NRDC
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NATURAL RESOURCES DEFENSE COUNCIL

NRDC Comments on the 2016 Draft Title 24 Building Energy Standards
November 24, 2014

On behalf of our 1.4 million members and online activists, 250,000 of whom are in California, the Natural Resources Defense Council respectfully submits the following comments on the draft 2016 Title 24 Building Energy Standards. The Title 24 Building Energy Standards assure that all new buildings and renovations in California meet minimum levels of efficiency, providing cost-effective energy savings for Californians, reducing energy demand, and cutting greenhouse gas emissions. NRDC has participated in the proceedings to develop Title 24 since their inception because of these important consumer and environmental benefits. Title 24 has saved Californians over $30 billion on their energy bills since the first standards were adopted in 1975, in addition to cutting the associated pollution emissions.[1] These benefits do not even include the value of increased comfort in new homes, nor the benefits of decreases in gas and electricity prices that result from reducing demand.

NRDC offers the following comments on the draft 2016 Standards.

Comment Overview

In general, NRDC strongly supports the CEC's efforts to update the Title 24 Standards. As recognized by the CEC and as NRDC has stated in previous comments, this update to the standards is critical to achieving the zero net energy (ZNE) goals for new residential construction by 2020 and new nonresidential construction by 2030.

The draft residential standards represent a good step forward toward meeting these goals, however there are some instances where the CEC proposed standards stops short of what is cost-effective and technically achievable with currently available technology, potentially undermining the CECs ability to reach ZNE by 2020. We offer detailed comments on the following proposed changes to the residential standards below:

- **Ducts in Conditioned Space or High Performance Attics**: NRDC strongly supports this measure, which will provide flexibility to builders while promoting the use of two design options likely necessary to reach zero net energy. As discussed in our comments below, modifications are necessary to ensure that this measure achieves this goal and does not allow for ducts in non-conditioned spaces, such as basements and crawlspaces (if the ducts in conditioned space option is pursued). Moving ducts into conditioned space reduces wasted energy as any duct leakage occurs into conditioned space, providing useful heating or cooling to that space, rather than being wasted into an unconditioned crawlspace or garage. Furthermore, moving ducts into conditioned space reduces energy wasted through conduction

[1] http://www.energy.ca.gov/releases/2013_releases/2012_Accomplishments.pdf

when cold air ducts run through a hot attic or warm air ducts run through a cold basement. For these reasons, the CEC should ensure that the ducts in conditioned space option truly requires that the ducts be in conditioned space.

- **High Performance Walls**: NRDC strongly supports updating the residential wall insulation requirements. While the proposed values are a step in the right direction, they stop short of what is cost effective. For a small additional upfront cost (see Figure 3), the standards can achieve additional energy savings that will pay back over the life of the home. It makes much more sense to add this additional insulation at the time of construction when the wall is already open, rather than having to add it later as a retrofit. Furthermore, failing to adopt cost-effective opportunities now could short-circuit the CEC's ability to achieve ZNE by 2020 as builders will not gain experience with efficient construction practices, which could limit future innovation. We recommend that the CEC revise its proposal to be a maximum of U=0.44 in all climate zones as discussed in detail below.

- **Water Heating**: NRDC supports the proposal to require a tankless gas or propane water heater, hot water pipe insulation, or a compact hot water distribution system. This proposal will lead to energy savings, while providing flexibility to the builder. However, NRDC is very concerned with the lack of a heat pump water heater option in the prescriptive path and as a baseline in the performance path for builders that elect to use electricity as the water heating fuel. NRDC recommends that the CEC add heat pump water heaters as a compliance option under both the prescriptive and performance path.

- **Residential lighting**: In general, NRDC strongly supports the proposed changes to the residential lighting requirements. The proposed requirements will provide flexibility to builders while ensuring that there is a quality, high efficacy bulb in every socket. As discussed below, NRDC has concerns with the proposed requirement of a minimum color rendering index (CRI) of 90, given the lack of data showing consumer dissatisfaction with CRI 80 and the energy and cost penalty of CRI 90. NRDC recommends that the CEC align the Title 24 standards with the proposed Title 20 requirement of CRI 82 and 84.

