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Docket Number:	17-BSTD-01
Project Title:	2019 Building Energy Efficiency Standards PreRulemaking
TN #:	217458
Document Title:	NRDC Comments on CECâ€™s Staff Workshop on the 2019 Zero Net Energy Residential Standards
Description:	N/A
Filer:	System
Organization:	Alexander Hillbrand - NRDC
Submitter Role:	Public
Submission Date:	5/5/2017 2:37:34 PM
Docketed Date:	5/5/2017

Comment Received From: Alexander Hillbrand - NRDC
Submitted On: 5/5/2017
Docket Number: 17-BSTD-01

NRDC Comments on CECâ€™s Staff Workshop on the 2019 Zero Net Energy Residential Standards

Additional submitted attachment is included below.

NRDC Comments on CEC's Staff Workshop on the

2019 Zero Net Energy Residential Standards

May 5, 2017

The Natural Resources Defense Council (NRDC) appreciates the opportunity to comment on the California Energy Commission (CEC)'s Staff Workshop on 2019 Zero Net Energy (ZNE) Residential Standards on April 20, 2017. The 2019 update to the California building energy code will be instrumental in achieving California's climate and energy goals, for example SB 350's goal to double California's energy savings from energy efficiency by 2030 and SB 32's aim to reduce the State's greenhouse gas emissions by 40% in 2030.

The 2019 Standards usher in the next decade of residential construction and will enter force in 2020, by which time CEC and the California Public Utilities Commission (CPUC) aim to reach ZNE. While the proposed Standards revisions don't reach ZNE alone – the updated Standards get us 50-60% of the way from 2016's code to that goal – they provide a framework through which the State's additional policies and programs can approach ZNE. NRDC applauds CEC for its efforts leading up to the pre-rulemaking. Above all, we encourage CEC to:

1. Adopt the four building envelope energy efficiency measures, as proposed;
2. Adopt the Energy Design Rating (EDR) metric and maintain separate EDR requirements for energy efficiency and on-site solar generation, thereby ending the solar compliance credit that was established in 2016 as a one-time credit; and
3. Make further progress towards reducing building-related greenhouse gas (GHG) emissions associated with on-site fuel combustion for water and space heating.

NRDC offers the following comments in two main parts: 1) general comments on the proposed updated Standards, and 2) comments on the Standards' progress towards enabling thermal load decarbonization as a key strategy to help achieve the State's climate goals.

Part I. General Comments

I. NRDC supports the shift to an EDR metric.

NRDC supports CEC's shift to measuring Standards compliance by scoring home designs on an EDR scale. The EDR system gives homes an energy efficiency score on a 100-point scale, based on the performance of exterior walls, floors, ceilings, roofs, attics, foundations, windows, doors, ductwork, heating, ventilation, and air conditioning (HVAC), water heating, and more. The home EDR will be calculated either by a) compliance with the prescriptive standards, or b) CBECC-Res in the performance pathway, and aligns with the Residential Energy Services Network (RESNET)'s Home Energy Rating System (HERS). New homes must meet the target EDR for their climate zone.

As indicated by CEC during the Workshop, EDR offers several advantages. First, the home EDR score shows how close the home is to ZNE on a linear scale from 100, representative of the average new construction home, to 0, or 100% ZNE. EDR also offers compliance flexibility by offering multiple pathways to reach the target score, can be set at different target levels for different climate zones, is compatible with reach codes that set more stringent targets, works with various building sizes, and can be used with credits to incent new technologies, such as grid harmonization strategies.

NRDC notes that, **despite EDR's benefits, it continues to be based on California's time dependent valuation (TDV)**, a consumer energy cost metric used to capture the hourly grid energy cost. As such, it does not capture the energy and climate benefits of energy efficient all-electric homes and of the decarbonization of thermal loads, in particular water heating. NRDC intends to work with CEC to evolve TDV towards more accurately capturing the societal cost of carbon emissions. These topics will be discussed in more detail in further sections of these comments.

