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NRDC comments on the Draft 2019 ACM Reference Manuals and Compliance Software Tools

Additional submitted attachment is included below.

NRDC NATURAL RESOURCES DEFENSE COUNCIL

March 1, 2019

Commissioner McAllister
California Energy Commission
1516 9th St, Sacramento, CA 95814

Re: NRDC Comments on the 2019 Building Energy Standards Draft Alternative Calculation Method Reference Manuals and Compliance Software Tools

Dear Commissioner McAllister:

The Natural Resources Defense Council (NRDC) appreciates the opportunity to comment on the California Energy Commission (CEC)'s Draft Alternative Calculation Method (ACM) Reference Manuals for the 2019 Title 24 Building Energy Efficiency Standards ("the Standards") on behalf of our more than 95,000 California members who have an interest in receiving affordable energy services while reducing the environmental impact of California's energy consumption.

NRDC appreciates the commission's work to date on the Standards, which are an essential policy tool to help California implement its climate and energy goals. The 2019 Standards finalized last year took a major step forward towards achieving these goals by increasing energy efficiency requirements, leveling the playing field for all-electric single-family and low-rise multifamily homes, and becoming the first building code to require new homes to be designed to zero net electricity standards.

The ACM manuals are a critical component of the implementation of the Standards. They define the rules by which buildings are modeled under the performance path. While the performance path is primarily defined in the Standards, the details of implementation are left to the ACM and these details have a significant impact on which designs achieve compliance under the code.

Summary

In the 2019 Standards, the CEC has made significant progress toward removing standards-related hurdles to high-efficiency and low-emissions electric space and water heating. This is a major step towards buildings that have a minimal carbon footprint, not just minimal energy use.

Unfortunately, **these hurdles remain in the proposed 2019 ACM and compliance software in the non-residential sector, including mid- and high-rise residential and commercial buildings**. This is due to the 2019 ACM's alignment with the ASHRAE 90.1-2016 baseline system mapping for DHW and HVAC, which uses gas systems. The use of the time-dependent valuation (TDV) metric with this baseline makes it difficult for efficient buildings with efficient electric systems to comply with the 2019 standards. This is because the TDV metric sets the compliance bar higher for electric systems despite their lower source energy and GHG emissions. A similar situation also remains in CBECC-Res for central DHW system with recirculation.

In some cases, the disincentive for low-emissions electric systems is worse in the proposed 2019 ACM than in the 2016 version: air-to-water heat pumps for DHW can't be installed at all because they're not allowed under the prescriptive path and can't be modeled under the performance path. And the change of the HVAC baseline for multifamily buildings up to 7 stories to a single zone constant volume system with furnace would also make electric designs more challenging under the 2019 code.

This is particularly problematic for multifamily and commercial buildings, which represent a large share of California's new construction. We appreciate the harmonization benefits of aligning California's building code with ASHRAE 90.1, but harmonization should not hinder California from pursuing its climate and clean air goals. Unfortunately, using ASHRAE 90.1's gas baseline as the single baseline in California's building code is not compatible with the state's climate goals. Instead, we recommend adding an independent electric baseline for buildings that use electricity for space or water heating in the proposed design. This preserves general alignment with ASHRAE while also supporting California's emissions goals.

If unresolved, this issue will not only hinder the adoption of efficient and low-emissions electric DHW and HVAC systems in multifamily and commercial buildings built over the next three years, locking in significantly higher emissions over the life of these buildings, **it will also impact the implementation of SB 1477 in multi-family buildings and make it more difficult and costlier to achieve AB 3232's goal of reducing emissions in California's building sector by 40 percent by 2030 below 1990 levels.**

The BUILD program in SB 1477, currently being implemented by the California Public Utilities Commission (CPUC), will most likely rely on the Title 24 compliance software to calculate the GHG emissions savings of new buildings and enable builders and developers to claim the BUILD incentives. The inability to model electric heat pumps for central water loops for DHW and HVAC systems in multi-family buildings greater than 3 stories would preclude these systems from being used and therefore incentivized under BUILD. And even where electric systems can be modeled, comparing them with a gas baseline would discourage developers from using electric systems, which are a critical way to achieve low-emissions cost-effectively in new construction.

Our detailed comments illustrate on 4 building types how efficient electric systems get **a 40-percent to 100-percent higher TDV score**, making it very challenging for them to comply under the performance path, **despite reducing emissions by 30-percent to 50-percent.**

Mid-rise multi-family buildings (4 to 7 stories) represent a large share of new construction in California and are key to being able to fulfil the 30-percent minimum target for affordable housing requirement in the SB 1477's BUILD program.

We urge the commission to resolve these issues before the 2019 code goes into effect and offer the following recommendations, divided into three main sections:

1. Priorities for 2019, which we are requesting that the CEC address before the 2019 code goes into effect on January 1, 2020

2. Mid-cycle and 2022 cycle priorities, which we are raising here but expect may take longer to address than the 2019 timeline allows due to data collection or software development timelines
3. Editorial comments suggested to improve clarity of the ACM.

Detailed Comments

1. 2019 Priorities

1.1 Space Heating and Domestic Hot Water Baseline System Mapping for Multifamily and Commercial Buildings

1.1.1 Overview

We are concerned that the domestic hot water system and heating baseline system mapping proposed in the 2019 draft ACM for non-residential and mid- and high-rise residential buildings does not reduce barriers to low-emissions, all-electric domestic hot water and space heating systems, and in some cases increases them.

The baseline system mapping is a critical component of the ACM as it defines the baseline system type in the standard design building that the proposed building is compared to. If a proposed system has a higher TDV energy use than the baseline system, savings must be found elsewhere in the building for it to comply under the performance path. Since the relative TDV values for electricity are significantly higher than for the same amount of energy use from gas, if an electric system is compared to a gas baseline system, it is challenging to comply without making efficiency improvements elsewhere in the building, which adds cost and acts as a barrier to adoption for developers and builders.

This is despite the fact that electric systems can achieve significantly lower emissions and are a critical strategy to achieving the state's emissions reductions goals. This issue has been mostly fixed in the residential ACM by using a "same-energy source" baseline in the standard design as is used in the proposed system. However, it remains in the non-residential ACM and is exacerbated by the proposed changes in 2019. *As described in more detail below, we recommend that the non-residential ACM map the baseline system energy source to that of the proposed building, mirroring the approach adopted in the residential ACM.*

This issue is particularly concerning for mid- and high-rise residential domestic hot water systems, because the prescriptive path[1] no longer allows air-to-water heat pumps for central water heating systems in the 2019 code. Since these systems cannot be modeled in CBECC-COM, there is currently no path for compliance for central water heating systems. *In addition to the recommended changes to the system mapping, we recommend that the Executive Director issue an equivalency exception so that central water heating systems can comply under the prescriptive path.[2]*

[1] Section 150.1(c)8.B.i)
[2] Similar to what was done for residential heat pump water heaters under the 2016 Standards.