The draft nonresidential standards fall short of the progress necessary to reach ZNE by 2030. NRDC understands that the CEC has chosen to focus on the residential standards for this standard update, but NRDC objects to the notion that this means that no progress beyond a national model energy code developed prior to 2013, namely ASHRAE 90.1-2013, can be made on the nonresidential standards in this update. The CEC should adopt measures that go beyond ASHRAE where there are cost-effective opportunities. Failing to adopt cost-effective efficiency opportunities in this standard update will only make the ZNE goals more difficult to reach in future code updates. Specifically, we offer detailed comments on the following:

- **Opaque Envelope:** NRDC is disappointed with the proposed requirements for nonresidential and high-rise residential roofs. The proposed requirements fall short of what the CASE study finds to be cost-effective and in some places fall short of the ASHRAE requirements, even though the ASHRAE requirements are cost-effective. As with the residential envelope requirements, it is important to implement the highest insulation levels that are cost-effective at the time of construction. Additionally, given the high benefit to cost ratios found for the construction assemblies analyzed in the CASE report, even further savings would likely be possible than those identified in the report. We recommend that the CEC conduct additional analysis using construction assemblies required by ASHRAE 90.1-2013 for climate zones 4 through 8. These assemblies are technically feasible as they have already been vetted through the ASHRAE process. Furthermore, it is justified to analyze these assemblies for California as California covers many ASHRAE climate zones, not just climate zone 3, and the use of time dependent valuation (TDV) in California means that higher levels are likely to be cost-effective in California than on a national average basis.

- **Outdoor lighting requirements:** NRDC strongly supports the proposed outdoor lighting requirements which will provide significant energy savings.

- **Indoor lighting:** NRDC supports the proposed updates but recommends further updates for space types that do not correspond to ASHRAE and which have not been updated since 2001. Specifically, we recommend that values that have not been updated since 2001 be updated to reflect current best practices, such as high performing T-8s.

<u>Detailed Comments</u>

<u>Residential</u>

1. Ducts in conditioned space and high performance attics

NRDC strongly supports the requirement for either a high performance attic or ducts in conditioned space and recommends that CEC modify the proposed language to ensure that one of these two options is required. These two measures have been identified as key measures to reach zero net energy goals and will provide cost-effective savings to consumers. Providing builders with a choice between high performance attics and ducts in conditioned space will give builders flexibility and allow additional time for the industry to transition to these construction practices.

The CASE report estimates significant savings from this proposal:

	First Year Statewide Savings			First Year TDV Savings
	Electricity Savings (GWh)	Power Demand Reduction (MW)	Natural Gas Savings (MMtherms)	TDV Electricity and Gas Savings (Million kBTU)
HPA – including R-13 below deck	20.9	34.3	1.67	1,628
DCS – Verified Ducts in Conditioned Space	22.4	38.6	2.85	1,981

Figure 1: Estimated first year savings from high performance attics and ducts in conditioned space.[2]

While we support the intent of the measure, we are concerned by the language proposed on page 214 of the draft standards. This language would allow ducts in basements, crawl space and other unconditioned space under the "ducts in conditioned space" option. This is counter to the intent of this measure which is both to get ducts out of the hot attic and also to ensure that any leakage from ducts occurs into conditioned space. Furthermore, while these unconditioned spaces may not have the same temperature differential as a hot attic, there is still likely to be a temperature differential and consequent energy losses from locating ducts in these spaces. This is particularly true for hot-air ducts in cold crawl spaces and basements. Ducts with leakage in unconditioned and thus not lived-in spaces may result in suction pressures that can present indoor air quality problems if the crawl space is used for storing volatile chemicals. Finally, allowing ducts outside of conditioned space to qualify would violate the intent of the measure which is to encourage more builders to become familiar with construction practices necessary to move ducts into conditioned space as well as with ductless equipment, as this is a key measure identified as necessary to reach ZNE. <u>We recommend that CEC modify the draft language to ensure that ducts are truly only allowed in conditioned space under the ducts in conditioned space compliance option.</u>