NRDC strongly supports CEC's proposal to include two separate EDR scores – one for energy efficiency measures alone and one to capture the benefits of photovoltaic (PV) solar, which we will discuss in the next section.

II. NRDC supports an energy efficiency-only EDR and the end of the PV credit.

NRDC supports energy efficiency, particularly of the building envelope, as the primary means to achieve energy savings in buildings. As such, we strongly agree with CEC's approach to include a target EDR that may only be achieved through energy efficiency measures. Such an approach will end the one-time PV credit available in the 2016 Standards, which NRDC points out was never intended to continue to the 2019 code and which we strongly agree should end.

The PV credit in 2016 intended to provide flexibility to builders as they began to install high performance walls and attics (HPWs and HPAs). As CEC notes, innovation and progress in the deployment of HPWs and HPAs clearly indicates that the PV credit is no longer needed. Many builders have begun installing these features widely, but some others have continued to comply via the PV credit. NRDC believes this pattern suggests that **the PV credit can and must end** for these important envelope measures to be widely deployed.

NRDC believes the 2019 code should require the most stringent, cost effective energy efficiency measures available, including the proposals to strengthen requirements for HPWs, HPAs, and windows, and to prescriptively require quality insulation installation (QII). Energy efficiency measures last a long time and are much easier to include in a home during initial construction. Retrofitting homes after they are built with better-insulated walls, for example, is much costlier than installing HPWs from the outset.

In addition, energy efficiency measures provide savings day and night, not simply during times the sun is shining and the PV array is generating energy. California utilities are facing a growing challenge of grid load ramping up quickly as home and grid-scale PV productivity drops in the evening, often meeting this fast-changing load with inefficient, more carbon intensive natural gas peaking plants. In line with California's carbon emissions reduction goals, homes should be designed to be as efficient as possible to minimize this effect.

Separating the energy efficiency EDR from the PV EDR is a good way to ensure homes are maximally energy efficient while still capturing the benefit of PV in pursuit of ZNE. NRDC supports CEC's approach of allowing extra energy efficiency EDR points to offset the PV EDR requirement but not the other way around, consistent with the rational we have explicated.

III. NRDC supports a mandatory PV EDR.

NRDC supports CEC's proposal to require on-site PV through a mandatory PV EDR component score. On- or near-site generation is clearly featured in the definition of ZNE: to reduce net energy use to zero, renewable energy production must occur to offset it.

NRDC understands that CEC has proposed sizing PV to offset 100% of the annual electricity use in homes, which is cost effective in all climate zones without an investment tax credit (ITC) and under conservative assumptions about future net-energy metering (NEM) rules. NRDC supports CEC's proposal to adjust this sizing requirement for all-electric homes, instead requiring PV sized just to offset electricity use of an average mixed-fuel home (e.g. homes with gas-fired space heating, water heating, cooking and appliances).

NRDC notes that, contrary to the intent of the Standard's PV sizing requirement, the definition of ZNE includes more than just zero net electricity. CEC has not addressed offsetting non-electric energy use such as natural gas use in this code. As such, NRDC again highlights the importance of maximizing energy efficiency measures to offset all possible non-electric fuel use (in addition to the grid benefits of energy efficiency mentioned earlier). NRDC understands CEC's concerns about grid harmonization, however, and, to avoid exacerbating the duck curve, PV sizing should focus on offsetting electricity consumption for this code revision.

CEC should be judicious in defining exceptions to the mandatory PV EDR. While in some cases on-site PV is truly not feasible, NRDC is concerned that a widely-used exception could erode the benefits of mandatory PV in the code. We encourage CEC to circulate a draft definition for sites note suitable for PV for stakeholder feedback to ensure it is not deficient in some way or subject to abuse.

When on-site PV is not possible at all, or cannot be sized to meet 100% of the remaining electricity consumption, **NRDC suggests CEC require a more stringent target EDR that can be met by several cost-effective combinations of better envelope and/or HVAC measures.** This approach would replace the PV EDR requirement, or some portion thereof, with an equal energy efficiency EDR contribution, without aggravating preemption. This requirement would provide a pathway for homes unsuitable for PV to approach the same level of ZNE performance as the average compliant home with PV.

