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Comment Received From: Pierre Delforge
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NRDC Comments on Title 24 Compliance Workshop

Additional submitted attachment is included below.

April 26, 2022

Dear Commissioner McAllister,

The Natural Resources Defense Council (NRDC) submits the following comments on behalf of its more than 450,000 members and activists in California who are advocating for affordable and equitable decarbonization and clean air policies to help mitigate the climate crisis and advance a sustainable economy. These comments are in response to the California Energy Commission's (CEC) first workshop of the 2025 Title 24 code cycle discussing compliance tools and overall priorities for the 2025 code. NRDC appreciates the focus on compliance this early in the code development process as compliance is critical to achieving the energy savings and greenhouse gas (GHG) emissions reductions potential of the code. NRDC offers the following comments both on overall priorities for the 2025 code cycle and the specific compliance issues raised in the workshop.

NRDC has two overarching priorities for the 2025 code cycle, both driven by the urgency and imperative to decarbonize the entire building sector:

- **1) Develop a strong pro-electric code for new multifamily and nonresidential building decarbonization**. The 2022 code resulted in a strong pro-electric code for single family homes and more modest advances in multifamily and nonresidential buildings. We recommend that decarbonization requirements be expanded to most other building types in 2025. Specifically, we recommend that the CEC develop prescriptive heat pump requirements and baselines for most building types that do not already have them and expand the modeling capabilities needed to model large all-electric buildings.[1]
- **2) Increase the focus on existing building alterations and additions, including electrification requirements during renovations, equipment changeouts, and additions.** Specifically, we need expanded requirements for electrification of space and water heating during additions, equipment changeouts, and alterations through replace-on-burnout and other code trigger-based requirements[2] that would require the installation of cost-effective heat pumps, particularly in applications that are already cost-effective. For example, gas-AC rooftop units already have the required electrical service so a heat pump alternative can be a cost-effective drop-in replacement. The vast majority of buildings that will exist in California in 2050 have already been built, so the code must address electrification of these buildings, lest legacy gas infrastructure will otherwise continue to be used for decades.

We support both of these issues being listed in the CEC's list of priorities in slide 9 of the presentation and look forward to continuing to provide further input on these measures to the CEC and the CASE team throughout the code development process. Compliance is central to both of these priorities, in particular additions, alterations, and equipment changeouts, as code changes won't be effective if permits are not pulled, or the code is not enforced.

As evidenced by the workshop, while there is good compliance with certain elements of the code, compliance is almost non-existent in other areas such as HVAC changeouts. We appreciated the format

[1] See attached memo submitted to Energy Commission staff 1/24/22

[2] E.g. Project size or scope thresholds.

of the workshop, which allowed for many different perspectives on compliance gaps and solutions to be heard. Across all of these stakeholders it was clear that there are large gaps in compliance, in particular in certain sectors, that should be addressed by the CEC and other Title 24 Stakeholders. Some of the key themes we heard across the presentations in the workshop include:

- Building department staff have limited time and Title 24 is at or near the bottom of their list of importance. Building departments find it hard to stay up to date on the code given limited resources and the complexity of the code.
- The energy code is complex. The California building industry currently relies on a small group of experts to know what is in the code in detail.
- Most designers and builders are good actors – if we remove friction for compliance (whether that be in improving understanding of requirements or removing costs or other barriers) compliance will increase. We need to incentivize compliance and remove friction for compliance throughout the supply chain; the weight of compliance shouldn't just be on building departments.
- Automation is a powerful tool to help reduce friction to code compliance both in helping users comply with the code and code officials enforce the code. A good example of this was the anecdote that Erik Kolderup shared of running some of his lighting projects through the CodeCycle platform. CodeCycle caught things that were out of compliance in his design that he was unaware of, despite being an experienced practitioner. The increased use of tools like CodeCycle has the potential to outsource detailed understanding of the code to software, making it easier for practitioners to comply with the code and jurisdictions to enforce the code.
- Permitting is costly, time-consuming, and uncertain, and builders and contractors are competing on lowest cost and speed, which leads many projects to be unpermitted. Increased use of online permitting and automated processes to reduce permit review timelines would help to ease these burdens. Allowing for after-the-fact permits for emergency equipment changeouts would also help increase the number of jobs that pull a permit.
- HERS raters and builders often develop ongoing relationships that result in a perverse incentive for raters to pass homes they test. If a rater does not pass a home, they are unlikely to be rehired, so it is not an arm's length transaction. This could be solved through a rotating pool of raters or rater dispatch app that would assign a rater to a specific job.