2. High Performance Walls

NRDC strongly supports increasing the residential envelope requirements. Highly insulating walls are likely to be a key measure to meet ZNE in homes, providing cost-effective savings for consumers and increased comfort. <u>However, the CEC's proposal in the draft standards does not go far enough and leaves cost-effective savings on the table, which will make it that much more difficult to reach the zero net energy goal by 2020.</u>

[2] October 2014 CASE Report, "Residential Ducts in Conditioned Space/High Performance Attics"

	First Year Statewide Savings			Statewide TDV Savings	
	Electricity Savings (GWh)	Power Demand Reduction (MW)	Natural Gas Savings (MMtherms)	TDV Energy Savings (Million kBTU)	TDV Dollar Savings (Million $)
U-factor=0.046	8.3	10.7	2.2	844	$145
QII	6.9	7.7	2.5	817	$141
U-factor=0.046 and QII	14.2	16.8	4.5	1,552	$268

Figure 2: Estimated first year savings for the CASE study proposed U-factor of U=0.046.[3]

The CEC proposes increasing the wood-frame wall U-factor to U=0.05 in all climate zones. However, the CASE report found that a U-factor of U=0.044 would be cost-effective in almost all climate zone (except climate zones 6-8). The CASE report recommended a U-factor of U=0.046 which corresponded to the highest level evaluated using 2x4 studs. We recommend that the CEC modify the proposed standards to require a U=0.044. Stopping short of the highest levels found to be cost-effective is likely to impede efforts to reach zero net energy by 2020. Setting levels at the highest level that are cost-effective will allow builders to become more familiar with construction techniques to reach these levels, potentially leading to innovation and further cost-effective savings in the future. Alternatively, failing to adopt the highest cost-effective levels now could limit future savings opportunities.

Additionally, the CEC should require a U-factor of U=0.044 in all climate zones, even though the CASE analysis did not show it to be cost-effective in climate zones 6-8. There are several reasons for this. First, the CASE report does not take into account any reduced equipment costs from smaller equipment enabled by the reduced heating and cooling loads that come with increased envelope insulation. Therefore, the CASE report most likely overestimates the cost of reaching a given U-factor in all climate zones. If these costs were taken into account it is probable that a U=0.044 would be cost-effective in all climate zones. Secondly, the CEC would most likely find a U=0.044 to be cost-effective in all climate zones even without taking into account reduced equipment costs, if evaluated compared to historic practice (rather than the most recent standard), as the Warren-Alquist Act requires. Finally, the Warren-Alquist Act also requires that the standards be cost-effective in total, not that every proposed change be cost-effective. The increased cost of a U=0.044 in climate zones 6 through 8 will likely be offset by savings from other measures, resulting in standards that are cost-effective overall.

Finally, we recommend that the CEC require quality insulation installation (QII) for all new homes. QII is important to insure that insulation is installed properly and actually delivering the intended benefits. As seen in Figure 2, almost half of the first year energy savings for high performance walls identified in the CASE analysis would come from QII. However, instead of requiring QII for all homes, the CEC has proposed to make it one of the options for the water heating requirement. Failing to require QII for all

[3] September 2014 CASE Report, "Residential High Performance Walls and QII"

homes will deprive consumers of these energy savings. We recommend requiring QII for all new homes as proposed in the CASE analysis.