As an additional option, CEC should explore alternate code compliance pathways with provisions for community PV generation, provided they are cost effective.

IV. NRDC strongly supports strengthening requirements for HPAs, HPWs, windows, and including QII as a prescriptive requirement.

NRDC strongly supports CEC's proposal to tighten requirements for HPAs and HPWs in severe climate zones to the most cost effective levels. CEC's current proposal improves HPAs by 46% and HPWs by 11-19% in those climate zones, and modestly enhances the requirements on window U-value and solar heat gain coefficient.

NRDC also strongly supports including QII as a prescriptive requirement. As demonstrated in the Case Reports, QII is critical to achieving in-the-field insulation performance commensurate with code requirements. Including it as a prescriptive requirement will allow flexibility to builders pursuing performance path compliance while adding the benefits of QII to the reference building energy budget.

NRDC also urges CEC to consider strengthening requirements on air tightness of homes. Air leaks contribute significantly to heating and cooling loads on HVAC equipment, leading to additional, unnecessary energy consumption. Passive houses demonstrate that very tight envelopes (0.6 air changes per hour, ACH50) with balanced heat-recovery ventilation can achieve excellent indoor air quality (IAQ) at very low energy levels. This shows that there is a clear pathway for improvement in the Standards, in which the air tightness requirement is only 5 ACH50 and is not verified.

Several steps could be taken to reduce energy use in this area: first, **the Standards could offer credit to those homes on which a blower door test is performed**. Currently, the limit on air tightness is not directly measured, although QII does include a provision to inspect air sealing. Second, CEC could provide **credit for increasing air tightness**, which would be easily achievable until requirements approach the levels required by passive house standards (about 2 ACH50).

Part II. Comments on Removing the Barriers to Electric Heat Pump Space and Water Heating in the Building Standards

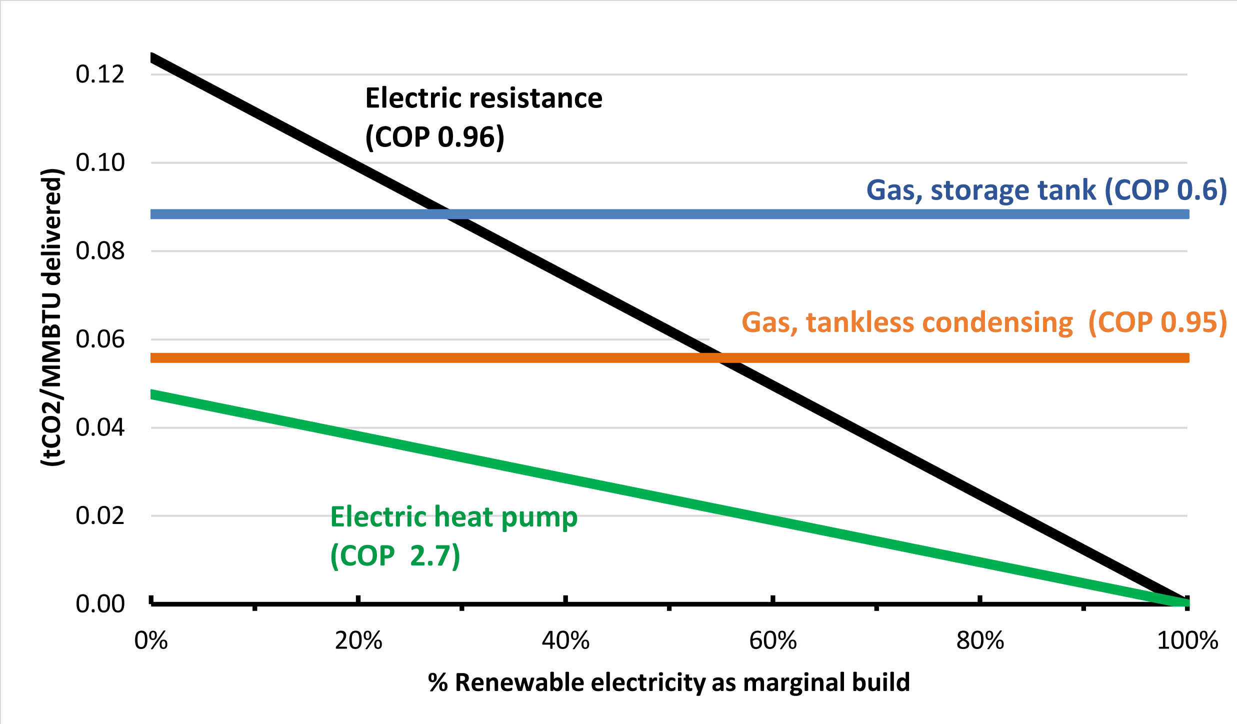
We commend CEC for its efforts to develop a fuel-neutral building energy code that does not put electric water and space heating at a disadvantage. Despite the recent progress, we strongly encourage CEC to continue leveling the playing field between gas and electric heating solutions and unlock electrification as a critical tool to help California achieve its climate and energy goals.

