Wilde Lake has an energy use intensity of **13.7 kBTU** per square foot per year and produces twice as much energy as it consumes.

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[1] https://insideclimatenews.org/news/27082019/12-years-climate-change-explained-ipcc-science-solutions

[2] See MCCC Building Energy Transition Plan.

School construction costs from 2016 - 2021 have averaged between $335-$405 per square foot.

Data from Interagency Commission on School Construction.	Average Building Construction Cost Without Site Preparation (per square foot)	Average Building Construction Cost With Site Preparation (per square foot)
July 2021	$341	$405
July 2018	$302	$360
July 2016	$282	$335.58

Wilde Lake Middle School ($329 per sq ft, with site preparation & solar panels)
Columbia, Maryland

- New Net-Zero LEED Platinum
- Completion date: August 2017
- Total construction cost including site preparation and solar panels: $35,000,000 or $329/square foot
- Energy produced during performance period: 821,618 kWh (approximately 2X use)
- Energy use during performance period: 428,301 kWh
- Net Energy Use: -393,317 kWh (meaning this school's energy use is net-negative)
- Energy Use Intensity (EUI): 13.7 kBTU/sq ft/yr

Graceland Park / O'Donnell Heights Elementary/Middle ($358.16 per sq ft, with site preparation & solar panels)- Baltimore, Maryland

- Design Started: 2015/2016
- Construction Purchase Order: June 4, 2018
- Substantial Completion Phase 1 (Replacement Building): August 26, 2020
- Construction cost, including site and solar panels: $33,752,000.00 or $358.16/square foot

Holabird Academy ($364.30 per sq ft with site preparation & solar panels)
Baltimore, Maryland

- Design Started: 2015/2016
- Substantial Completion Phase 1 (Replacement Building): August 26, 2020
- Construction cost, including site and solar panels: $34,330,500.00 or $364.30/square foot

Montgomery County Public Schools Average Energy Use:
2017 average energy use intensity: 54 kBTU per sq ft per year (for comparison: MCPS conventional schools use 54kBTU/sq ft/year compared to Wild Lake's 13.7 kBTU)

For more information contact MLC Climate Justice Wing at mlcclimatejusticewing@gmail.com.