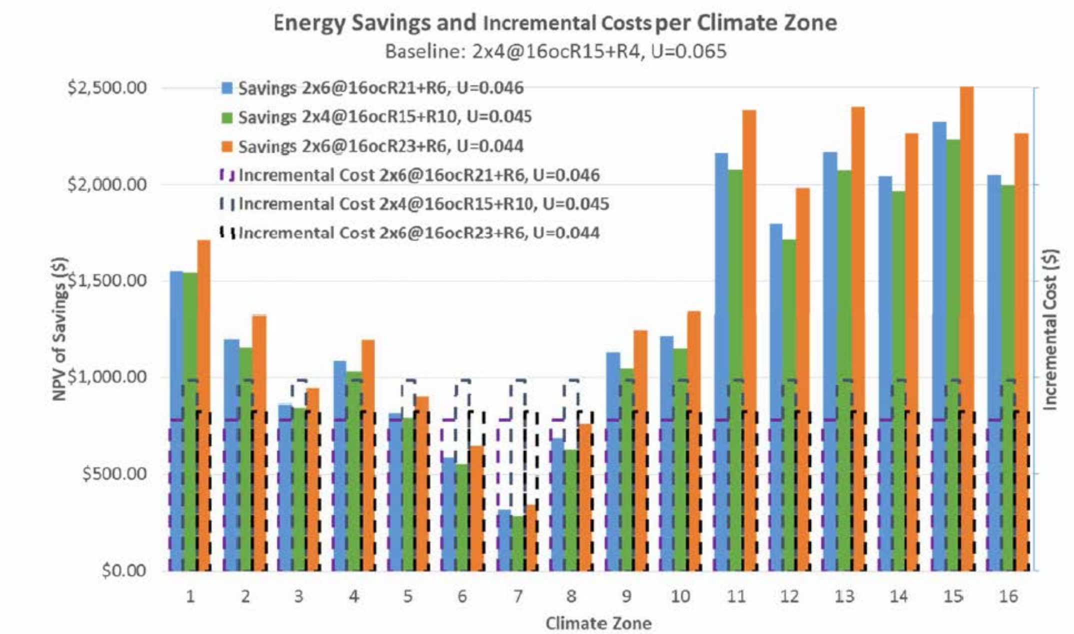

Figure 3: Energy Savings and Incremental Cost Analysis for assemblies with U=0.046 and below.[4]

3. Water Heating

NRDC supports the changes to the residential water-heating requirements proposed in the draft standards but seeks further modifications. As written, the proposal would allow for the installation of an instantaneous gas or propane water heater or a gas or propane storage water heater in combination with quality insulation installation and a compact hot water distribution system or hot water pipe insulation. We support these options for cases where a gas or propane water heater is installed (with the exception that, as stated above, QII should be required for all homes). This proposal will lead to significant natural gas savings (see Figure 4) while providing flexibility to builders as to how they achieve these savings.

	Electricity Savings (GWh)	Power Demand Reduction (MW)	Natural Gas Savings (MMtherms)	First Year TDV Energy Savings (Million kBTU)[1]
Proposed Measure	-6.16	-1.34	3.17	828
TOTAL	-6.16	-1.34	3.17	828

1. TDV energy savings calculations include electricity and natural gas use.

Figure 4: Estimated first year savings from revised water heater requirements.[5]

[4] September 2014 CASE Report, "Residential High Performance Walls and QII"

However, we are very concerned that the proposed draft language text completely deletes the option to install an electric water heater under the prescriptive path. In the 2013 standards, an electric water heater may be installed in combination with a solar hot water heater. NRDC commented during the pre-rulemaking phase that Title 24 should be amended to better allow for and encourage the installation of heat pump water heaters. Currently the installation of a heat pump water heater is prohibited under the prescriptive path and strongly discouraged (through the comparative TDV values of gas and electricity) under the performance path.

This restriction is bad for California because it increases greenhouse gas emissions and makes it harder to achieve California's goal to reduce emissions by 80% in 2050. This conclusion can be seen by comparing the amount of gas needed to operate a tankless gas water heater to the amount of gas used to generate the electricity to run a minimum NAECA heat pump water heater. If including the effects of California's RPS, this conclusion is only strengthened.