1.1.2 Detailed Description

Currently, the 2016 ACM uses all gas baseline systems for domestic hot water and space heating for non-residential and mid- and high-rise residential buildings, regardless of the proposed energy source. The 2019 draft ACM attempts to better align with ASHRAE 90.1-2016 Appendix G both in space type definitions and in baseline system types for HVAC systems. For non-residential buildings, the 2019 draft ACM largely[3] aligns with ASHRAE. For multifamily residential buildings over three stories, the 2019 draft ACM does not actually align with ASHRAE despite this stated objective. Instead, the 2019 draft ACM proposes a distinction between residential buildings with 7 stories and below and those above, while ASHRAE uses a single baseline system type for residential buildings regardless of number of stories; these baseline system types are also different. A table comparing the 2016 ACM, 2019 draft ACM, and ASHRAE 90.1-2016 HVAC system mapping is provided as an appendix to these comments.

Overall, the 2019 ACM draft system mapping results in baseline systems that do not encourage lower emissions outcomes, as detailed in the examples below.

1.1.3 Examples

To illustrate the issue with the baseline system mapping proposed in the 2019 draft ACM, we modeled electric heating systems compared to the standard design in four prototype buildings in climate zone 12: 4-story and 9-story multifamily buildings, a small hotel, and a medium office building.[4] We then compared the TDV energy use and projected 2030 emissions[5] of the proposed electric heating systems compared to the standard gas baseline system. While a comprehensive evaluation of this issue was not feasible within the timeline of the software release and comment deadline, this modeling illustrates the significant difference between the TDV energy ratings and emissions of different system types. These results highlight the misalignment between the TDV baseline set using a gas system and electric system types when it comes to allowing or encouraging system types that are in line with the state's climate goals.

A) <u>Mid-Rise Multifamily Prototype</u>

NRDC modeled a 4-story multifamily building using a preliminary prototype model developed by Southern California Edison. This building had the following characteristics:

Stories	4 (1 story of non-residential and 3 stories of residential)
Conditioned Floor Area	34,000 sq ft

[3] See editorial comment section for comments on remaining ambiguity on the space type definitions.
[4] Climate zone 12 was chosen for the sake of example as a climate zone that falls relatively in the middle of the range of heating and cooling loads seen in California.
[5] An emissions rate of .208 kg CO2/kWh was used for this analysis. This rate was developed following the methodology described in *Does Zero Net Energy Mean Zero Net Carbon? Reevaluating California's Time-Dependent Valuation Metric as the State Moves to a Net Zero Code*, ACEEE Summer 2016, by Meg Waltner. The best guess emissions estimate (25% peak, 75% off-peak) in this paper was updated to reflect the 60% RPS in 2030.

2019 ACM baseline heating system	Single zone AC with gas fired furnace serving guest rooms; packaged VAV with hot water reheat fed by natural gas boiler serving non-residential areas
NRDC alternative electric baseline heating system	Individual packaged terminal heat pumps (PTHPs) serving residential units; VAV with HP primary heat and electric resistance reheat serving non-residential areas

The results found that the proposed electric heating system had TDV energy use that was 160% of the baseline heating system, with emissions that were 49% lower than the baseline system. These results are shown in Figures 1 and 2.

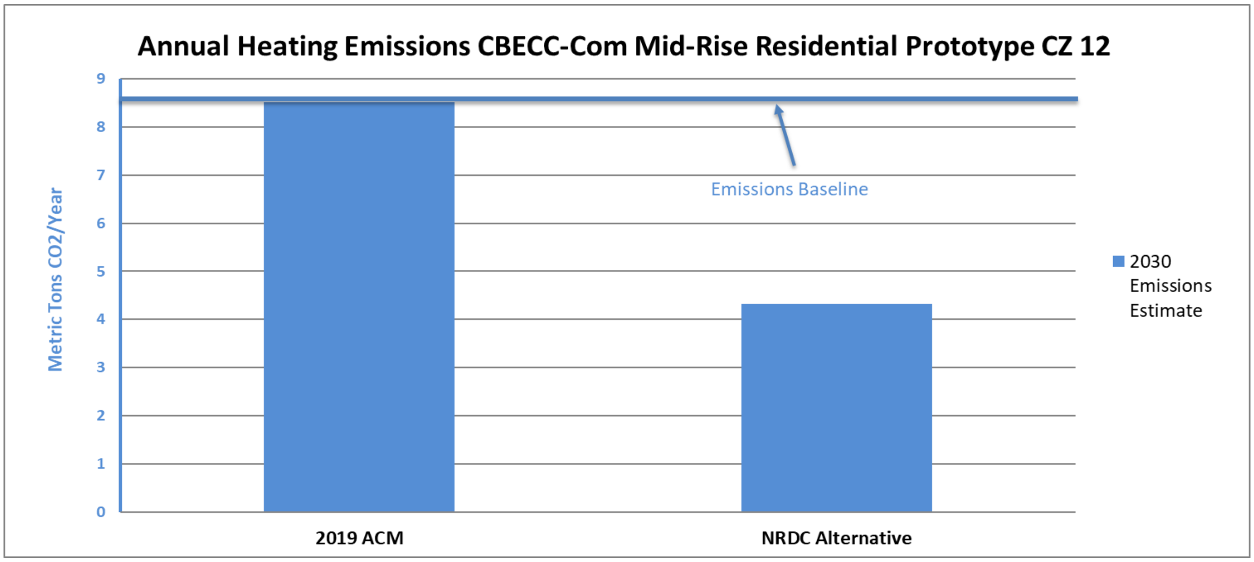

Figure 1: Space heating emissions for 2019 ACM baseline system and proposed baseline system type in a 4-story mid-rise residential prototype in Climate Zone 12.

