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July 1, 2022

New York State Climate Action Council
625 Broadway
Albany, NY 12233

Re: Public Comments, New York State Climate Action Council Draft Scoping Plan

Dear Members of the New York State Climate Action Council:

Johnson Controls is grateful for the opportunity to provide comments New York State Climate Action Council Draft Scoping Plan, dated December 30, 2021.

Johnson Controls (JCI) is a leading global provider of heating, ventilating and air conditioning equipment, building controls, security and fire/life safety solutions which includes brands such as York, Metasys, Simplex, Grinnell, Zettler and Tyco. The company has more than 100,000 employees and 2,000 locations across six continents with over a thousand employees across eighteen branches in New York. JCI first set sustainability goals in 2002, and the company has reduced its greenhouse gas emissions intensity from our global operations by more than 70%. Since then, JCI has committed to reducing its Scope 1 & 2 emissions in alignment with a 1.5°C pathway for global temperature rise, as well as reducing Scope 3 emissions in alignment with a well below 2°C pathway, both of which have been approved by the Science Based Targets Initiative. Further, we are AAA rated by MSCI and are recognized as among the Top 100 Most Sustainable Companies by Corporate Knights.

JCI strongly supports New York's pursuit of economy-wide decarbonization, including the objectives laid out in the Climate Leadership and Community Protection Act (CLCPA). The organization prides itself on providing solutions to help our customers reduce their carbon footprint while maintaining superior building performance, in alignment with our vision for healthy people, healthy places, and a healthy planet. Further, we are supportive of nearly all the Key Sector Strategies as drafted in Chapter 12 of the Draft Scoping Plan, which is focused on the buildings sector. Many of these recommendations – notably those focused on net zero new construction, benchmarking, and disclosure requirements as well as building performance standards for existing buildings – will send the clear regulatory and market signals to move the buildings sector to net zero by 2050. However, for Strategy B2 JCI recommends a revised or clarified approach to "Zero emissions standards to phase out fossil fuel combustion equipment" by applying these standards in the short-to-mid-term to *primary* space heating equipment. This strategy represents the swiftest approach to breaking down current barriers to heat pump deployment in all building types, thus accelerating the deepest cuts to GHG emissions from building space heating while still preserving pathways to net zero building emissions in the long-term.

Understanding Heat Pumps and Supplemental Heating Requirements

Policy strategies for building decarbonization commonly recommend that space heating end uses switch from on-site fossil fuel combustion to electric heat pumps. JCI agrees that electrification of heating is critical to building decarbonization and that heat pumps hold the key to unlock this strategy at scale. However, it is also important to recognize that nearly all heat pump applications require some form of supplemental (or backup) heat. The Draft Scoping Plan begins to acknowledge this issue in the State of the Sector section in Chapter 12, page 120 when discussing the necessary shift to heat pumps for space heating: "In the State's coldest regions, where heating systems are designed for temperatures of zero (0F) or lower, some homes that install cold climate ASHPs may therefore use supplemental heat (wood, home heating oil, propane, or gas) for peak cold conditions to avoid unnecessary oversizing of heat pumps and to mitigate electric grid impacts."

