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Daikin Comment Letter

Additional submitted attachment is included below.

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September 7, 2023

Mr. David Hochschild, Chair
Dr. Andrew McAllister, Commissioner
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814-5512

Re: Docket 22-BSTD-01
(Submitted electronically to Docket 22-BSTD-01: Daikin Comments on 2025 Energy Code Pre-Rulemaking[1])

Dear Chair David Hochschild and Commissioner Andrew McAllister,

Daikin U.S. Corporation submits the following comments in response to the 2025 Energy Code Pre-Rulemaking. Daikin U.S. Corporation ("Daikin") is a subsidiary of Daikin Industries, Ltd., the world's largest air conditioning equipment manufacturer. The Daikin Group of companies operating in the United States includes Daikin Applied, Daikin Comfort Technologies North America, AAF Flanders, and Daikin America. In California, Daikin and Goodman branded equipment represented at more than 150 company-owned or independent distribution locations to more than 1,000 installing contractors.

I. Daikin Supports California's Heat Pump and Equitable Building Decarbonization Goals

Daikin supports the Commission's efforts to accelerate building electrification and decarbonization through the Energy Code, which is known as Title 24, Part 6 (Title 24). Daikin perceives that Title 24 will play a critical role in helping California meet its 2030 6 million Heat Pump goal. Also, Daikin believes that heat pumps are a proven technology that can substantially reduce greenhouse gas (GHG) emissions reduction in both residential and nonresidential buildings and appreciates the Administration and the Legislature's strong support in endorsing Heat Pumps[2].

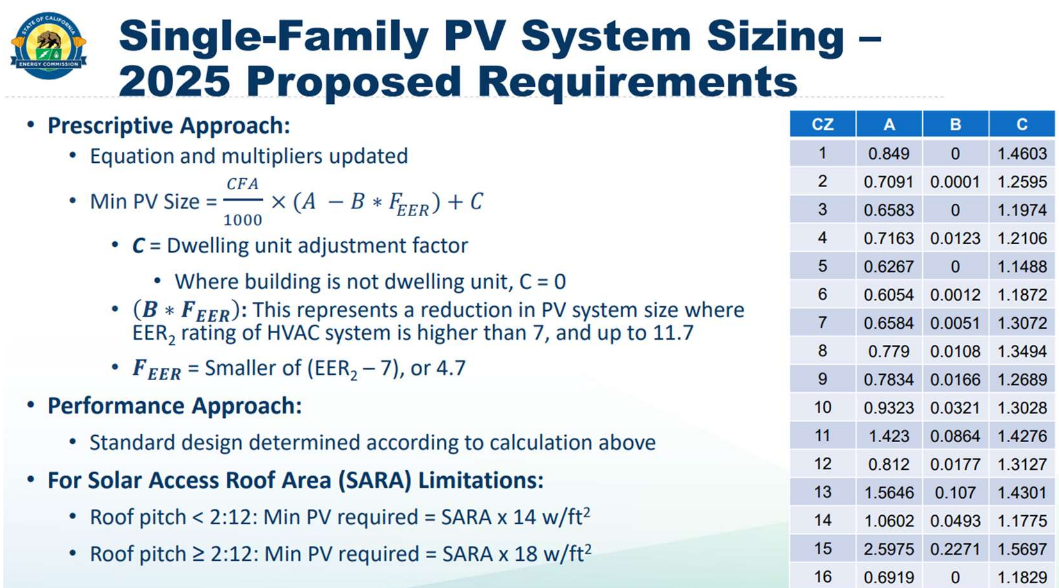
In particular, Daikin wants to emphasize the importance of variable speed heat pumps (VSHP or "inverter" heat pumps) in meeting California's climate and energy efficiency goals. VSHP, which provide variable compressor speeds (rather than simple binary on-off operation) bring considerable energy savings, enhanced demand response and grid management capability, and allow for lower refrigerant usage. As explained below, they bring other benefits, including less material usage, smaller form factors, and lower transportation emissions. VSHP are the dominant heat pump technology in Europe, Japan, China and increasingly, in developing nations around the world. We provide these comments today with a particular focus on how Title 24 can help promote the proliferation of VSHP in California and the United States, and with the consumers the CEC looks to benefit with Title 24. Specifically, we will focus on how to best tailor the incentive criteria used for VSHP to ensure their adoption.

[1] Perez, Javier. 2023. 2025 Energy Code Pre-Rulemaking. California Energy Commission.