Historically, natural gas offered a cleaner way to heat space and water in California homes, because electric heating was based on electric resistance technology and was powered by electricity generated almost entirely from fossil power plants. In these conditions, natural gas burnt on-site in furnaces and gas-fired water heaters is less polluting than electricity. However, with the advent of high-efficiency heat pump technology and California clean electricity policies, e.g. its 50% renewable portfolio standard (RPS) by 2030, home owners now have a high-efficiency electric heating option that significantly reduces source energy use and GHG emissions compared to natural gas-fired alternatives.

As previously discussed, while the Standards aim to save energy, it is important to keep in mind that climate is one of California's overarching policy priorities. To that end, it is important to provide equal opportunities for gas and electric water and space heating solutions. These end uses are responsible for roughly half of the GHG emissions from buildings in California.[1]

[1] Jones C., Kammen D., "Bay Area Consumption-Based Greenhouse Gas Emissions Inventory", Jan. 2016

GHG Emissions of Water Heating[2]



NRDC supports both electrification of space and water heating and the decarbonization of natural gas (such as biogas and synthetic gas) to cut emissions from energy use in buildings. Both pathways should be developed and allowed to compete without advantage to achieve the state's objective of 80 percent building decarbonization by 2050.

While the CEC has made significant progress over the past few years in reducing the bias toward gas in the code, there remain significant barriers to electric space and water heating that should be removed to ensure the State can take advantage of high-efficiency electric heat pump technology to achieve its goals.

Water heating is the easiest thermal end use to electrify because technology is ready, affordable, and lacks barriers to customer acceptance. We appreciate and strongly support CEC's statements at the workshop that it intends to remove some of these barriers, particularly finding a solution to the heat pump water heating penalty, valuing the grid harmonization benefits of HPWH, streamlining the update process for NEEA-certified HPWH models in the compliance software, and including a societal cost of carbon in CALGreen 2019. We look forward to engaging with

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[2] NRDC analysis based on the following sources and assumptions: 47% efficient combined cycle power plant (CEC Draft Staff Report: ESTIMATED COST OF NEW RENEWABLE AND FOSSIL GENERATION IN CALIFORNIA (May 2014)), 4.7% T&D losses for electricity (EIA 2015 for California), 1.05 source-to-site ratio for natural gas (ENERGY STAR Portfolio Manager).

CEC to ensure that the proposed solutions achieve CEC's stated objective of being fuel neutral, which should mean making it no more difficult to meet code with a HPWH than with a gas water heater of the same source energy efficiency, everything else being equal.

The following barriers prevent the Standards from being fuel-neutral and urge CEC to work towards removing them:

I. Barrier #1: There is no electric water heating baseline and the performance path favors gas.

There is no prescriptive baseline in the 2016 code for electric water heating. Electric water heaters can only comply through the performance path, where they get compared with a gas tankless water heater using an electric-to-gas equivalency based purely on 30-year average consumer rate projections (as reflected by TDV). This equivalency strongly favors gas because gas prices are currently at a historical low and TDV does not account for the societal cost of carbon other than that is reflected in rates, and does not account for the uncertainty of fossil fuel prices and the possibility that they could go up much more than currently forecasted over the next 30 years.