One element that was missing from the workshop was a more nuanced discussion of how these compliance issues vary by sector. Compliance rates and barriers vary by sector as do the solutions. For example, improving compliance in commercial new construction requires different interventions than improving compliance for residential equipment changeouts. In general, we see three main categories with distinct compliance issues, which could further be broken down into residential and commercial:

- ***Equipment changeouts*** – Equipment changeouts are rarely permitted and are conducted by a wide and diffuse market. Barriers to code compliance in this market segment include the time and cost of pulling a permit and following all code requirements, as well as the knowledge of process and requirements. This market segment is important, as HVAC and water heater changeouts in particular are a major decarbonization opportunity, as these equipment are responsible for the lion share of emissions and energy costs in buildings. We recommend making this area of compliance the top priority and a focused effort. Compliance is a broad issue that is challenging to address as a whole. Prioritizing HVAC and water heater changeouts would provide an opportunity for targeted solutions that have an outsized benefit on GHG emissions and energy costs.

- ***Major renovations and additions*** - Major renovations and additions are often permitted, but not always, and are completed by a diverse range of market actors from a single unlicensed person to large, sophisticated companies that have a wide variety of knowledge of the code.
- ***New construction*** – In the new construction market, permits are being pulled for almost all projects, and actors are typically sophisticated and well-intentioned. However, even well-intentioned designers and builders have trouble keeping their teams up to speed on code changes and the AHJs enforcing code are overstretched, with energy codes on the bottom of the priority list.

We recommend that the CEC prioritize one to two key areas to take immediate action. Specifically, we recommend that the CEC focus on HVAC and water heater changeouts, consistent with the upcoming SB 1414 report and SB 1164, which is currently under development. Compliance with code requirements at the time of equipment changeout represents a key opportunity for cost-effective decarbonization.

Specifically, we recommend that the CEC develop an automated compliance system that will track statewide equipment sales and energy compliance data in a single system, starting with HVAC and water heating equipment changeouts. Housing this data within a single system would facilitate enforcement when there are discrepancies between sales and compliance submissions. This system should be user friendly and provide information to both building professionals and code officials on what requirements apply in various situations. For example, the system could flag key requirements (e.g. type of replacement system allowed, required efficiency, HERS requirement) based on the specifics of the job. This automated compliance system could also help improve compliance in unpermitted jobs amongst good actors – specifically for small projects in the residential and small commercial sectors, where other factors (review time, cost) may drive projects to be unpermitted.

More broadly, while the CEC will not be able to address every aspect of compliance, we recommend that the CEC embrace automation in general to reduce friction in the compliance process. Title 24 is complex and even sophisticated, experienced designers don't know all the code requirements in detail. Automated compliance systems can help designers, contractors, and code officials enforce compliance by flagging key requirements given the site-specific scenario. We recommend that the CEC develop a specific system as described above to address compliance for equipment changeouts and to leverage automated solutions where feasible to improve compliance in other areas of the code.

We appreciate the CEC addressing this important topic and welcome further dialogue on these issues.

Sincerely,

Pierre Delforge

MEMO

TO: CALIFORNIA ENERGY COMMISSION

FROM: PIERRE DELFORGE, NRDC
JOSE TORRES, BDC

SUBJECT: MODELING CAPABILITIES FOR NON-RESIDENTIAL AND LARGE MULTI-FAMILY HEAT PUMP SPACE HEATING EQUIPMENT

DATE: APRIL 26, 2022

As the California Energy Commission works to develop the 2022 compliance software and begins development of the 2025 Title 24 standards, we urge you to prioritize the development of further modeling capabilities in the CBECC-Com compliance software to support efficient electrification of non-residential and multifamily buildings in the 2025 building code update. The ability to appropriately model multizone, central heat pump space heating technologies that are typically used in large nonresidential and multifamily buildings is one of the biggest barriers to achieving this objective in 2025.

Current limitations: CBECC-Com is currently limited to modeling the following all-electric system types:

- **Packaged air-to-air or air-to-water heat pumps**, which are typically only relevant for smaller buildings and uncommon for central systems.
- **Electric resistance systems** (e.g. variable air volume systems with electric resistance reheat or hot water reheat served by electric boilers), which are significantly less efficient than heat pumps and are not able to beat the gas TDV baseline without complementary measures.
- **Variable refrigerant flow (VRF) and hydronic fan coil systems**.[3] VRF systems are typically installed in small and medium sized buildings and represent only one of many central heat pump system technology types typically used. Furthermore, VRF modeling is currently limited in that it does not allow for multi-speed fan control and therefore does not reflect the operational efficiency that these systems can achieve. Similarly, hydronic fan coil units, which may be paired with

[3] While VRF systems can be modeled currently, this capability is limited, as discussed in more detail below.

air-to-water heat pumps and heat recovery chillers, cannot be modeled with multi-speed fan control.