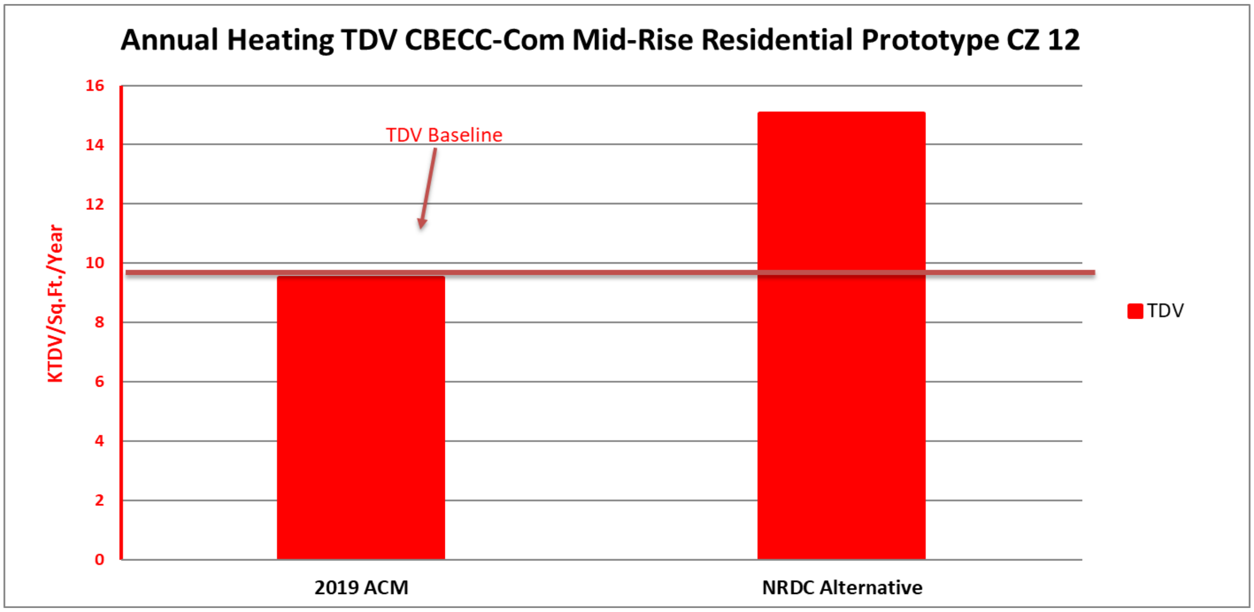

Figure 2: TDV Energy for 2019 ACM baseline system and proposed baseline system type in a 4-story mid-rise residential prototype in Climate Zone 12.

B) __High-Rise Multi-Family Prototype__

NRDC modeled a 9-story multifamily building using a preliminary prototype model developed by Southern California Edison. This building had the following characteristics:

Stories	9 (1 story parking garage, 1 story of non-residential and 7 stories of residential)
Conditioned Floor Area	68,000 sq ft
2019 ACM baseline heating system	Four pipe fan coil fed by natural gas boiler serving residential units; VAV with hot water reheat fed by natural gas boiler serving non-residential areas
NRDC alternative electric baseline heating system	Individual packaged terminal heat pumps (PTHPs) serving residential units; VAV with HP primary heat and electric resistance reheat serving non-residential areas.

The results found that the proposed electric heating system had TDV energy use that was 230% of the baseline heating system, with emissions that were 27% lower than the baseline system. These results are shown in Figures 3 and 4.

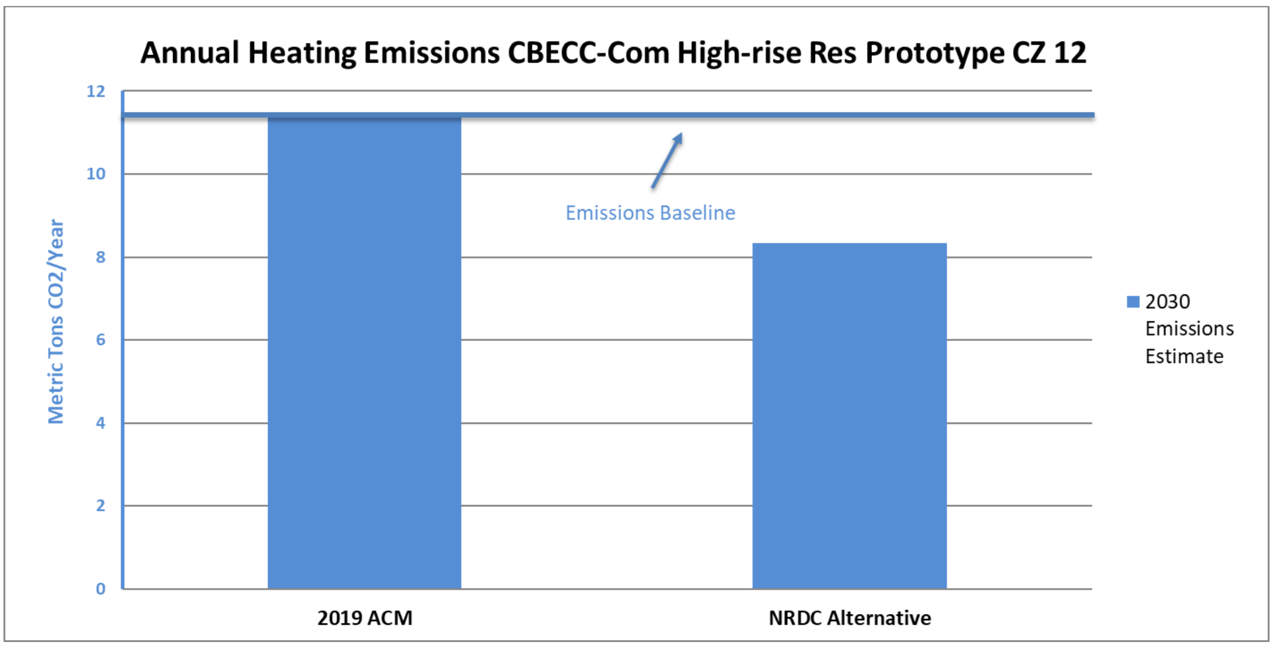

Figure 3: Space heating emissions for 2019 ACM baseline system and proposed baseline system type in a 9-story high-rise residential prototype in Climate Zone 12.

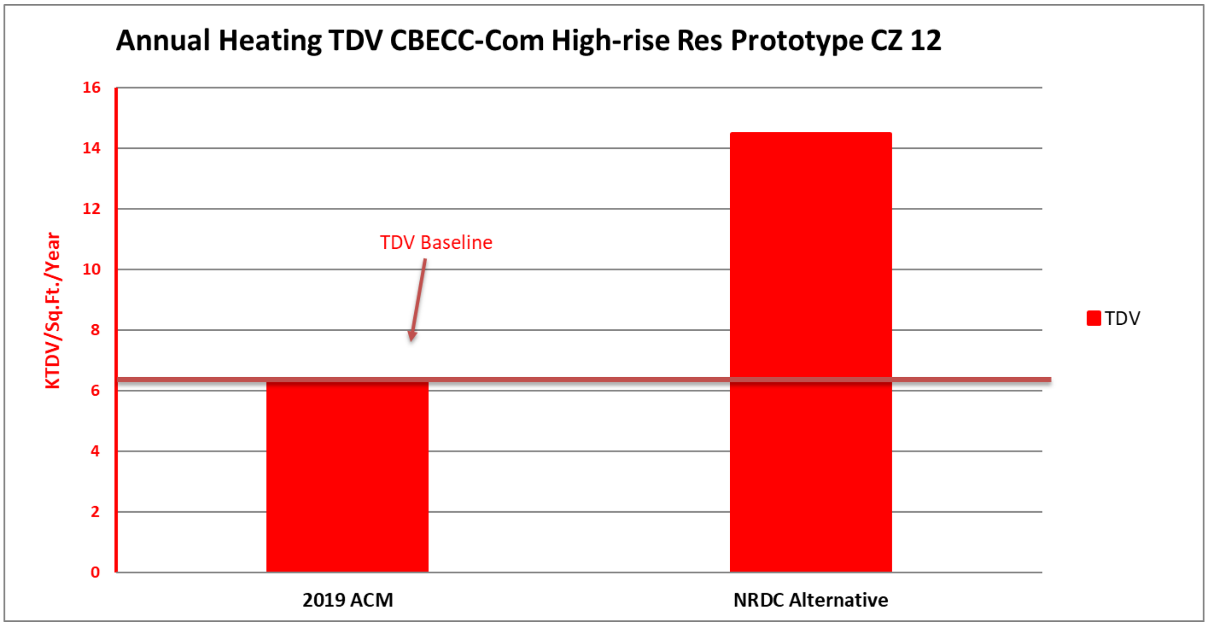

Figure 4: TDV Energy for 2019 ACM baseline system and proposed baseline system type in a 9-story high-rise residential prototype in Climate Zone 12.

