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California Air Resources Board
Industrial Strategies Division
1001 I Street
Sacramento, CA 95814

Re: Public Comments, 2022 Scoping Plan Update – Building Decarbonization Workshop

Dear California Air Resources Board Staff:

Johnson Controls is grateful for the opportunity to provide comments following the California Air Resources Board (CARB) 2022 Scoping Plan Update – Building Decarbonization Workshop, held on December 13, 2021, and input into the 2022 State Strategy for the State Implementation Plan (SIP).

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. 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 California's pursuit of economy-wide decarbonization, including the goal of 40% reduction of GHG emissions in the buildings sector by 2030 as established in AB 3232. 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. We are generally supportive of the strategies outlined the for the 2022 SIP as presented in the December 13 Workshop, but with respect to space heating, JCI recommends a revised approach to accelerate decarbonization. Rather than a target for 100% of space heater sales to be zero emission, we recommend a pathway which encourages space heating electrification while also allowing the continued use of hybrid (or "dual fuel") systems. This represents the swiftest approach to breaking down current barriers to building decarbonization, thus enabling the deepest cuts to GHG emissions from building space heating.

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 backup heat. This is due to the technical constraint that as outdoor temperatures decrease, air source heat pumps operate less efficiently – and perhaps more importantly, they see a decrease in heating capacity (in Btu/hr) provided to the building. When a heat pump can no longer meet its required heating demand, backup heating is triggered, and in conventional all-electric heat pump systems, this backup heat source is an extremely inefficient electric resistance coil. Where a residential split system heat pump may have a seasonal coefficient of performance (COP) of 2.5, electric resistance has a COP of 1.0, meaning it uses 2.5 times the amount of electricity to produce the same amount of heat when called upon by the system.

Similar to an all-electric system, a hybrid/dual fuel system utilizes a heat pump for primary heating. However, instead of electric resistance for backup, these systems use fuel combustion when the heat pump cannot meet the indoor heating demand, such as during an extreme cold weather event. In the same residential split system application described above, a heat pump outdoor unit can be combined with a furnace indoor unit, and both are controlled by a single thermostat that “locks out” the furnace as long as the heat pump satisfies the heating demand. The system does not have electric resistance heating, meaning that when the backup furnace is triggered, the entire heating load shifts from electricity to gas. Unlike a heat pump with electric resistance backup heat, dual fuel systems do not see an instantaneous spike in electricity consumption when backup heating is used.

A policy that requires 100% of space heater sales to be zero emission, and results in a prohibition on hybrid heating systems, would effectively mandate that backup space heating be met with electric resistance. By comparison, a policy that considers the benefits of hybrid heating systems will achieve the same level of efficient electrification, while simultaneously reducing the inefficient electrification of backup heating in contrast to the all-electric path. Inefficient electrification of backup heating will have the unintended consequences of higher GHG emissions, lessened grid reliability, and higher cost burdens across California residents. As demonstrated in the following section of these comments, allowing hybrid heating in the mid-term will help overcome these barriers, achieve deeper GHG reductions, address grid capacity constraints more smoothly, and enable a more equitable transition to a decarbonized building sector.

Addressing Market Barriers

In essence, the only difference between an all-electric heat pump system and a dual fuel heat pump system is the form of backup heat used: electric resistance vs. fuel combustion. The distinction between these two backup heating sources becomes extremely important as California pursues building electrification policies at scale. JCI urges CARB to avoid recommendations for mid-term building decarbonization strategies which rely on electric resistance as the sole form of backup space heating, which could be the case when 100% of space heater sales are zero emission. Reliance on electric resistance backup heating creates three major market barriers for building decarbonization solutions:

1. The source emissions attributable to electric resistance heat operation during peak periods are larger than the site emissions from a furnace that addresses the same heating load
2. Electric resistance heating will result in a 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, while also resulting in higher operational costs

Hybrid heating systems will help break down these critical barriers. As a result, California can maximize emissions reductions from buildings in the mid-term while addressing the barriers to full electrification over the long-term. Dual fuel systems in the context of these issues are discussed below.

Reduced Site/Source Emissions

Like all-electric systems, the operation of a heat pump in dual fuel heating systems will dramatically reduce GHG emissions attributable to buildings in California. As long as the heat pump satisfies the indoor

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heating demand, space heating is efficiently electrified, and the carbon intensity of this electricity decreases as more zero-carbon generation sources are added to California's electricity mix. In portions of the state that experience mild winters, it is conceivable that some buildings will go through a complete heating season without using backup heating – be it electric resistance or fuel combustion – thus achieving near-zero carbon operation.

However, as end-uses in California are electrified and winter grid loads take on new shapes, the use of backup space heating when needed will coincide with periods of peak electricity demand on the grid. It is reasonable to assume that these peak periods will rely on natural gas "peaker" plants at least until the grid fully transitions to zero carbon generation sources. When peak electricity loads are served by natural gas generation, the demand-side use of electric resistance backup heating will be responsible for more source GHG emissions than the site emissions from a backup furnace to meet the same heating load.

Consider two identical residential split system heat pumps, the only difference being that one uses electric resistance for backup heat and the other uses fuel combustion for backup. 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 backup heating is triggered will the systems see a difference in GHG emissions; for simplicity, this example will use an illustrative load of 10,000 Btu/hr. The electric resistance backup heat has a COP of 1.0, thus consuming 10,000 Btu/hr in electricity. Assuming 58% in generation, transmission, and distribution losses, a gas peaker plant would consume 23,810 Btu/hr of gas to meet this load. By contrast, a backup gas furnace with a 92% AFUE rating would consume 10,870 Btu/hr of gas on-site, or 12,077 Btu/hr assuming a conservative 10% in transmission losses, to meet the same 10,000 Btu heating load. This assessment is summarized in the table below. The carbon intensity of electric resistance demand on California's non-Baseload resources, using EPA's eGRID emissions rate, yields a similar result to the use of a generic gas plant.