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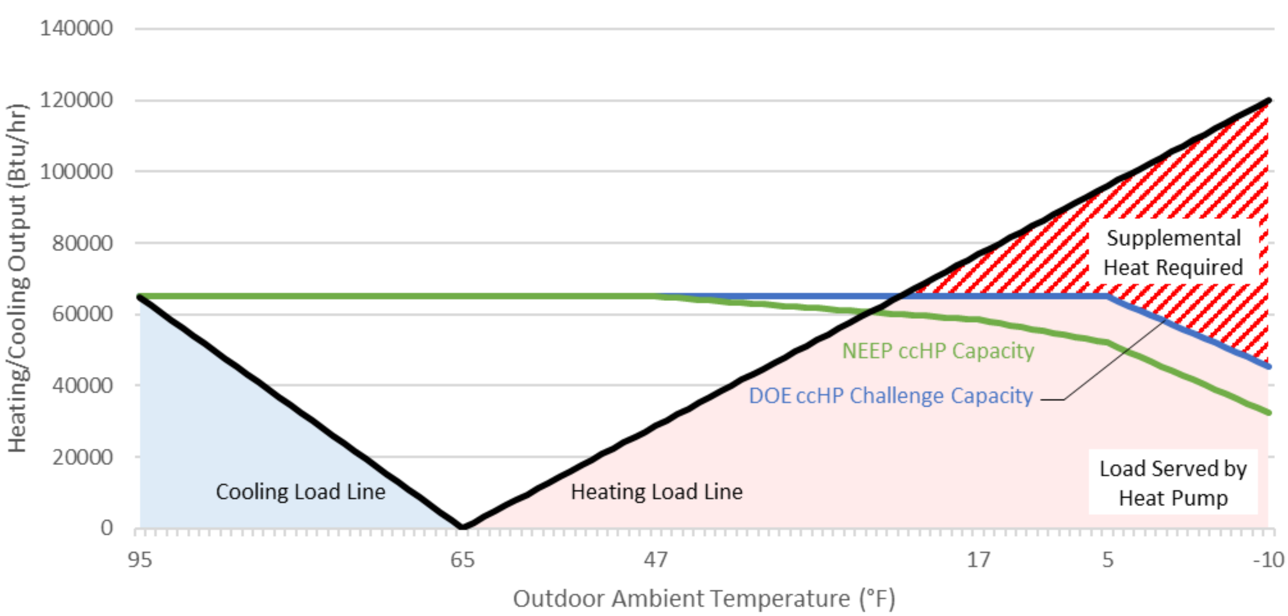
Indeed, cold climate heat pumps are seeing a technology shift where 100% heating capacity down to ambient temperatures of 5°F becomes possible, notably by leveraging highly advanced variable speed compressors that can overspeed at extremely cold temperatures. This is exemplified in the specification for the U.S. Department of Energy Cold Climate Heat Pump Challenge, under which JCI is a participating manufacturer. However, it is critical to recognize that while cold climate air source heat pumps may be able to meet 100% of its rated heating capacity down to 5°F, residential heat pumps have a maximum rated heating capacity of 65,000 Btu/hr, and below 5°F ambient, their heating output will decrease below their rated capacities. Residential heating loads in upstate New York, where a design temperature of -10°F is common, can reach as high as 140,000 Btu/hr. Thus, cold climate heat pumps in many applications will rely on supplemental heating sources, especially as outdoor temperatures drop below 5°F. This issue is demonstrated in the graph below, which shows how much of a 120,000 Btu/hr furnace can be displaced by hypothetical cold climate heat pumps with a design temperature of -10°F. At an outdoor ambient of -10°F, over 60% of the heating load is met with supplemental heat.

120,000 Btu/hr Furnace Heating Load Displacement with Cold Climate Heat Pumps



While the issue of heat pump heating capacity vs. building load is more significant in low-rise residential buildings in upstate New York, existing high-rise and complex commercial buildings also see some challenges, as continued on page 120 of the Draft Scoping Plan: "Larger multifamily, mixed-use, or complex commercial buildings that are concentrated downstate also may use supplemental heat (likely gas) for peak cold conditions, with a plan to phase it out over time as technology develops." For these typically hydronic applications, there are air-to-water and water-to-water applied heat pump solutions available today from JCI and other manufacturers that can significantly displace boiler heating loads in existing buildings. Further, we are investing heavily to boost the supply water temperature and energy efficiency of these heat pumps specifically to address the need for efficient electrification in these commercial applications. However, these heat pump system designs tend to be highly custom where heating needs will vary, and we agree with the section authors that in the mid-term, small supplemental boilers may need to be utilized during peak heating conditions.

High performance cold climate heat pumps are available today in virtually any space heating application, and this technology will continue to advance over time. While these heat pumps are more complex than conventional heating methods, we argue that the most significant barriers to their adoption are triggered not when installing these heat pumps, but when attempting to electrify their supplemental heating source. Electrification of supplemental heating relies on extremely inefficient electric resistance appliances; having the mid-term option to use natural gas as a supplemental fuel during peak heating conditions will result in lower GHG emissions, a more resilient electric grid, and lower upfront and operational costs for building occupants. Regulatory action to adopt zero emission standards that "prohibit gas/oil replacements (at end of useful life)" of heating equipment, as proposed in Strategy B2 on page 129 of the Draft Scoping Plan, could effectively mandate that heat pump supplemental heating be met with electric resistance, leading to significant unintended consequences for emissions, grid resiliency, and cost-effectiveness. Adopting zero emissions standards for primary heating systems in the mid-term while allowing fuel combustion for supplemental heating only will address these market barriers and are discussed in more detail in the following section.