The proposed amendment to delete the solar water heater plus electric water heater option in the prescriptive path is a step in the wrong direction. We recommend that the solar water heating option under the prescriptive path be reinstated and that <u>an additional option of a heat pump water heater be added, regardless of gas availability</u>. While in the past there was a significant difference in favor of gas, in terms of operating cost and environmental impact between gas and electric water heating, technological advances and the changing generation mix make the preferred choice of water heating fuel less clear. Given the advances in heat pump water heating technology, the updated federal standards that require large water heaters to use heat pump technology, and the potential benefits of grid-interactive heat pump water heaters, the standards should be updated so as not to be unfairly biased against this technology.

<u>Specifically, we recommend that the CEC allow for the installation of a heat pump water heater under the prescriptive path even if gas is available</u>. This should be a standalone option and should not require the installation of a solar water heater. <u>The CEC should also update the baseline under the performance path for all electric homes to a 56 gallon electric water heater (i.e. a heat pump water heater).</u> For homes with gas available, the CEC should allow for the use of the same water heating fuel type in the reference and proposed design. That is to say that a builder should be required to use a heat pump water heater in the reference design if electricity is used for water heating in the proposed design.

4. Lighting

In general, NRDC strongly supports the proposed changes to the residential lighting requirements. The proposal would simplify compliance with the standards, while ensuring that there is a high-efficacy, high-performance bulb in every fixture. This will result in significant energy savings: the changes to the residential lighting requirements have the largest projected energy savings of the residential measures considered in the CASE analyses, saving a projected total of 85 GWh in the first year. Put another way,

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[5] September 2014 CASE Report, "Residential Instantaneous Water Heaters"

according to the CASE analysis the proposed requirements have the potential to reduce a home's annual lighting energy use by an average of over 50 percent.

	First Year Statewide Savings[1]			TDV Savings[2]	
	Electricity Savings[3] (GWh)	Power Demand Reduction (MW)	Natural Gas Savings (MMtherms)	TDV Electricity Savings[4] (Million kBTU)	TDV Natural Gas Savings[4] (Million kBTU)
Recessed Luminaires	43.7	-	N/A	945.6	N/A
All Other Lighting	41.3	-	N/A	894.1	N/A
TOTAL	85.0	-	N/A	1,839.7	N/A

Figure 5: Estimated first year savings from residential lighting requirements.[6]

The proposal simplifies the current residential lighting requirements by requiring all light fixtures to be high-efficacy, removing the need to calculate the percentage of high-efficacy fixtures. Currently, low efficacy fixtures can be installed if they are installed with a dimmer or vacancy sensor and this option is widely utilized today. Eliminating this option will lead to significant energy savings. The proposal also provides greater flexibility by allowing screw-based fixtures to qualify as high efficacy as long as they meet the performance standards in Appendix JA-8. This is essential to the success of this proposal, as a homeowner who is not satisfied will simply unscrew these bulbs and may replace them with lower efficiency alternatives, negating the energy savings. Given the progress in both quality and decreased costs of LEDs, this requirement is feasible. Furthermore, the Energy Independence and Security Act (EISA) standards will take effect in 2018 and provide a backstop for any consumers who do replace screw-based bulbs. We offer the following comments on the details of the proposed requirements:

Recessed luminaires: NRDC strongly supports the proposal to not allow the use of screw-based bulbs in recessed luminaires. There are several reasons why screw-based bulbs should not be allowed in recessed luminaires. Recessed luminaires are commonly installed today and so it is important that high efficacy bulbs are installed and maintained in these fixtures. Since there is a higher price differential between high and low efficacy bulbs for the bulbs used in recessed fixtures, there is a bigger risk that the bulbs could be switched out between the final permit check and the time of occupancy, which would negate energy savings. Furthermore, the EISA standards that take effect in 2018, which will require most bulbs to be significantly more efficient, do not apply to directional bulbs used in recessed fixtures, so there is a larger risk of the consumer replacing with the bulb with a less efficient version. Finally, heat management is an important consideration for recessed fixtures and this can be better managed with a dedicated fixture. Since over half the savings for the residential lighting proposal comes from recessed luminaires, it is very important to maintain this requirement and prevent a potential loophole in the standards.