C) Small Hotel Prototype

NRDC modeled the CEC's small hotel prototype. This building had the following characteristics:

Stories	4 stories, with mix of guest rooms and non-residential spaces on first floor and primarily guest rooms on floors 2 through 4
Conditioned Floor Area	42,500 sq ft
2019 ACM baseline heating system	Single zone AC with gas fired furnace serving guest rooms; packaged VAV with hot water reheat fed by natural gas boiler serving non-residential areas
NRDC alternative electric baseline heating system	Individual packaged terminal heat pumps (PTHPs) serving residential units; VAV with HP primary heat electric resistance reheat serving non-residential areas.

The results found that the proposed electric heating system had TDV energy use that was 145% of the baseline heating system, with emissions that were 53% lower than the baseline system. These results are shown in Figures 5 and 6.

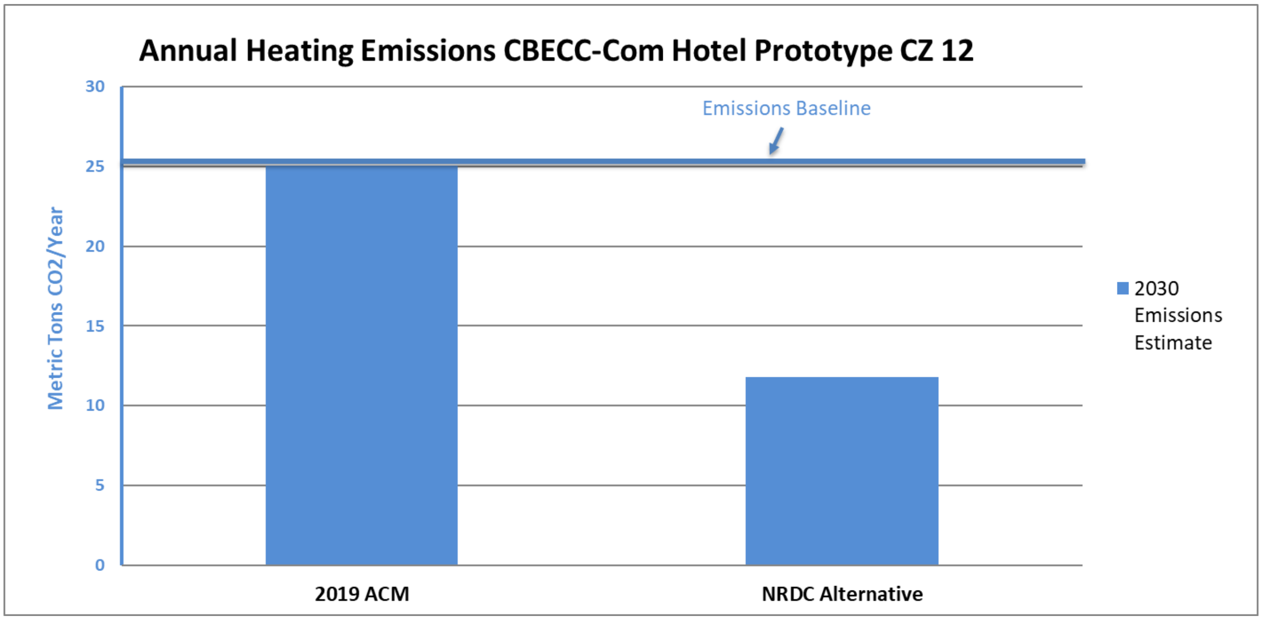

Figure 5: Space heating emissions for 2019 ACM baseline system and proposed baseline system type in small hotel prototype in Climate Zone 12.

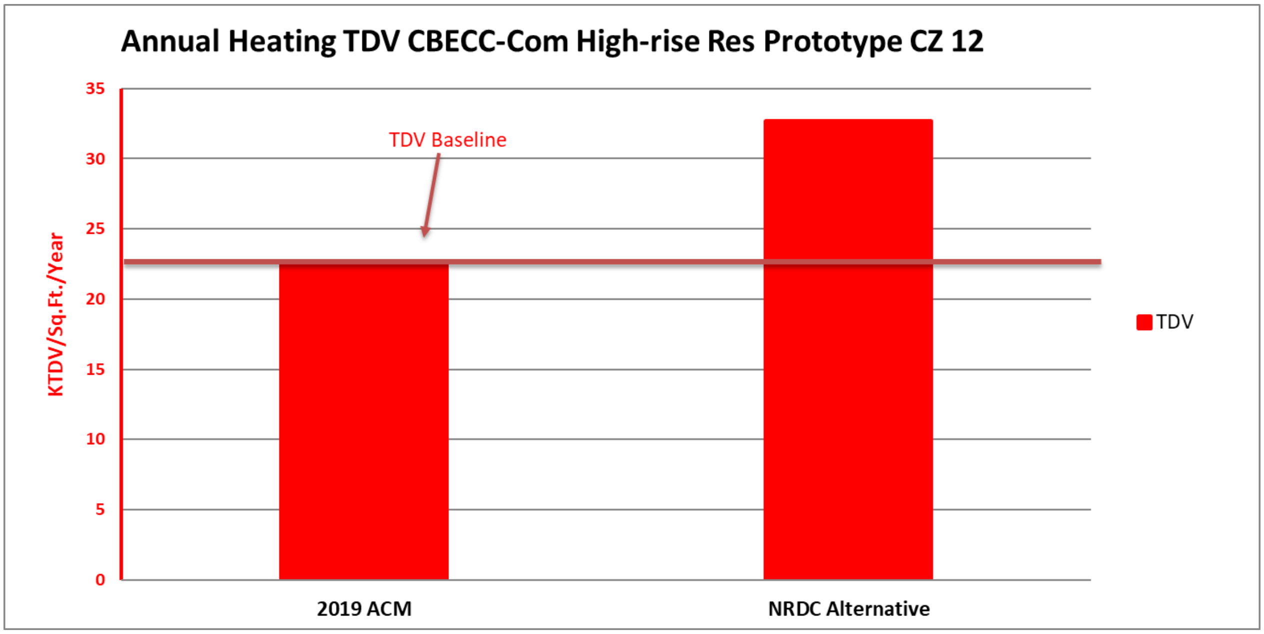

Figure 6: TDV Energy for 2019 ACM baseline system and proposed baseline system type small hotel prototype in Climate Zone 12.