Under the current TDV values, replacing a gas tankless water heater by one of the highest efficiency hybrid heat pump water heater available on the market (EF 3.5) causes the prescriptive prototype building to no longer comply, despite cutting water heating GHG emissions in roughly half (with 50% RPS).

For the code to be fuel-neutral, either an electric water heating baseline needs to be included in the code, or the metric used in the performance path needs to better reflect other state priorities such as GHG reductions than TDV currently does.

One of the challenges with setting an all-electric baseline is that federal appliance standards set the minimum efficiency for electric water heaters of more than 55-gallon capacity to an energy factor (EF) of 2.0. Most the market is now at EF 3.0 or greater. Setting the prescriptive baseline at EF 2.0 would provide a significant energy efficiency trade-off. **While some level of trade-off is justified to provide a glide path for HPWH**, just like incentives were provided to gas tankless water heaters for many years and enabled gas tankless to become the prescriptive baseline, **the level of incentive can be controlled by adding water heating efficiency requirements to the electric baseline, such as a larger tank, an insulation blanket etc.** These additional requirements would be traded-off under the performance path and would limit the efficiency trade-off while allowing builders to comply with a HPWH using the same level of envelope efficiency as in the prescriptive prototype building.

Alternatively, **a societal cost of carbon could be added to TDV**, to account for the higher GHG impacts of gas appliances relative to electric heat pump appliances powered by clean electricity. An appropriate level of societal cost of carbon around $250/ton, in line with CPUC's Energy

Division staff proposal, would level the playing field for HPWH under the performance path with a gas tankless baseline.

This is an important issue on which stakeholders should have the opportunity to discuss CEC's proposed approach. We encourage CEC to include this, and other barriers to electrification, in an upcoming 2019 code pre-rulemaking workshop.

II. Barrier #2: All-electric rates are not reflected in TDV.

Investor-owned utility (IOU) customers who have electric space heating benefit from higher baselines in tiered electricity rates. However, buildings with electric space heating are assessed with the same electric TDV values as those with gas heating. TDV is therefore not reflective of the average rate for homes that have electric space heating. Thus, all-electric homes are at a disadvantage because their electric water heater gets compared to a gas tankless water heater using TDV values that are not representative of electric rates for the building.

Short of developing a specific set of TDV values for all-electric buildings, a solution could be to **provide a TDV credit for all-electric buildings** to better reflect actual rates for these buildings.

III. Barrier #3: Grid benefits are not valued (load flexibility/ DR).

HPWH can provide grid benefits in the form of thermal energy storage. They can shift load from peak to off-peak hours, helping absorb mid-day solar generation (the belly of the duck curve) and reduce exports of excess solar electricity from the building to the grid.

The compliance software does not currently value this benefit. We are encouraged by CEC's indication at the workshop that CEC is considering providing such an incentive, and encourage CEC to ensure that the incentive is meaningful enough to make a difference. We are concerned that valuing this capability only in terms of grid energy costs, as represented by TDV, would not capture the value of thermal storage to help deep renewables integration. TDV reflects grid costs driven by cooling energy demand in late summer and early fall well, but does not reflect the issue of overgeneration in spring and the impact overgeneration has on making investments in solar generation more expensive due to curtailment. **The incentive for energy storage, both thermal and battery, should reflect both grid energy costs and the solar curtailment (duck curve) challenges to achieving the state's clean electricity objectives.**

IV. Barrier #4: Gas infrastructure costs are not accounted for in prescriptive baseline.

Making gas available to gas-fired appliances in a building requires multiple infrastructure investments:

- Distribution main lines under the street,

- Gas meter and connection to the main,
- Gas piping within the building, and
- Exhaust venting

These infrastructure investments have a substantial cost. While there is a lack of comprehensive data to accurately estimate these costs, anecdotal evidence from recent utility bills show costs ranging from $8,800 in Palo Alto to $14,700 in an IOU territory for a single-family home, for gas main connection alone.