[2] Letter from Governor Newsom to Chair Liane Randolph, California Air Resources Board. https://www.gove.ca.gov/wp-content/uploads/2022/07/07.22.2022-Governors-Letter-to-CARB.pdf (Last accessed July 22, 2022,)

II. <u>Applying EER2 thresholds for PV System Sizing could be counterproductive for adoption of variable speed heat pumps</u>

Daikin supports the Energy Code and the benefits of replacing gas fired equipment with electric alternatives, in addition to PV Systems. Daikin understands that this PV system sizing 2025 proposed requirements is intended to address that lower EER2 HVAC systems could increase peak power usage and thus requires larger PV systems. Yet Daikin believes that, while EER2 can be effective to manage peak demand for fixed-speed HVAC systems, as mentioned in the rest of this section, the metric is an irrelevant to do the same for VSHP technology. In consequence, we believe that prescribing EER2 for sizing PV Systems, as currently proposed, could be counterproductive to the adoption of VSHP technology and the attainment of the state's heat pump and decarbonization targets per Figure 1 below. Therefore, Daikin proposes that F_{EER} should be fixed at 4.7 for the VSHP technology.



CZ	A	B	C
1	0.849	0	1.4603
2	0.7091	0.0001	1.2595
3	0.6583	0	1.1974
4	0.7163	0.0123	1.2106
5	0.6267	0	1.1488
6	0.6054	0.0012	1.1872
7	0.6584	0.0051	1.3072
8	0.779	0.0108	1.3494
9	0.7834	0.0166	1.2689
10	0.9323	0.0321	1.3028
11	1.423	0.0864	1.4276
12	0.812	0.0177	1.3127
13	1.5646	0.107	1.4301
14	1.0602	0.0493	1.1775
15	2.5975	0.2271	1.5697
16	0.6919	0	1.1829

Figure 1: PV Sizing requirements for Heat Pumps under 11.7 EER2 in CEC's 2025 Energy Code Pre-Rulemaking Docketed Document

EER2 is not a metric that in any way captures the benefits and performance of VSHP's. As explained below, Daikin believes that requiring EER2 for VSHP PV System integration may slow their adoption and fail to recognize and capitalize their inherent benefits.

a. <u>EER2 is not representative of peak load performance due to field sizing practices.</u>

The EER2 metric is intended to measure peak load performance at 95F outdoor. This test condition, per DOE Appendix M1, has 100% sizing factor, meaning the system is tested at full capacity at 95F. When a VSHP operates in an unloaded state, as is does when applied with over 100% sizing, the operational efficiency increases. This improved applied efficiency is not accounted for in the DOE Appendix M1. However, DOE uses a 110% sizing factor for typical in SEER2 calculations. A similar sizing consideration is not reflected in the EER2 metric. Consequently, unit efficiency is impacted due to unmatched load and capacity when sized with this factor. Furthermore, similar sizing of fixed speed heat pump systems will lead to cyclic operation and resultant loss of efficiency, whereas VSHP systems can operate in partial load operation modes at higher efficiency.

While 110% sizing is used in the SEER2 calculations, real-world equipment sizing is even larger. DOE published a paper[3] that found that typical equipment sizing in real-world applications ranges between 133-148%. Daikin conducted an analysis using DOE Appendix M1 calculation method to evaluate the impact of this real-world sizing practice compared to the EER2 rated condition. With a typical 140% sizing based per DOE's paper, the evaluation showed that the applied EER2 of a single speed unit can drop to 97% due to cyclic operation, whereas the applied EER2 of VSHP systems may increase up to 130% due to partial load operation (see Figure 1). This result demonstrates that EER2 does not represent true peak load energy efficiency in actual field conditions, particularly for VSHP systems and the industry sizing practices discovered by the DOE.

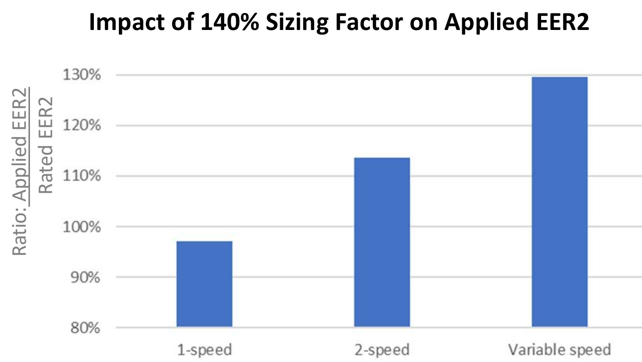


Figure 2. Applied EER2 calculations for a typical equipment operation at below full load conditions.