D) Medium Office Building

NRDC modeled the CEC's medium commercial building prototype. This building had the following characteristics:

Stories	3
Conditioned Floor Area	53,600 sq ft
2019 ACM baseline heating system	VAV system with hot water reheat fed by natural gas boiler
NRDC alternative electric baseline heating system	VAV with HP primary heat and electric resistance reheat

The results found that the proposed electric heating system had TDV energy use that was 170% of the baseline heating system, with emissions that were 45% lower than the baseline system. These results are shown in Figures 7 and 8.

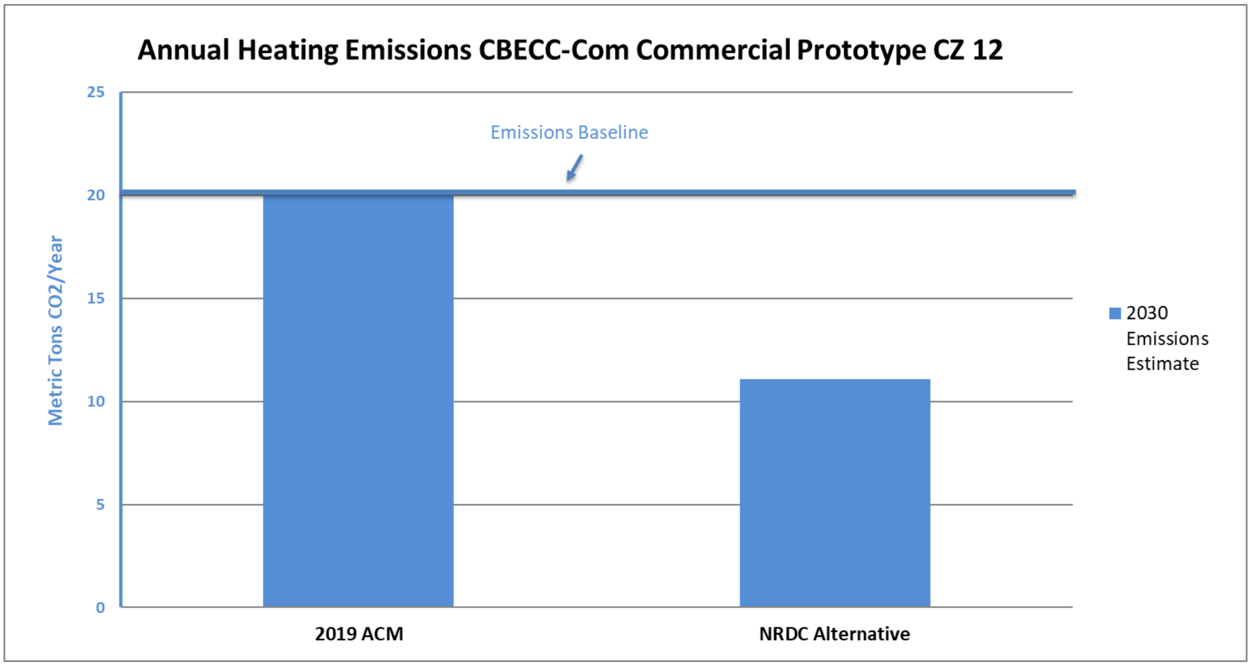

Figure 7: Space heating emissions for 2019 ACM baseline system and proposed baseline system type in the medium office prototype in Climate Zone 12.

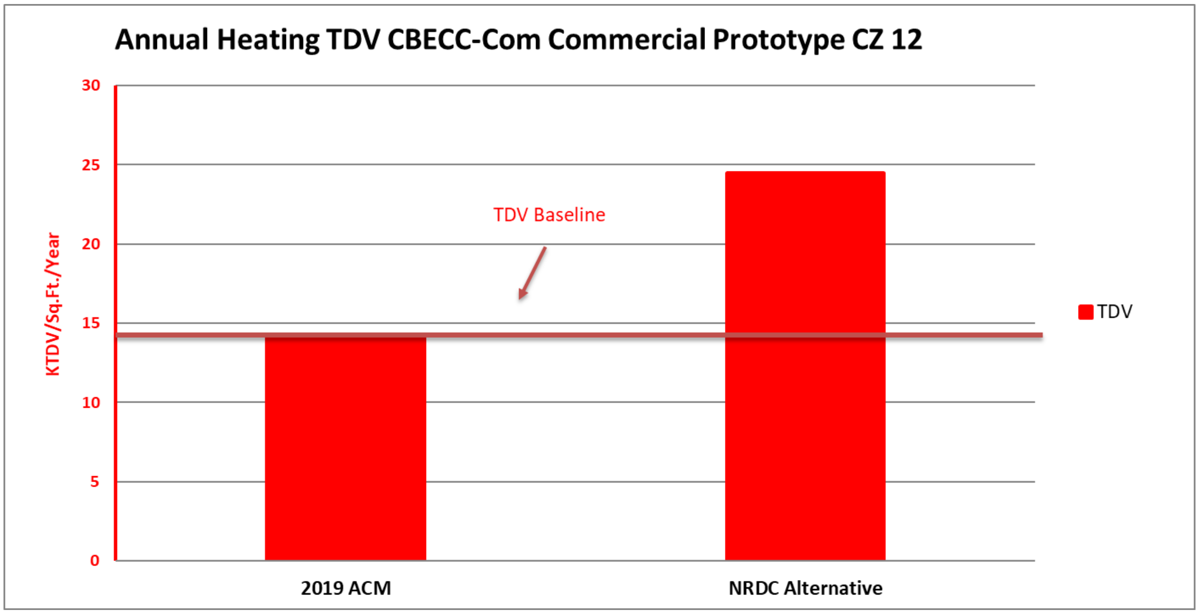

Figure 8: TDV Energy for 2019 ACM baseline system and proposed baseline system type in the medium office prototype in Climate Zone 12.

The use of the electric resistance reheat proposed system for the medium office building was chosen due to recent research conducted by the UC Berkeley Center for the Built Environment, TRC, and Taylor Engineering, indicating that losses in real-world hot-water reheat systems are significant and that VAV with electric resistance reheat may be a lower emissions and cost alternative when combined with PV.[6] The high losses in real-world reheat systems[7] are due largely to low heating loads in modern buildings which cause boilers to operate at low capacity factors, low heating airflows due to VAV control logic, and recirculation losses. While this research is still preliminary, it indicates that an appropriately modeled VAV with electric resistance system (potentially combined with PV) may be an appropriate baseline for proposed commercial buildings that use electricity as the proposed heating system.

[6] Raftery et al., *Quantifying Energy Losses in Hot Water Reheat Systems*, Energy & Buildings 170 (2018) 183-199
[7] As illustrated by Figure 9.