Since all-electric buildings are an option, the cost of providing natural gas service should be accounted for in the cost effectiveness analysis for gas water heating and gas space heating in dual-fuel buildings. To ignore that cost when gas appliances are not essential, favors gas rather than being fuel neutral.

We encourage CEC to fully account for the costs of both gas and electric infrastructure in its cost effectiveness analyses, to allow the State to achieve its energy and climate goals at the lowest cost.

V. Barrier #5: There is no prescriptive path for electric space heating in retrofits.

The 2016 code does not provide a prescriptive option for electric space heating in retrofit projects. The only option is the performance path which requires energy modeling of the building, adding cost and time to the project. This hurdle discourages homeowners and builders from switching to electric heating, foregoing potential energy and GHG emissions reductions.

CEC has engaged with SMUD and Palo Alto to perform a pilot project to assess the feasibility of a prescriptive space heating retrofit option. We commend SMUD, Palo Alto and CEC for this initiative and encourage it to adopt a prescriptive space heating retrofit path as soon as possible.

VI. Barrier #6: The latest NEEA-certified HPWH models are not available in the modeling software.

In 2016, CEC improved CBECC-Res to better model NEEA-certified HPWH by leveraging their certification data to more accurately model their performance. We support this improvement, but unfortunately it is no longer effective because the software has not been updated to reflect the latest NEEA-certified HPWH models on the market. Models that are not specified in CBECC-Res get de-rated, which means that the latest HPWH models with energy factors up to 3.5 get modeled as low-performing HPWH.

To treat HPWH fairly, CEC must streamline its software update process so that new NEEA-certified models are available in CBECC-Res within one or two weeks of NEEA-certification.

Alternatively, CEC could include a NEEA-certified checkbox and treat new models based on their energy factor with no de-rating.

VII. Barrier #7: HPWH is not modeled for central water heating.

The CBECC-Com compliance software does not allow specifying a water heater with an energy factor greater than 1, in effect not recognizing heat pumps. This overestimates the energy use of central heat pump water heaters by a factor of 2 to 4. We urge CEC to allow the modeling of heat pumps for central water heating solutions in CBECC-Com.

VIII. Barrier #8: Mini-splits are not receiving full efficiency credit.

The performance of ductless space heating heat pumps, also called mini-splits, is not fully valued by the compliance software compared to ducted heat pumps due to the lack of field performance verification. CEC has indicated that they're working with AHRI mini-split manufacturers to properly value minis-splits performance. We encourage CEC to complete this work as soon as possible to allow new construction in California to take advantage of this technology where appropriate.

NRDC urges CEC to address the barriers we have discussed, and we look forward to working with CEC to achieve fuel neutrality in the 2019 Standards and beyond.

IX. CEC should prescribe that all new dual-fuel buildings be "heat pump water heater-ready" and "EV-ready."

The 2013 building code included a "High-efficiency Water Heater Ready" requirement that required the following:

- A 240V electrical receptacle close to the water heater
- A Category III or IV vent, or a Type B vent with a straight pipe between the outside vent termination and the space where the water heater is installed
- A condensate drain line
- A gas supply line with a capacity of at least 200kBtu/hr to support the installation of a tankless water heater

The 2011 High-Efficiency Ready CASE study demonstrated the cost effectiveness of the above measures in two scenarios:

1. If the measures are installed with a condensing storage water heater or a tankless water heater with energy factor (EF) rating higher than 0.82, the overall system is cost effective.

2. If the measures are installed with a standard-efficiency water heater, the avoided future retrofit costs to accommodate a HE water heater required by future regulations are much higher than the initial incremental costs of these measures.

The same reasoning and cost-effective rationale applies to heat pump water heaters and electric vehicles (EV) chargers. HPWHs and EV chargers require a 240V electrical conduit from the electric panel to the location of the HPWH and EV charger. This costs relatively little in new construction scenario when the electrician is already onsite, around $200 per conduit, according to NRDC conversations with contractors. The cost can be much higher in retrofit situations, and it is a barrier particularly to switching to electric water heating because 90% of water heater replacements are emergencies, when the water heater needs to be replaced the same day it failed, which leaves little time to coordinate with an electrician for an emergency conduit installation.