Addressing Market Barriers: Cold Climate Heat Pumps with the option for Combustion Supplemental (or backup) Heating

In essence, the only difference between an all-electric heat pump system and heat pump system with gas supplemental heating is the form of supplemental (or backup) heating used: electric resistance vs. fuel combustion. The distinction between these two heating sources becomes extremely important as New York pursues building electrification policies at scale. JCI urges the State to avoid mid-term strategies for building decarbonization which rely on electric resistance as the sole form of supplemental space heating, as it creates three major market barriers for heat pump adoption and building decarbonization solutions more broadly:

1. The source emissions attributable to electric resistance heat operation during peak periods are larger than the emissions from supplemental gas combustion when addressing the same heating load
2. Electric resistance heating use will result in an enormous spike in heating electricity consumption, threatening grid reliability
3. The upfront installation costs of electric resistance can be a significant prerequisite for all-electric heating, and using electric resistance to meet peak heating demands will often result in higher operational costs when compared to fuel combustion supplemental heat

Preserving the option to use fuel combustion for supplemental heating will help break down these critical barriers. As a result, New York can maximize emissions reductions from buildings in the mid-term while addressing the barriers to full electrification over the long-term. Fuel combustion supplemental heating in this context is discussed below.

Reduced Site/Source Emissions

The mass deployment of cold climate heat pumps as a primary heating source in New York's buildings will dramatically reduce GHG emissions attributable to space heating. As long as compressor-driven heating satisfies the indoor heating demand, space heating is efficiently electrified, and the carbon intensity of this electricity decreases as more zero-carbon generation sources are added to the electricity mix. During shoulder seasons and mild winters, it is conceivable that some buildings will need only limited use of supplemental heating – be it electric resistance or fuel combustion – thus achieving near-zero carbon heating. And, during colder winter periods, cold climate heat pumps will address at least a portion of building heating loads.

However, as end-uses in New York are electrified winter peak electric loads will increase dramatically, and the use of supplemental space heating will coincide with these periods. In New York, natural gas "peaker" plants are the predominant source of electricity during peak periods today, and while the state has ambitious goals for the deployment of zero carbon electricity generation, it is not reasonable to assume that gas peaker plants will be fully retired from the grid in the mid-term given the trajectory of electrification across all sectors. When peak electricity loads are served by natural gas generation, the demand-side use of electric resistance supplemental

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heating will be responsible for more source GHG emissions than the source emissions from fuel combustion supplemental heating to meet the same heating load.

Consider two identical residential split system heat pumps, the only difference being that one uses electric resistance and the other uses fuel combustion for supplemental heat. In both systems the heat pump runs for as long as possible, and as long as the heat pump is running, the systems have an identical GHG emissions intensity. Only when the supplemental heating is triggered will the systems see a difference in GHG emissions; for simplicity, this example will use an illustrative load of 100,000 Btu/hr. The electric resistance supplemental heat has a COP of 1.0, thus consuming 100,000 Btu/hr in electricity. Assuming 58% in generation, transmission, and distribution losses, a gas peaker plant would consume 238,095 Btu/hr of gas to meet this load. By contrast, a natural gas supplemental heating system with a 95% AFUE rating would consume 105,263 Btu/hr of gas on-site, or 106,758 Btu/hr assuming a conservative 1.4% in distribution losses, to meet the same 100,000 Btu heating load. This assessment is summarized in the table below. The carbon intensity of electric resistance demands on New York's non-Baseload resources, using EPA's eGRID emissions rate, yield similar results to the use of a generic gas plant.