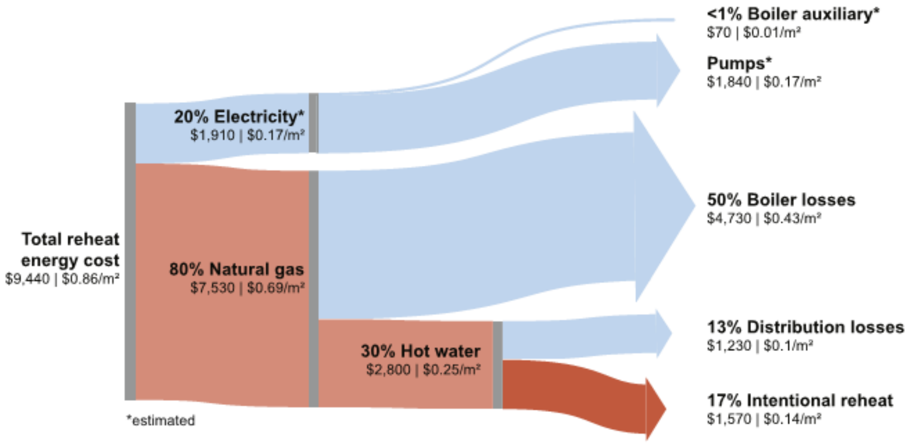

Figure 9: Total heating energy use compared to intentional reheat energy in a 120,000 sq. ft. Bay Area office building during operational hours.[8]

NRDC also considered an air-to-water heat pump serving the VAV hot water reheat loop as a potential proposed system type, but did not propose this system type as it is unable to be modeled in CBECC-Com.

NRDC also ran the medium office building prototype with an electric resistance boiler serving the reheat loop. An odd result was found for this run: the overall heating load in the building was lower for the electric resistance boiler than the electric resistance reheat at the VAV terminals. This does not make sense and indicates a potential bug in the software as losses in a hot water reheat system are inherently larger than with electric resistance reheat.

1.1.4 Recommended Solutions

Across the board, the modeling runs conducted showed that TDV energy use is higher and emissions are lower using the proposed electric heating system compared to the baseline system. To remove this barrier to low-emission electric options, NRDC recommends setting the baseline system based on the energy source used in the proposed design. Specifically, for heating systems we recommend that the baseline system types:

- Mid- and High-rise residential: Packaged terminal heat pumps
- Low-rise non-residential: Packaged single zone or rooftop heat pump
- Mid- and High-rise non-residential: VAV with electric reheat combined with rooftop PV

For domestic water heating, we recommend that CEC work to incorporate central water heating capability into the software as soon as possible and in the interim that the baseline water heating system for multifamily buildings be set using individual heat pump water heaters, for buildings where electricity is used as the proposed water heating fuel type. While we did not model water

[8] Raftery et al., *Getting Out of Hot Water: Is electrification better than VAV reheat?, UC Center for the Built Environment,* April 2018

heating energy use because a central water heating serving multiple dwelling units cannot be modeled in CBECC-COM, setting a same energy source baseline for water heating is also critical.

In summary, we recommend that the CEC make the following adjustments in the 2019 ACM related to the baseline system mapping:

- Set the baseline system type based on the energy source used in the proposed design, as shown in Appendix Table A.1.
- VAV with electric resistance combined with PV should be further evaluated as a baseline system type, based on the research and limitations in CBECC-COM described above.
- Update software to allow air-to-water heat pumps[9] to be modeled on space and domestic hot water loops.
- Provide an Executive Director equivalency exception to allow central water heating to comply via the prescriptive path for mid- and high-rise multifamily buildings, given that they cannot be modeled in the performance path.
- CBECC-Res still uses a single gas baseline for central DHW with recirculation. We recommend modifying this baseline to be a central electric water heating for electric buildings.

1.2 Electric Water Heater Self-Utilization Credits

The 2019 Standards include a significant change to the residential performance path by replacing the calculated energy budget with an *Energy Design Rating (EDR)*. The EDR is further broken down into *Energy Efficiency* (EE) and *Solar Electric Generation and Demand Flexibility (SEGDF) Design Ratings.* While generally speaking the EE rating is based on the energy efficiency attributes of the building, the 2019 Residential ACM includes a “self-utilization” credit that allows a battery storage system to count towards the EE rating, up to 90% of the difference between the 2019 and 2016 residential envelope measure improvements.

We recommend that this self-utilization credit be updated to include water heater thermal storage systems, in particular, storage heat pump water heaters with demand management controls. These systems can use the water heater’s thermal storage capability to provide demand flexibility and grid services similar to a battery and should be appropriately credited as such in order to encourage their voluntary adoption in new construction, and pave the way for a potential prescriptive requirement in the future.

This credit is justified as a Self-Utilization credit because it can be implemented in a way that is largely independent from user behavior, providing a high likelihood that the water heater will provide the self-utilization and grid benefits over the life of the system.

We provide a draft Join Appendix 13 for electric water heating demand management as Appendix A.2 of these comments. We are still seeking comments from other stakeholders on this draft and will send the commission any updates by mid-March.

[9] Including air-to-water heat pumps for both central DHW and space heating.

1.3 Updated Modeling for VRF and Mini-/Multi-Split Systems

To date, variable capacity residential HVAC systems, including VRF, mini-, and multi-split systems, have been modeled as minimum efficiency equipment in the performance path. This is despite the potential efficiency and emissions-reduction benefits of these systems. We understand that there are concerns based on the research conducted in the Stockton test homes that these systems do not consistently perform relative to their AHRI ratings.

We support the CEC's step forward in the draft 2019 ACM which provides a credit for residential variable capacity systems and a proposed modeling methodology for non-residential VRF systems. These changes provide a small incentive to install these systems while limiting the risk of unwarranted energy efficiency trade-offs in the performance path in the absence of more robust performance data and field verification procedures.

While these changes still need continued improvement moving forward to make sure they both fully capture the decarbonization potential of these systems relative to conventional combustion systems, while also reflecting the way these systems perform in the field, they are a step in the right direction for the 2019 code update. We encourage the CEC to continue to work with stakeholders, including advocacy groups, utilities, regional efficiency organizations, and manufacturers to conduct further research and use more representative test methods as necessary to ensure that variable speed HVAC systems are adequately and accurately accounted for in the performance path.

2. Mid-Cycle and 2022 Priorities

2.1 Update multi-family solar thermal hot water modeling to better value electric backup systems

As discussed above, currently central electric water heating for mid- and high-rise residential cannot be modeled in CBECC-Com under the performance path and are also not allowed under the prescriptive path. Modifying the software to allow the user to model central electric water heating and creating a prescriptive path for this equipment is a key priority for 2019.

However even with this change, multifamily buildings are still required to include a solar thermal system with a solar savings fraction of 20 to 35 percent, depending on the climate zone. This is both a prescriptive requirement and used to set the baseline in the performance path. This solar thermal requirement provides additional barriers to implementation of electric water heaters both because of how heat pumps interact with solar thermal systems in the field and how these systems are modeled in CBECC.

Solar thermal systems do not work well with heat pumps in the field due to COP degradation of the heat pumps with high inlet water temperatures. To account for this issue, we recommend that the CEC consider an alternative prescriptive approach for a heat pump water heater combined with PV instead of a solar thermal system. This prescriptive package should then be used to set the performance baseline for systems that use an electric water heater in the proposed design.