b. <u>EER2 requirements could exclude variable speed equipment from eligibility in this program, and limit their potential to deliver greater annual energy savings and reduce energy bills.</u>

As shown above, EER2 is a metric measured at high ambient (95F) conditions. High ambient conditions, however, represent only a small portion of time in a year across most locations in the US, albeit an important time period from a load management perspective. Figure 2 shows percentage of bin hour of high ambient condition (>93F) at a few densely populated US cities. Based on weather data from National Oceanographic and Atmospheric Agency (NOAA) for twelve major U.S. cites (Phoenix, Houston, Los Angeles, Washington D.C., Atlanta, Miami, New York, Philadelphia, San Francisco, San Diego, Chicago and Seattle), the average duration that the temperature exceeded full load temperature conditions (>93F), between 2019-2021, was only 2.2% of the total annual hours. The average duration that cities experienced temperature conditions between 93-97F was 1.2% of the annual hours.

Specifically, in California, across its 16 climate zones, based on weather data from 2017, the average number of hours over 95F is estimated to be 189 hours annually, which is about 4.4% of total cooling load hours. Some of the hotter CA climate zones experience over 30% of cooling operating hours above 90F with over 20% of cooling operating hours above 95F as well. However,

[3] U.S. DOE, Office of Energy Efficiency & Renewable Energy, 2018, Residential HVAC Installation Practices, A Review of Research Findings.

we note that in the study published by the DOE[4] that most of the products installed in homes are oversized. As a result, it is expected that due to potential oversizing of HPs sold in California, they can adequately meet the cooling and heating loads, provide options for load shedding and provide higher efficiency operation for the majority of its annual operation.

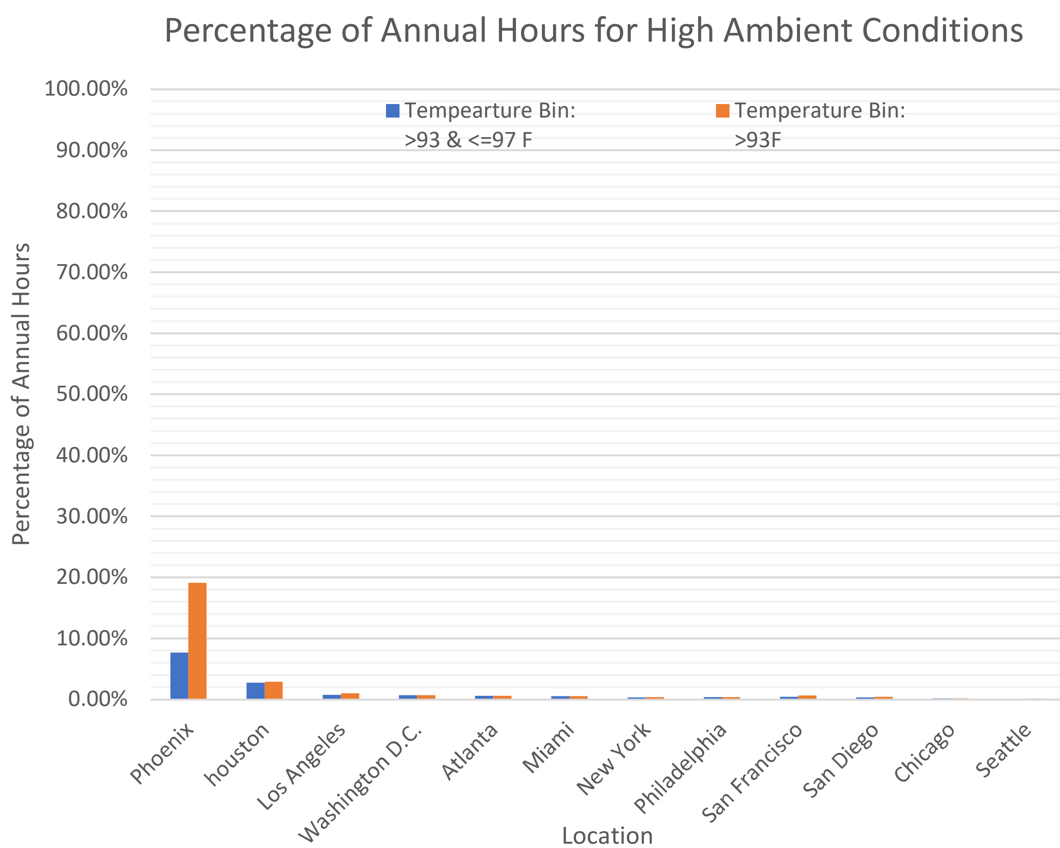


Figure 3. Percentage of hours for high ambient conditions for 12 cities, 2019-2021