Supplemental Heating Source Comparison: Natural Gas vs. Electric Resistance

Supplemental Heat Source	Energy Source	Appliance Efficiency	Site Energy	G/T/D Losses[1]	Source Energy	Emissions Factor[2]	kg CO_2 per 100000 Btu of Space Heating
Natural Gas	Gas Distribution	95% AFUE	105263 Btu Gas	1.4%	106758 Btu Gas	0.000072 kg CO_2/Btu	**7.70**
Natural Gas	Gas Distribution	80% AFUE	125000 Btu Gas	1.4%	126775 Btu Gas	0.000072 kg CO_2/Btu	**9.14**
Electricity	Generic Gas Peaker Plant	1.0 COP	100000 Btu Elec	58%	238095 Btu Gas	0.000053 kg CO_2/Btu	**12.64**
Electricity	NY Upstate non-Baseload	1.0 COP	29.31 kWh Elec	N/A	N/A	0.4037925 kg CO_2/kWh	**11.83**
Electricity	NY Downstate non-Baseload	1.0 COP	29.31 kWh Elec	N/A	N/A	0.4609496 kg CO_2/kWh	**13.51**

[1]Generation heat rate for gas power plants assumed to be 53% per EIA Electric Power Annual data. Transmission and distribution losses for electricity assumed to be 5%. Distribution losses for natural gas pipelines assumed to be 1.4% per EPA Inventory of U.S. Greenhous Gas Emissions and Sinks. This is a conservative estimate, as this figure is representative of all upstream and downstream methane leakage.

[2]Emissions factor for natural gas from EIA Energy Annual data. Emissions factor for natural gas distribution adjusted to account for 1.4% methane leakage at 27x the carbon intensity of carbon dioxide. Regional electricity emissions factors for New York from EPA eGRID data.

The analysis above demonstrates that fuel combustion supplemental heating is nearly 40% less carbon intensive than electric resistance when gas peaker plants are utilized to meet peak electricity loads. As the New York grid adds significant "clean firm" resources like utility-scale battery storage over the long term, the emissions intensity of non-baseload electricity generation will come down, potentially to a value where electric resistance supplemental heating will have a lower source emissions intensity than on-site combustion for supplemental heating. Allowing fuel combustion supplemental heating will make this transition go more smoothly, placing less upward pressure on fossil peaker resources, and ultimately yielding an optimal result in terms of overall emissions reductions.

Improved Grid Resiliency

As discussed in the Draft Scoping Plan, a cold climate air source heat pump will operate less efficiently and lose heating capacity as outdoor ambient temperatures decrease. At the same time, the space heating load in the building will increase, until reaching a point where supplemental heating is required. As a result, a heat

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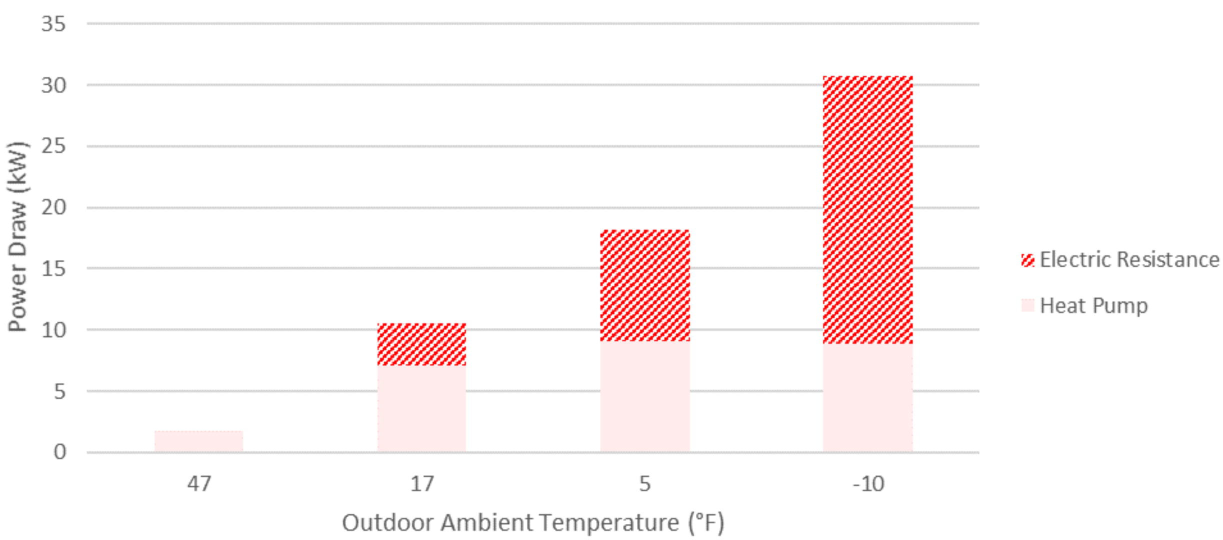
pump's electricity consumption will increase exponentially as temperatures decrease, and will spike dramatically if electric resistance is used for supplemental heat. Generally, a heat pump's electricity demand is larger for heating operation than for cooling, especially once supplemental electric heating is utilized. As buildings in New York are fully electrified, the New York Independent Service Operator must prepare for a new coincident winter peak load that will be significantly larger than that of today. The chart below illustrates how the electricity consumption of a cold climate heat pump with electric resistance supplemental heating will increase as outdoor ambient temperatures decrease.