To facilitate a future replacement of a gas water heater by a HPWH and the purchase of an electric vehicle, we request that CEC include a heat pump water heater and EV-ready requirement to have a 240V conduit installed to suitable HPWH and EV charger installation locations in the garage.

X. CEC's concern about a seasonal mismatch between electric heating and renewable electricity generation can be mitigated.

On slide 18 of the ZNE Strategy presentation, CEC expressed a concern that "a large number of all-electric homes on the grid could cause a winter peak that may be as large as or larger than the summer peak with limited solar resources in the winter to help".

While we understand CEC's concern, we believe this concern can be mitigated and should not be a constraint on the deploying of all-electric homes, for the following reasons:

1. **It is important to separate peak and total demand concerns:** Peak demand occurs for a few hours each day, most likely in winter mornings before the sun rises and when the temperature is lower and heating loads are highest. **Peak demand can be managed through a combination of load shifting from peak to off-peak hours and energy storage**. For example, high-performance homes have significant thermal inertia. They can be pre-heated gradually overnight, and use limited heating setbacks, so that they can largely coast through morning peak hours, with little or no heating load. Grid-interactive controls will be critical to ensure heating loads are operated in an optimal manner, including pre-heating, load shedding on-peak, and slow ramps to avoid unnecessary electric resistance use. This is a challenge that the industry and utilities can meet over time with the right enabling policies, and we urge CEC to provide meaningful incentives to direct them toward that objective, **specifically the use of smart electric heat pump heating controls that allow pre-heating, progressive ramps, and load shedding**.

2. **Total demand** will only become an issue if new load growth from electrification outpaces renewable generation growth in winter time (both distributed and utility-scale) and necessitates the building of more fossil generation resources than required by the RPS. This risk can be mitigated by several strategies:
   a. **Prioritize heating electrification in high-performance homes**, including new construction and efficiency retrofits of existing homes, so that heating loads can be minimized. Existing homes should only be electrified after, or as part of, an energy efficiency retrofit to ensure it meets occupants comfort expectations while operating mostly in high-efficiency heat pump mode.
   b. **Minimize use of electric resistance through cold climate technology and grid-interactive controls**. High-efficiency modern air-source space heating heat pumps of all types --ductless, ducted and VRF, available from all major manufacturers including Carrier, Sanyo, Fujitsu, Mitsubishi, Bryant, Lennox, Daikin—offer low-temperature compressors that would never go into resistance mode in California, except occasionally in climate zone 16 in the Sierras. It is important to note that high-efficiency heat-pump space heating **uses less source energy[3] and produces lower GHG emissions than high-efficiency gas furnaces even when the build marginal power plant is a combined cycle gas power plant** (the build margin is made of the new resources that will be built or procured to serve new electrified loads). Renewables will be a significant part of the build margin due to the RPS, and electrified space heating will produce significantly lower GHG emissions than a gas furnace in most cases as long as the use of electric resistance is minimized through high efficiency technology and robust control programs.
   c. **A differentiated climate zone strategy would largely mitigate the risk of a winter heating peak** - 2 climate zones (CZ 1 & 16) are responsible for one third of the total winter heating load in CEC's illustration, and 4 climate zones (1, 2, 5, 16) for half. However, these groups of climate zones only represent 2% and 6% of California's population respectively and even less in terms of housing starts. The vast majority of housing starts takes place in mild coastal, warm southern, and harsher but still suitable central valley climate zones, where there is limited risk of a winter peak if heating loads are well managed.
   d. **Multi-family homes have significantly lower heating loads** - The numbers on slide 18 seem to be for single-family only. Approximately half of housing starts in

[3] When using a California-specific source-to-site ratio and DOE's Captured source energy methodology to account for renewable energy. https://www.energy.gov/eere/analysis/downloads/accounting-methodology-source-energy-non-combustible-renewable-electricity