Seasonal Energy Efficiency Ratio is a better indicator of annual energy consumption and a higher SEER2 can reflect measurable energy savings, and a reduction in GHG emissions. Building decarbonization, in the context of CEC's Equitable Building Decarbonization Direct Install program, cannot be realized by ensuring EER2 thresholds, because the heat pump systems will be operating below the full load conditions for majority of its lifetime in operation. Thus, it is more effective to allow for variable speed equipment that performs better than fixed speed equipment in part load conditions. Lastly, due to the combination of EER2 thresholds and the Section J's pricing and cost caps, program administrators may be encouraged to use fixed speed equipment, further adding to the problem of incentivizing less effective HPs over VSHPs.

c. **<u>Higher EER2 results in larger refrigerant charge sizes due to the need to drive up the full load efficiency of a refrigerating system.</u>**

[4] U.S. DOE, Office of Energy Efficiency & Renewable Energy, 2018, Residential HVAC Installation Practices, A Review of Research Findings.

Based on our analysis of the charge sizes for models with varied EER2 and SEER2 ratings, we can observe that the charge size tends to increase with increasing EER2 levels (see Figure 3). This is expected because a bigger heat exchanger enables heat exchange with lower power consumption, because it leads to a lower pressure difference between the OD and ID units. While this drives up the EER2 ratings, it also requires more material and larger refrigerant charge sizes. Larger refrigerant charge sizes are required to accommodate the longer channel length of heat exchangers. This raises concerns because there will be limitations to the total amount of refrigerant available in the market, as a result of AIM Act allocations. Creating a policy that indirectly encourages the use of equipment with larger charge sizes is also directly in conflict with the fundamental premise of new federal regulations that phase down the use of high Global Warming Potential (GWP) refrigerants (i.e., the AIM Act). With limited refrigerant allocations, CEC should consider deployment of technologies that reduces charge sizes while still meeting the heating and cooling loads for the majority of the year.

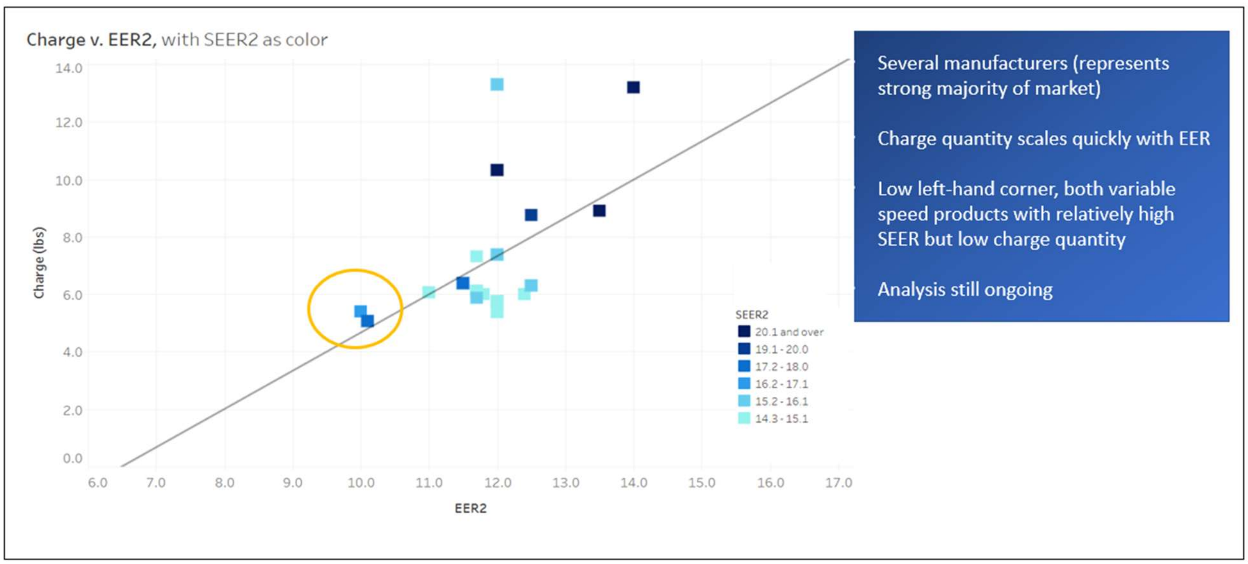


Figure 4. Charge size relationship with EER2 and SEER2 for 2-Ton Heat Pump systems

d. <u>Higher EER2 leads to larger unit size which not only requires more space for installation, but also drives up material usage and greater transport/logistics emissions.</u>