Electricity Consumption: Cold Climate Heat Pump with Electric Resistance Supplemental Heat Sized for 120,000 Btu/hr



Assumptions by outdoor ambient temperature:
47°F: heating load=28,000 Btu/hr; heat pump COP=4.7; heat pump output=28,800 Btu/hr
17°F: heating load=76,800 Btu/hr; heat pump COP=2.7; heat pump output=65,000 Btu/hr; supplemental heat output=11,800 Btu/hr
5°F: heating load=96,000 Btu/hr; heat pump COP=2.1; heat pump output=65,000 Btu/hr; supplemental heat output=31,000 Btu/hr
-10°F: heating load=120,000 Btu/hr; heat pump COP=1.5; heat pump output=45,500 Btu/hr; supplemental heat output=74,500 Btu/hr

Cold climate heat pumps with fuel combustion supplemental heating can be a part of the mid-term solution for managing New York's grid because of their potential for electric load shedding. Within a matter of seconds, this system can shift a heating load from electric to gas, providing immediate relief to a congested electric grid. The "changeover point" between the two fuel sources can be controlled by a single thermostat, which can be connected and enrolled in a utility demand response program. With little effort, and no impact to the occupant's comfort or well-being, cold climate heat pumps with fuel combustion supplemental heat are ideal demand response assets.

Allowing cold climate heat pumps the option to use fuel combustion for supplemental heating in the mid-term will enable the rapid deployment of heat pumps without fear of increasing winter coincident peak electricity loads. This will lead to faster achievement of New York's decarbonization goals when compared to an electric-only approach, while giving the grid more time to build out the needed infrastructure to manage new electricity demands economy-wide.

Consumer Cost-effectiveness

For existing buildings with central heating and cooling systems, conversion to a cold climate heat pump with fuel combustion supplemental heating will often be the most cost-effective solution for significant

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decarbonization of the space heating load. In homes with split systems specifically, replacement of the outdoor air conditioning unit with a cold climate heat pump and the installation of a compatible thermostat is all that is required. This conversion will often be less costly than redesigning the system to a heat pump with electric supplemental heat, which requires additional electrical service investments to power the resistance heating element and may require expanded ductwork to accommodate changes in supply airflow.

Heat pumps with fuel combustion supplemental heat will also allow New York ratepayers of all economic classes to take advantage of time of use electricity rates. Allowing fuel combustion supplemental heating will also enable disadvantaged and rural communities – where a lack of sufficient electrical capacity and energy infrastructure presents an even larger challenge – to utilize fuel that can be stored on-site in order to shed electrical loads as needed. Innovative rate designs can encourage efficient heat pump operation while also protecting consumers from extreme spikes in energy costs during the simultaneously occurring periods of high heating loads and peak electricity demands. Such a strategy enables dramatic, cost-effective displacement of fossil fuel combustion without having to sacrifice space heating when it is needed most.

Consumer costs both direct (e.g. building retrofits) and indirect (e.g. electric rate increases) can be better managed through a building decarbonization pathway that includes an option for fuel combustion supplemental heat. These costs can be spread more thinly over a longer period, reducing sticker shock and enabling better payback periods while still achieving deep decarbonization and improving grid resiliency.

Importantly, fuel combustion supplemental heating can also be cost-effectively electrified when the market barriers, such as grid readiness to handle electric resistance supplemental heat, have been addressed. When ready to fully electrify these systems, only the gas burner section needs to be replaced with an indoor air handler and electric resistance heat coil (or another source of supplemental heat), while the existing outdoor heat pump can remain in place.