[6] October 2014 CASE Report, "Residential Lighting"

Elevated temperature requirements: NRDC supports the elevated temperature performance requirements proposed in Appendix JA-8 for bulbs installed in recessed cans and enclosed fixtures. These bulbs are subject to higher temperatures which can affect bulb performance. Bulbs that do not perform adequately at elevated temperatures could lead to consumer dissatisfaction and potentially negate energy savings if bulbs are switched out for less efficacious alternatives. NRDC supports the requirement that bulbs that do not meet the elevated temperature requirements be labeled as "not for use in enclosed fixtures" which will enable builders, consumers, and code inspectors to identify bulbs that are installed in the wrong type of fixture.

Disclosure: NRDC supports the proposal to require disclosure of installed lighting from the builder to the consumer. This is important because it creates accountability for the builder while also providing information to the consumer. Without this requirement, a builder might be tempted to switch out bulbs with cheaper, less efficacious alternatives between inspection and occupancy.

Dimmer requirements: NRDC supports the proposed requirement that dimmers meet NEMA SSL7A requirements. This will help ensure dimmer compatibility with the installed high efficacy fixtures and reduce potential consumer dissatisfaction from poorly matched dimmers and fixtures. This requirement is important because poor dimmer performance could lead consumers to switch out bulbs and replace them with lower efficacy alternatives.

Color Rendering Index: NRDC strongly supports the inclusion of a minimum color rendering index (CRI), as this will help prevent consumer dissatisfaction. NRDC recommends that the CEC modify the proposed CRI requirement in Title 24 to align with the proposed Title 20 requirements (CRI 82 and 84). NRDC does not support a CRI of 90 at this time. As submitted in NRDC's October 24, 2014 comments on the Title 20 LED Lamp Proposal and in oral testimony in that proceeding, there is no data showing that consumers have been dissatisfied with CRIs in the low 80s that would indicate that this level of performance is not adequate for consumers. [7] Furthermore, as submitted in the Title 20 proceeding, there is an energy and cost penalty associated with moving to a CRI of 90 and this penalty is not warranted, given the lack of consumer data supporting a higher CRI requirement. We support the proposal to also require a minimum R9 Value (red), given that this has been shown to be the most important color value to consumer. The exact level should be established based on additional dialogue with stakeholders including CLTC, lamp manufacturers, and other interested stakeholders.

Circuitry requirements: As submitted during the pre-rulemaking workshops, NRDC continues to recommend a separate switch requirement for under cabinet lights. Homeowners often leave kitchen lights on even when the kitchen is not in use, sometimes as a form of night light or to indicate someone is

[7] The one study that stakeholders could identify on consumer preference and CRI compared only one bulb at a CRI of 80 with one other bulb at a CRI of 95. While this study did identify a preference for the latter bulb, the report also noted that this particular lamp had enhanced light output in the range of 280 to 45 nanometers, which may be associated with health risks.

present in the house. Given this tendency, it is important to allow consumers the flexibility to only leave some of the kitchen lights on by putting the under cabinet lighting on a separate switch, as under cabinet lighting is not likely needed for these purposes. This separate switching requirement will result in energy savings by allowing consumers to better control the level of lighting in the kitchen to meet specific needs.

Non-residential and high-rise residential

1. Opaque Envelope Requirements

In general, NRDC is disappointed by the nonresidential and high-rise residential opaque envelope measures proposed in the draft 2016 standards. While the CEC has chosen to focus on updating the single-family and low-rise residential requirements for the 2016 standard update, this does not justify leaving cost-effective opportunities on the table for non-residential and high-rise residential, in particular when the analysis itself shows that higher levels are justified. Failing to adopt cost-effective opportunities during this standards update will impede future standards improvements and threaten CEC's ability to achieve the nonresidential zero net energy goal by 2030.