Based on Daikin's product portfolio and a comparison of sizes between its fixed speed systems and VSHP systems, there is a significant reduction in OD unit size. Variable speed systems can be almost 50% lighter and a quarter of the size while maintaining similar capacity and seasonal efficiency. Consequently, VSHP systems can use significantly less raw materials (i.e., aluminum, copper and steel), enabling greater reduction in carbon emissions over product life cycles including lower transport and logistics emissions (see Figure 4).

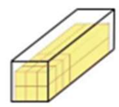
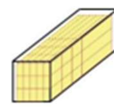
	Conventional models Fixed Speed System		New technology Inverter (Variable Capacuty) ⌊FIT⌉	
Appearance				
SEER2	17.2	≃	16.3	
EER2	12.5	>	8.7	
Weight	117 kg (257 LBS)	>>	60 kg (133 LBS)	Lightweight 1/2
Product volume	0.82m3 (29 ft3)	>>	0.23 m3 (8 ft3)	Volume 1/4
Refrigerant volume	4.4 kg (155 oz)	>	2.4 kg (85 oz)	Refrigerant saving 45%
Transportation  typical 53 ft Trailer load	 68 units		 204 units	Loading efficiency 3x

Figure 5: A Comparison Example of 3-ton Class Outdoor Unit of Fixed Speed System and Variable Speed System

III. Key assumptions for HVAC Cooling Sizing in the Field

As mentioned in Section II.a, the DOE published paper, Residential HVAC Installation Practices, 2018, findings suggest HVAC residential systems are oversized on average by 40%. The DOE research findings more accurately reflect the cooling dominated climate zone housing field stock in order to apply the design key assumptions. The NIST 2014 Study reflects heat pump systems of which a significant majority, if not all, are single-speed compressor technology. Thus, by referencing the DOE published paper where HVAC systems currently in the field are typically oversized by 40%, VSHP systems are well suited to increase peak load efficiency.

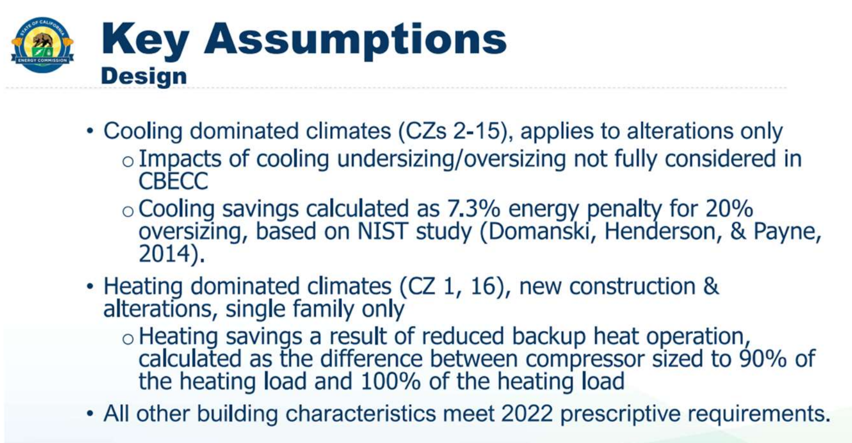


Figure 6: Design Key Assumptions in CEC's 2025 Energy Code Pre-Rulemaking Docketed Document

IV. Recommendations

Daikin urges the CEC to revise the specification requirements in the proposed 2025 Energy Code Pre-Rulemaking such that EER2 is not a metric used for sizing PV systems for VSHP's. Daikin also urges the CEC to utilize the DOE published paper data, Residential HVAC Installation Practices, 2018, for cooling dominated climate zone design key assumptions to accurately reflect the current HVAC installed residential systems in the field, which are currently oversized, on average, by 40%.

We look forward to following up with CEC's Building Standard Staff, such as Javier Perez and Muhammed Saeed, regarding these critical matters in the CEC 2025 Energy Code Pre-Rulemaking.

Sincerely,

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