Policy Recommendations

As regulatory strategies for building decarbonization are considered in the Draft Scoping Plan, JCI recommends including mid-term policies that would achieve 100% of *primary* space heater sales to be zero emission. From a regulatory perspective, this could mean that where a heat pump is installed as the primary space heating source, the replacement of a combustion heater is allowed for supplemental (or backup) heating only. Such an approach would remove the barriers to space heating electrification and unleash the market penetration of heat pumps at an enormous scale, without mandating that heat pump supplemental heating be met with electric resistance. For a long-term strategy, JCI recommends that New York validate grid reliability when electric supplemental heating is used in all buildings as needed, and that the use of electric resistance during peak periods will result in lower source GHG emissions than when combustion fuels are used, before establishing a mandate for 100% of supplemental heater sales to be zero emission.

Finally, using the assumptions in these comments about next-generation cold climate heat pump capacity and efficiency, as well as emissions intensity for electricity generation and gas combustion, the chart below estimates the carbon intensity of space heating options at benchmark outdoor ambient temperatures. This assessment demonstrates how cold climate heat pumps with fuel combustion supplemental heating can yield optimal emissions reductions across the entire operating profile of system operation when compared to gas-only heating and cold climate heat pumps with electric resistance supplemental heating.

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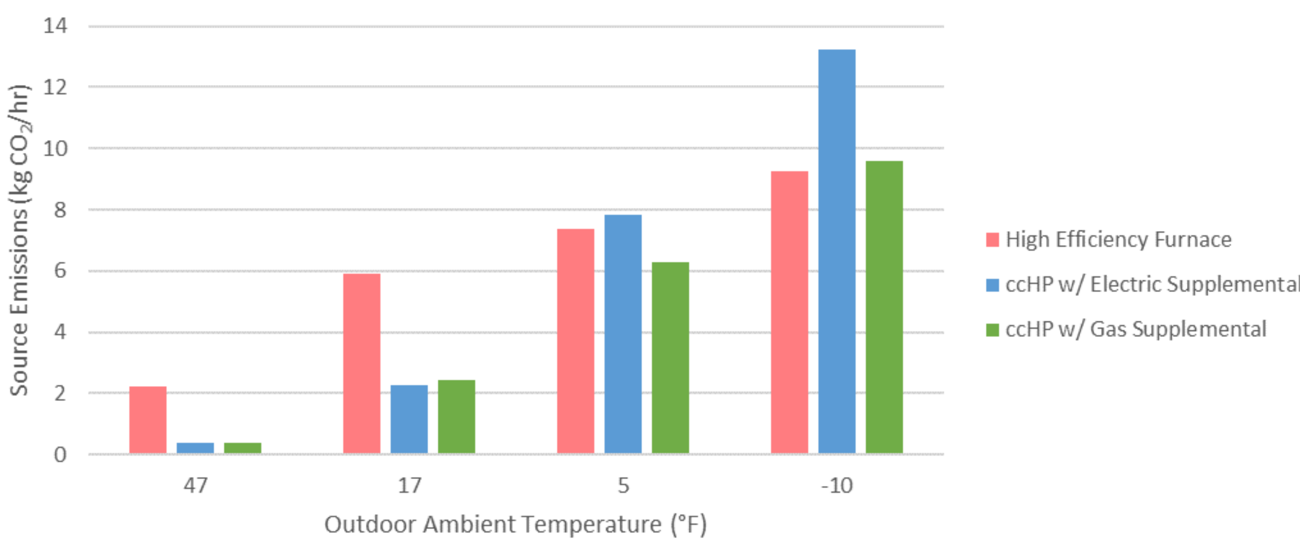
Emissions Intensity: Space Heating Options Sized for 120,000 Btu/hr



Assumes baseload electricity generation met with 50% gas power plants and 50% zero-carbon electricity at 47°F and 17°F ambients. Assumes space heating will add to non-baseload generation met with gas power plants at 5°F and -10°F ambients.

JCI is committed to the achievement of building decarbonization in New York and across the globe. We are eager to collaborate with NYSERDA and other stakeholders in the State to pursue policies that maximize the benefits of space heating electrification and yield optimal, cost-effective, and equitable building decarbonization outcomes.

Thank you again for the opportunity to comment on the New York State Climate Action Council Draft Scoping Plan. Should you wish to discuss these comments, please do not hesitate to contact us at the information below.

Respectfully,

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