These existing capabilities leave major gaps in the modeling software for central heat pump systems, such as **air-to-water heat pumps** (also known as "heat pump boilers" although the engineering community is generally discouraging this terminology) and various types of **heat recovery chillers and heat pumps.** These other system types are commonly used in large all-electric buildings (as well as in some small and medium-sized buildings) but cannot currently be modeled in CBECC-Com. Designers of buildings installing these systems are currently forced to use workarounds in the software or the prescriptive path for compliance, which are cumbersome and restrictive, acting as a barrier to electrification. There is strong agreement within the engineering community on the urgent need to add modeling capabilities for these central heat pump systems into CBECC-com.

The full range of central heat pump system types are described in the attached table, which categorizes the range of available central heat pump and heat recovery chiller system types, including both air and water-source systems. As described in more detail in the attached table, we have categorized these equipment types as follows:[4]

#	Technology
1	Air-to-Water Heat Pumps
2	Water-to-Water Heat Pumps
3	Water-to-Water Heat Recovery Chillers – Modular/Reversible
4	Water-to-Water Heat Recovery Chillers – Primary Chillers
5	Air-to-Water Heat Recovery Chillers (both modular/reversible and primary chillers)
6	Thermal Storage

[4] These categories attempt to align with ASHRAE and Energy Solutions' categorization of products. These do not necessarily reflect the order of prioritization for incorporation into the CBECC-Com software.

Our understanding is that work has already begun to incorporate two of the categories identified in the table into the software: category 1 (air-to-water heat pumps) and category 4 (heat recovery chillers – primary chillers). **We urge the CEC to continue this work and to finalize these capabilities in time for the release of the 2022 software.** Finalizing these capabilities in time for the 2022 software release will ensure that energy modelers have multiple options for modeling central heat pump space heating systems as the code takes effect.

While incorporating these technologies is an important first step, they are limited in application: category 1 only provides space heating while category 4 provides cooling and recovered heat, but typically cannot meet a building's full heating load on its own. Together, these two technologies do not represent the full range of products typically being installed in all electric buildings. **As a second priority, we urge the CEC to work to integrate category 3 products (water-to-water heat recovery chillers – modular/reversible) into the software and to integrate the ability for these products to be used in conjunction with thermal storage.** Category 3 includes modular and/or reversible heat recovery chillers that have the capability to meet a building's heating and cooling loads simultaneously. There are a variety of products in this category – some have the capability to only control to either the heating or cooling load at a time, while others have integrated storage that allows them to control capacity to meet both loads simultaneously. Thermal storage is also a critical feature for both category 3 products as well as all of the other categories described. Thermal storage can be paired with any of the technologies described and can be a key system attribute to balance mismatched heating, cooling, and hot water loads. It is therefore critical that CBECC-Com allows central heat pump technologies to be modeled in conjunction with thermal storage, so that systems can be modeled as accurately as possible.

A secondary priority to those discussed above is to update the VRF model in CBECC-Com to better reflect the field performance of these systems. The engineering community's experience of the way CBECC-com currently models VRF systems is that the performance curves utilized are not based on standardized tests and result in major penalties in CBECC-com when used in some building types (e.g. multifamily). **Therefore, as an additional and secondary priority to those discussed above, we urge the CEC to update the VRF equipment prototype models with standardized performance test data to more accurately represent energy usage from this system type.**

In summary, we urge the CEC to incorporate the following features into CBECC-Com before the finalization of the 2022 software:

- The ability to model air-to-water heat pumps (category 1)
- The ability to model heat recovery chillers that act primarily as chillers but are also able to utilize heat recovery to meet space and domestic hot water loads (category 4)
- The ability to model multi-speed fan control capabilities for VRF and hydronic fan coil terminal units to better reflect the operational efficiencies these systems can achieve.

We also urge the CEC to begin work to incorporate the following features so that they become available during interim software updates during the 2022 cycle:

- Modular/reversible heat recovery chillers (category 3)
- The use of thermal storage with all of the technology options described here
- Update of VRF modeling to better reflect the performance of these systems across all building types by updating performance curves based on lab tested performance data

As the CEC works to develop the 2025 standards, we recommend that the CEC continue to expand CBECC-Com functionality to capture all technologies described in the table. Ultimately, the CEC will likely need to develop a more robust framework for modeling heating and cooling plants in the ACM that allows for the combination of the technologies described here, rather than continuing the current individual technology approach. This would allow systems to be built up of multiple components in the software (e.g., heat pumps, heat recovery chillers, and thermal storage) as they are in the field. Key elements of this framework would include: 1. Defining how system components are operated to meet heating and cooling set points (e.g., lead/lag equipment, preheat from heat recovery with final heat from different equipment); 2. A schedule for staging heating and cooling components; and 3. Identifying the functionality and location of storage (e.g., heat only, cooling only, buffer tank for setpoint control, both/switching).