California is now in the multi-family sector[4] where heating loads are relatively much lower than in single-family.

e. Lastly, the market transformation toward decarbonized space heating in buildings will take decades, and given climate imperatives, **it is necessary to accelerate the electrification of new buildings in parallel with evolving the grid to serve these loads**. We cannot proceed sequentially and wait for tomorrow's grid to get started. Any risk of a seasonal winter peak is decades away given the very low market share of electric space heating in new construction. This gives utilities and policy makers plenty of time to plan for winter renewable resources (including hydro and wind from both in-state and out-of-state), and to continue to improve the performance of new buildings through future building code update cycles, so that a seasonal winter peak can be avoided.

The "Christmas Turkey" chart on slide 19 does not mean that all-electric homes will cause a winter peak. First, as noted above, future improvements in building energy performance, in heat pump performance and control programs, and the inclusion of multi-family homes in the mix will significantly reduce the gap between winter on-site generation and demand. Second, utility-scale wind and solar, imports of hydro power from the Pacific Northwest and wind from the West, will help bridge the gap with on-site renewables and should be able to avoid a winter peak with the help of appropriate policies.

Lastly, the chart is based on a 3.15 source energy ratio which is not representative of California's current grid, and even less of its future grid. We encourage CEC to use source-to-site multipliers that better represent California's thermal power generation fleet vs. a national average that includes coal and less efficient natural gas plants than those in use in California, and to follow DOE's accounting methodology for source energy of renewable electricity generation.[5] While this only impacts the scale, not the shape of the curves, it is important to use representative source energy estimates of electricity use so that it can be compared with that of natural gas end uses.

We encourage CEC to extend its analysis to be more representative of the average new construction home in the state rather than use the example of one single-family home in one climate zone. The analysis should include climate zones that represent the majority of new construction activity and housing mix in the state. We also encourage CEC to frame its concern regarding a potential winter peak as a future risk to be mitigated through appropriate policies and to encourage the deployment of these policies.

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[4] https://www.census.gov/construction/bps/msamonthly.html

[5] https://www.energy.gov/eere/analysis/downloads/accounting-methodology-source-energy-non-combustible-renewable-electricity

XI. NRDC supports appropriate credits for energy storage, whether thermal or battery, and for demand response, EV-integration, and other grid harmonization strategies.

As discussed with HPWH load flexibility, we are encouraged by staff's indication at the workshop that CEC is considering providing incentives for grid harmonization benefits for batteries, HPWH, EV-charging, and demand response. These forms of energy storage and demand flexibility can shift load from peak to off-peak hours and help absorb mid-day solar generation (the belly of the duck curve) and reduce exports of excess solar electricity from the building to the grid. Leveraging these grid harmonization benefits is important to help accelerate renewables integration and mitigate consumer electricity bills.

We support valuing load flexibility at levels that balance the two conflicting objectives:

1. The incentives need to be meaningful enough to make a difference
2. They must not be so high and so easy to get that they would allow a trade-off of core efficiency measures such as quality insulation installation (QII), HPWs, HPAs, and windows in a large share of homes, hindering the market transformation for these four core efficiency measures.

We look forward to engaging with CEC to define appropriate incentive values that achieve these principles.

As discussed above for HPWH, we are concerned that valuing load flexibility solely in terms of grid energy costs, as represented by TDV, would not capture the value of load flexibility to help deep renewables integration. TDV reflects grid costs driven by cooling energy demand in late summer and early fall well, but does not reflect the issue of overgeneration in spring and the impact overgeneration has on making investments in solar generation more expensive due to curtailment. **The incentive for energy storage, both thermal and battery, should reflect both grid energy costs and the solar curtailment (duck curve) challenges to achieving the state's clean electricity objectives.**

Lastly, **CEC should include incentives for controlled electric heat pump heating** too. As discussed above, controlled electric heat pump heating is a key strategy to help mitigate CEC's concerns about a potential future winter peak due to uncontrolled electric space heating. Encouraging controls of electric space heating will spur innovation and market development in this space, helping all-electric homes develop in a grid-friendly manner.