Backup Heating Source Comparison: Natural Gas vs. Electric Resistance

Backup Heating Source	Electric Generation Source	Appliance Efficiency	Site Energy	G/T/D Losses	Source Energy	Emissions Factor	kg CO_2 per 10000 Btu of Space Heating
Furnace	N/A	80% AFUE	12500 Btu Gas	10%	13889 Btu Gas	0.00005307 kg CO_2/Btu	0.7371
Furnace	N/A	92% AFUE	10870 Btu Gas	10%	12077 Btu Gas	0.00005307 kg CO_2/Btu	0.6409
Furnace	N/A	95% AFUE	10526 Btu Gas	10%	11696 Btu Gas	0.00005307 kg CO_2/Btu	0.6207
Elec Resistance	Generic Gas Peaker	1.00 COP	10000 Btu Elec	58%	23810 Btu Gas	0.00005307 kg CO_2/Btu	1.2636
Elec Resistance	CA non-Baseload	1.00 COP	2.931 kWh Elec	N/A	N/A	0.43725397 kg CO_2/kWh	1.2815

Notes
Fan power for furnace and electric resistance air handler assumed to cancel out
Assumes 5% T&D losses for electricity
Generation heat rate for gas from: https://www.eia.gov/electricity/annual/html/epa_08_01.html
Emissions factor for gas from: https://www.eia.gov/environment/emissions/co2_vol_mass.php
Regional output emissions rates from: https://www.epa.gov/egrid/data-explorer

As the California grid adds "clean firm" resources over the long term, the emissions intensity of non-baseload electricity generation will come down, potentially to a value where electric resistance backup heating will have a lower source emissions intensity than on-site combustion for backup heating. Dual fuel systems 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 previously, a 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. As a result, a heat pump's electricity consumption will increase exponentially as temperatures decrease. This is true even for cold climate heat pumps; they too will operate less efficiently as it gets colder outside, until reaching a point where they must rely on a backup heating source. Generally, a heat pump's electricity demand is larger for heating operation than for cooling, especially once backup electric heating is utilized. As buildings in California are fully electrified, the California Independent Service Operator must prepare for a new coincident winter peak load that will be significantly larger than that of today.

Dual fuel heat pumps can be a part of the mid-term solution for managing California's grid because of their potential for electric load shedding. Within a matter of seconds, a dual fuel heat pump 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 is 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, dual fuel systems are ideal demand response assets.

Dual fuel heat pump systems enable the rapid deployment of heat pumps without fear of increasing winter coincident peak electricity loads. This will lead to faster achievement of California'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 that utilize a ducted furnace and air conditioner today, conversion to a dual fuel system will often be the most cost-effective solution for significant decarbonization of the space heating load. For buildings with split systems, replacement of the outdoor air conditioning unit with a heat pump and the installation of a compatible thermostat is all that is required. Likewise, a packaged air conditioner with an integral furnace can be replaced with a packaged dual fuel system. This conversion will often be less costly than redesigning the system to an electric-only heat pump, which requires additional electrical service investments for the backup resistance heating element and may require expanded ductwork to accommodate changes in supply airflow.

Dual fuel heat pumps also allow California ratepayers of all economic classes to take advantage of time of use electricity rates. Innovative rate designs can encourage efficient heat pump operation while also protecting consumers from extreme spikes in energy costs during simultaneous 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 hybrid solutions. 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, dual fuel split systems can also be cost-effectively converted to fully electric systems when the market barriers, such as grid readiness to handle electric resistance backup heat, have been addressed. When ready to fully electrify these systems, only the furnace section needs to be replaced with an indoor air handler and electric resistance heat coil, while the existing outdoor heat pump can remain in place. The building owner does not need to wait for the furnace's normal end of life to fully electrify the space heating system and can be incentivized to retire the furnace early.

Policy Recommendations

As CARB considers strategies for building decarbonization in the SIP, JCI recommends focusing on 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 appliance would be allowed as part of an integrated system. Such an approach would remove the barriers to space heating electrification and unleash the market penetration of heat pumps at an enormous scale, without requiring that heat pump backup heating be met with electric resistance. For a long-term strategy, JCI recommends that CARB validate grid reliability when electric resistance backup heating is used in all buildings, and that the use of electric resistance during peak periods will result in lower source GHG emissions than a furnace, before considering a mandate for 100% of backup heater sales to be zero emission.

To be clear, JCI is not making a policy recommendation relative to the extension of natural gas infrastructure to newly constructed buildings or to buildings that do not already have gas service in place. We expect that the California Energy Commission will continue addressing these issues in future revisions to Title 24, as the agency has done in the 2022 edition. Rather, our recommendation is that for existing buildings where a gas line is already installed, this infrastructure be allowed continued use to the extent that it can facilitate more impactful building decarbonization measures.

JCI is committed to the achievement of building decarbonization in California and across the globe. We are eager to collaborate with CARB and other stakeholders in California 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 2022 State Strategy for the State Implementation Plan. Should you wish to discuss these comments, please do not hesitate to contact us at the information below.

Respectfully,

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