There is also an additional barrier to electric water heaters in the software that should be corrected that is due to the way solar thermal systems are modeled. Specifically, these systems are modeled currently by applying an average solar savings fraction (SSF) evenly across every hour of the year, so that every hot water draw is reduced by this fraction. This makes sense when the water heater is a gas system which is not subject to high TDV peaks but treats electric water heating systems less favorably because SSF is constant during the hours when TDV peaks are highest (summer afternoons), even though during these hours the SSF is in reality close to 100%. If this actual hourly SSF was taken into account during these hours, it would result in significantly lower TDV energy use for the electric water heating system as the highest peak hours would be served 100% by solar energy. We recommend that CEC create an hourly solar savings fraction rather than current average that is applied to every hour of the year to more accurately treat electric water heaters.

2.2 Add the ability to model air tightness for multifamily units

Reducing envelope leakage is often a cost-effective measure to reduce HVAC energy use in residential buildings. Air tightness is particularly important because, like other envelope measures, it affects peak loads and equipment sizing. Reducing air leakage has the dual benefit of saving energy and saving first costs on smaller equipment. However, this measure currently cannot be modeled in the performance path for multifamily units. We recommend that the CEC update the software to allow field-verified air tightness to receive credit under the performance path for multifamily buildings.

2.3 Evaluate and potentially revise "self-utilization" credits for low-rise residential

NRDC supports self-utilization credits for batteries and water heater thermal storage only as temporary measures to provide flexibility for builders to adjust to the new 2019 envelope efficiency requirements, and on the basis that batteries and water heater storage are emerging technologies with low penetration.

We recommend that CEC revisit these credits as part of the 2022 code update. CEC should monitor the use of these credits during the 2019 code period, collect field data on these systems to ensure that the calculated credit appropriately values the benefits of these systems, and determine if one or both systems would be more appropriately credited as a Solar Electric Generation and Demand Flexibility credits instead, as those cannot be traded-off against energy efficiency.

While we highly value energy storage and demand flexibility as key clean energy technologies, once established in the market they should complement, not trade-off with energy efficiency. Envelope energy efficiency lasts for the life of the building, is largely independent from user behavior, and is most important to install at construction time to avoid costly retrofits later.

2.4 Update hot water modeling methods to better account for temperature maintenance control strategies, recirculation heat loss, and return water temperatures

There are several areas related to hot water systems that provide potential opportunities for energy efficiency but that are not able to be captured with the current software. These are:

a) Reflect heat loss during hot water recirculation in the model (including the effects of increased pipe insulation). Heat loss from hot water recirculation significantly effects overall energy use and as described above can significantly affect energy use. The 2022 software should be update to more accurately reflect these losses.
b) Provide the ability to model advanced temperature maintenance control strategies for central domestic hot water systems (e.g. circulation pumping controls, loop configuration, etc.)
c) Modify CBECC to take into account the effect of return water temperature on COP/AFUE to discourage oversizing of equipment.

We recommend that the CEC update the software in 2022 to include these capabilities.

2.5 Credit for Inclusion of Insulating Blanket and Floor Pad for Heat Pump Water Heaters

Since heat pump water heaters utilize a storage tank (as compared to gas tankless systems) there is an additional opportunity for efficiency in these systems by adding an insulating blanket and floor pad—two very low-cost measures. We recommend that the ACM be modified to include appropriate credit for the inclusion of these items with a storage heat pump water heater. This will encourage builders and contractors to utilize them, saving more energy.

3. Editorial comments

NRDC offers the following editorial comments to improve the clarity of the ACM.

Residential ACM:

- Page 4: Clearly describe distinction between standard, proposed and reference design from the outset of the ACM.
- Page 4: Some of the information in section 2.1 Overview is verbatim repeated in Section 2.2 Building. Recommend editing for clarity.
- Page 6: Clarify that the standard PV design size is based on the electricity use of a mixed-fuel building and that this size does not vary for all-electric buildings
- Page 8: Recommend explaining the rationale for the 1.6 sizing factor in the PV size limit. This limitation is not explained anywhere in the ACM.
- Page 9: Update self-utilization credit language to clarify that the magnitude as described is a maximum and the amount of credit is based on the energy benefit of the storage system up to this maximum. This appears to be reflected in the software but the language is not clear.
- Page 13: Language in section 2.2.2 is not very clear. What is the intent of this section beyond the material covered in sections 2.4 and 2.9? Could it be deleted?
- Page 27: Clarify that the installed heat pump capacity needs to meet auto selected capacity, if auto-selection is used.

Non-residential ACM:

- Non-residential system mapping: there is still some ambiguity compared to the ASHRAE space type definitions. Recommend clarifying the exact limitations on the non-residential space types in terms of square footage and number of story limitations.
- There appears to be a maximum effective SSF for solar thermal systems of 60% implemented in the software, but not described in the ACM. If there is an intended limitation on SSF, it should be described and explained in the ACM.

We appreciate the opportunity to provide this input and thank CEC for its careful consideration of our comments.

Respectfully submitted,

Pierre Delforge
Senior Scientist
Natural Resources Defense Council

<u>Appendix A.1</u>: Comparison of non-residential and mid- and high-rise residential baseline system types in the 2016 ACM, ASHRAE 90.1-2016 Appendix G, 2019 draft ACM, and NRDC's recommended baseline system type for buildings using electric heating in the proposed design

Space Type	**2016 ACM Baseline System Type**	**2016 ACM Baseline System Description**	**2016 ASHRAE 90.1 Appendix G Baseline[10]**	**2016 ASHRAE 90.1 Appendix G Description**	**2019 ACM Baseline System Type**	***NRDC Recommended Electric Building System Baseline***
Residential or hotel/motel 3 or fewer floors	System 1 - PTAC[11]	Ductless single-zone DX unit with hot water natural gas boiler	System 1- PTAC	Packaged terminal AC with hot-water fossil fuel boiler	Single zone constant volume AC with furnace for buildings up to 7-stories	PTHP[12]
Residential or Hotel/motel 4 or more floors	System 2 - FPFC[13]	Central plant with terminal units with hot water and chilled water coils, with separate ventilation source	System 1- PTAC	Packaged terminal AC with hot-water fossil fuel boiler	FPFC for buildings 8 stories and taller	PTHP
Nonresidential <10,000 SF, 1 floor	System 3 - PSV[14]	Single-zone constant volume DX unit with gas heating	System 3- PSZ-AC	Packaged rooftop AC with fossil fuel furnace	Single zone VAV up to 25,000 SF and <3 stories	Packaged single zone HP
Nonresidential <10,000 SF, 2+ floors	System 5 - PVAV[15]	VAV reheat system; packaged variable volume DX unit with gas heating and with hot water reheat terminal units	System 3- PSZ-AC (<25,000 SF, <4 stories)	Packaged rooftop AC with fossil fuel furnace	Packaged single zone VAV up to 25,000 SF; Packaged VAV 4 or 5 stories; Built up VAV >5 stories	Packaged rooftop HP
Nonresidential 10,000-150,0000 SF	System 5 - PVAV	VAV reheat system; packaged variable volume DX unit with gas heating and with hot water reheat terminal units	System 5- PVAV w/reheat (<25,000 SF and 4-5 stories OR 25-150,000 SF and <6 Stories)	Packaged rooftop VAV with DX and reheat, hot-water fossil fuel boiler	25,000-150,000 SF, Built up VAV with chilled water and hot-water fossil boiler	VAV with air-source HP heating and reheat or electric resistance reheat with PV