#	Technology	Description	Modeling Status	Priority	Applicability	Example Products
1	**Air-to-Water Heat Pumps**	An air-to-water heat pump transfers heat from the surrounding air to water that is used for space heating purposes. It works similarly to a heat pump water heater, except that the water is used for space heating.	In development (Noresco)	High	Widely applicable to many common system types. May require complementary measures to work in retrofits.	• https://colmacwaterheat.com/cxa-modular-air-source/ • https://www.heat2o.com/ • https://www.daikin.eu/en_us/products/emrq-ab.html • https://www.lg.com/global/business/heating-split-high-temperature • https://www.transomcorporation.com/wp-content/uploads/2020/04/Transom-Hatch-Air-source-heat-pump-potable-water-A1910-3.pdf
2	**Water-to-Water Heat Pumps**	A water-to-water heat pump is similar to an air-to-water heat pump, except that the heat source is a water body or loop (such as a geothermal loop) rather than the surrounding air.	**Not included**	Medium	Applicable to many common system types, but more limited due to need for water-loop and	• https://www.aermec.us/products-2/water-to-water-units/wwb-booster/?hsCtaTracking=262ea359-cae9-4f54-9471-1815e6074532%7C75efe365-74fa-4fb8-b386-e92485c61692

					typically higher first costs	• https://www.nordicghp.com/product/nordic-products/liquid-source-heat-pumps/liquid-to-water/w-series-commercial/ • https://www.carrier.com/residential/en/us/products/geothermal-heat-pumps/gw/
3	**Water-to-Water Heat Recovery Chillers – Modular/Reversible**	Modular/reversible heat recovery chillers have the capacity to operate primarily as chillers, as heat pumps, or in simultaneous heating and cooling mode, where heating and cooling loads are matched. The exact characteristics depend on the specific model of HRC, but they can be modular units that are used in sequence together or single large units. Some units (e.g. Multistack) have the capability to control to either a heating or cooling set point at a given time (but not simultaneously), whereas others (Aermec) have modular storage	**Not included**	High	Applicable to many system types in both new construction and retrofit applications. Retrofit applications may require complementary measures and/or system modifications.	• Aermec models ANK, ALK, CPS, NLC, NRK, etc: https://www.aermec.us/products-2/air-to-water-units/ • https://www.multistack.com/products/heating-and-heat-recovery-chillers/ • https://climacoolcorp.com/products/modular-chiller-systems.html

		tanks that allows them to be controlled to both heating and cooling set points simultaneously.				
4	**Water-to-Water Heat Recovery Chillers – Primary Chillers**	Heat recovery chillers that operate primarily as chillers are used to serve a building's cooling load, with the heat recovery component coming secondary to this main load. Waste heat that would normally be rejected to the air or a cooling tower is recovered instead to offset heating load that occurs simultaneous to the cooling load.[5] This recovered heat can be used for space heating or domestic water heating, but is typically	In development (Energy Solutions, Appendix D proposal)	High	Applicable to many common system types, but not a full electrification solution. Typically needs to be coupled with an additional space heating.	• https://www.aermec.us/products-2/air-to-water-units/nrb-58-231-tons/ • https://www.trane.com/commercial/asia-pacific/ph/en/products-systems/equipment/chillers/water-cooled-chiller/centrifugal-liquid-cooled-chillers/earthwise-centravac/HeatRecovery.html • https://www.carrier.com/commercial/en/us/products/chillers-components/heat-recovery/

[5] Heat recovery chillers can have partial, total, or dedicated heat recovery options. Partial heat recovery involves a desuperheater which recovers the heat from the super-heated refrigerant (i.e. refrigerant heated beyond the temperature needed for it to transition to a vapor) as it transitions to a saturated vapor, but do not recover any additional heat as the refrigerant condenses. Total heat recovery means that all waste heat can be recovered (the full cooling load and the compressor input power). Dedicated heat recovery means that the waste heat is used for a dedicated use and does not have another way to be rejected.

		insufficient to meet a building's total heating load.				
5	**Air-to-Water Heat Recovery Chillers (both modular/reversible and primary chillers)**	Similar to category 1, but with a reversing valve, free air-side cooling, and/or heat recovery capabilities. These include both products that are primarily chillers and recover waste heat, as well as products that operate primarily as heating equipment and those that can modulate to meet either the heating and/or cooling load.	**Not included**	Low	Limited available products	• https://www.multistack.com/wp-content/uploads/2017/11/arp-air-source-heat-pump-product-catalog-1.pdf
6	**Thermal Storage**	Thermal storage allows for the storage of heating or cooling produced and can be used in conjunction with the equipment described here to balance non-simultaneous heating and cooling loads.	Not currently integrated for use with the systems above	Medium	Most likely to be applied in new construction or major renovations. Broadly applicable, but particularly important for	

					heat recovery chillers.	