[10] For climate zones relevant to California.
[11] PTAC = Packaged terminal air conditioner
[12] PTHP = Packager terminal heat pump
[13] FPFC = Four pipe fan coil
[14] PSV = Packaged single zone
[15] PVAV = Packaged variable air volume

Space Type	2016 ACM Baseline System Type	2016 ACM Baseline System Description	2016 ASHRAE 90.1 Appendix G Baseline[10]	2016 ASHRAE 90.1 Appendix G Description	2019 ACM Baseline System Type	***NRDC Recommended Electric Building System Baseline***
Nonresidential >150K SF, 1 Floor	System 7 – SZVAV	Single-zone variable volume DX unit with variable-speed drive and gas heating	System 7 - VAV with Reheat (>5 stories or >150,00 SF)	Packaged rooftop VAV with chilled water and reheat, hot-water fossil fuel boiler	Built up VAV with chilled water and hot-water fossil boiler	VAV with air-source HP heating and reheat or electric resistance reheat with PV
Nonresidential >150K SF, 2+ Floors	System 6 – VAVS	Variable volume system with chilled water and hot water coils, water-cooled chiller, tower and central boiler	System 7 - VAV with Reheat (>5 stories or >150,00 SF)	Packaged rooftop VAV with chilled water and reheat, hot-water fossil fuel boiler	Built up VAV with chilled water and hot-water fossil boiler	VAV with air-source HP heating and reheat or electric resistance reheat with PV

Appendix A.2

Draft Joint Appendix JA13

Appendix JA13 – Qualification Requirements for Electric Water Heater Demand Management System

JA13.1 Purpose and Scope

Joint Appendix JA13 provides the qualification requirements for electric water heating demand management system to meet the requirements for electric water heating demand management compliance credit(s) available in the performance standards set forth in Title 24, Part 6, Sections 150.X(x). The primary function of the electric water heating demand management system is to serve domestic hot water user needs while providing daily load shifting for the purpose of customer bill reductions, maximized solar self-utilization, and grid harmonization.

JA13.2 Qualification Requirements

To qualify as an electric water heating demand management system for use for compliance with applicable performance compliance credits, the electric water heating demand management system shall be certified to the Energy Commission to meet the following requirements:

JA13.2.1 Safety Requirements

The electric water heating demand management system shall be tested in accordance to all federal, state, and local safety codes for electric water heaters.

If the electric water heating demand management system is installed with a set point higher than 125 F, then a thermostatic mixing valve that complies with all federal, state and local safety codes, and that closes in a position that only allows cold water to flow on failure must be installed. The thermostatic mixing valve may be built into the water heater or installed separately.

JA13.2.2 Minimum Performance Requirements

The installed electric water heating demand management system should meet or exceed the following performance specification:

a) Thermal storage: comply with the 2018 Uniform Plumbing Code (UPC) first hour rating requirements for storage water heaters (UPC, Chapter 5, Table 501.1).

b) Efficiency: for heat pump water heaters, meet the requirements of the Northwest Energy Efficiency Alliance (NEEA) Advanced Water Heater Specification Tier 3 or higher.

JA13.2.3 Control Requirements

The requirements below are applicable to all control strategies.

a) The electric water heating demand management system shall have the capability of being remotely programmed to change the control strategy.

b) The electric water heating demand management system shall have the capability of storing at a minimum 5 time-of-use schedules locally, each supporting at a minimum four separate seasonal schedules. The electric water heating demand management system shall support both local and remote setup, selection, and update of time-of-use schedules. Local setup, selection, and update shall be possible through a user-friendly and intuitive user interface.

c) The electric water heating demand management system settings, including operating mode, time-of-use schedules, and internal clock, shall be resilient to loss of power.

d) The electric water heating demand management system shall be setup to operate in one of the control strategies listed in JA13.2.3.1 and JA13.2.3.2.

e) The electric water heating demand management system shall provide the means for the user to easily override the demand management function. The override shall be temporary and have a maximum duration of 72 hours.

f) The electric water heating demand management system shall provide a visualization tool that indicates the control strategy that is currently active and the selected time-of-use schedule.

g) The electric water heating demand management system shall perform a system check on the following dates, to ensure the system is operating in one of the control strategies listed in JA13.2.3.1 and JA13.2.3.2:

    1) Within 10 calendar days before the onset of summer TOU schedule, and

    2) Within 10 calendar days before the onset of winter TOU schedule.

h) The electric water heating demand management system shall not increase customer cost due to providing load response such as by significantly increasing usage of electric resistance elements in preference to heat pump operation.

At the time of inspection, the electric water heating demand management system shall be installed to meet one of the following control strategies. The electric water heating demand management system also shall have the capability to remotely switch to the other control strategies.

JA13.2.3.1 Time-of-Use (TOU) Control

To qualify for the TOU Control, the electric water heating demand management system shall be installed in the default operation mode to serve domestic hot water user needs while optimizing water heater operation to reduce user bills under the selected time-of-use schedule. The electric water heating demand management system shall load up (charge) during the lowest priced TOU hours of the day and shed (minimize charging while serving user needs) during the highest priced TOU hours.

JA13.2.3.2 Advanced Demand Response Control

To qualify for the Advanced Demand Response Control, the electric water heating demand management system shall meet the demand responsive control requirements specified in Section 110.12(a). Additionally, the electric water heating demand management system shall change the load-up and shed periods in response to dispatch or price signals from the local utility or a third-party aggregator. If remote communication is lost for more than 12 hours while the water heater is under Advanced Demand Response Control, the water heater shall revert to TOU Control until remote communication is reestablished, and then revert back to Advanced Demand Response Control.

JA13.2.3.3 Alternative Control Approved by the Executive Director

The Executive Director may approve alternative control strategies that demonstrate equal or greater benefits to one of the JA13 control strategies. To qualify for Alternative Control, the electric water heating demand management system shall be operated in a manner that increases self-utilization of the PV array output, responds to utility rates, responds to demand response signals, and/or other strategies that achieve equal or greater benefits. This alternative control option shall be accompanied with clear and easy to implement algorithms for incorporation into the compliance software for compliance credit calculations.

JA13.3 Enforcement Agency

The local enforcement agency shall verify that all Certificate of Installations are valid. The electric water heating demand management systems shall be verified as a model certified to the Energy Commission as qualified for credit as an electric water heating demand management system. In addition, the enforcement agency shall verify that the electric water heating demand management system is programmed and operational with one of the controls listed in JA13.2.3.1, JA13.2.3.2, or JA13.2.3.3. The programmed control strategy at system final inspection and commissioning shall be the strategy that was used in the Certificate of Compliance.