As discussed in detail below, higher levels than proposed in the draft standards are cost-effective for many construction types. In several cases, the proposed levels in the draft standards are below the highest levels found to be cost-effective in the CASE analysis. Furthermore, the high benefit-cost ratios of the proposed levels for many assembly types indicate that further cost-effective improvements exist beyond those levels analyzed. Specifically, for nonresidential and high-rise residential metal buildings and wood frame roofs, we recommend that the CEC analyze ASHRAE 90.1-2013 assemblies for additional ASHRAE climate zones beyond climate zone 3.

The decision to only analyze climate zone 3 assemblies is flawed to begin with, as climate zones 2, 4, 5, and 6 also cover parts of California. Also given the use of time dependent valuation in California, higher levels are likely to be cost-effective in California than on a national basis. This is supported by the very high benefit cost ratios for the measures currently proposed. The use of ASHRAE assemblies from additional climate zones alleviates any potential concerns regarding constructability or market readiness, as these levels have already been vetted through the ASHRAE process. If levels vetted through the ASHRAE process are cost-effective in California than they should be certainly be adopted

NRDC offers the following high level recommendations:

- At a bare minimum, adopt the highest levels found to be cost-effective in the CASE report.
- Analyze assemblies for additional ASHRAE climate zones, as proposed below; adopt highest levels found to be cost-effective.

These are important steps to take on the long term path to net zero because envelope assemblies are longer lasting than the other systems of commercial and high rise residential buildings.

NRDC offers the following specific comments for each opaque envelope requirement considered in the CASE report:

Nonresidential Metal Building Roofs

The CEC should increase the proposed efficiency requirements for nonresidential metal building roofs. The draft standards propose a U-factor requirement of 0.041 for all climate zones, corresponding to the R 19 + R 10 filled cavity assembly analyzed in the CASE report. This U-value corresponds to the ASHRAE 90.1-2013 requirement for ASHRAE climate zone 3. The benefit to cost ratio at this level is very high ranging from 3.6 to over 11, depending on the climate zone. The highest level analyzed by the CASE report was an R-19 + R12.4 continuous insulation assembly (U = 0.36). Even without considering any additional benefits, this assembly is cost-effective in every CA climate zone (see last column, Figure 6).[8] At a bare minimum, the CEC should adopt the highest level found to be cost-effective in the CASE report, which in this case is an R-19 +R12.4 continuous insulation assembly with a U-factor of 0.036.

CZ	Current Assembly	Current U-Value	Assembly Choosen	U-Value	TDV Benefit ($/SF)	Incremental Cost ($/SF)	B/C	Highest Assembly Analyzed	U-factor of highest Assembly Analyzed	Incremental Cost ($/SF)	B/C (not counting additional beneftis)
1	R-19 batt	0.065	R-19+10 FC	0.041	$ 3.22	$ 0.85	3.79	R-19, R 12.4 ci	0.036	$ 1.79	1.80
2	R-19 batt	0.065	R-19+10 FC	0.041	$ 5.09	$ 0.85	5.99	R-19, R 12.4 ci	0.036	$ 1.79	2.84
3	R-19 batt	0.065	R-19+10 FC	0.041	$ 3.32	$ 0.85	3.91	R-19, R 12.4 ci	0.036	$ 1.79	1.85
4	R-19 batt	0.065	R-19+10 FC	0.041	$ 4.64	$ 0.85	5.46	R-19, R 12.4 ci	0.036	$ 1.79	2.59
5	R-19 batt	0.065	R-19+10 FC	0.041	$ 3.04	$ 0.85	3.58	R-19, R 12.4 ci	0.036	$ 1.79	1.70
6	R-19 batt	0.065	R-19+10 FC	0.041	$ 4.16	$ 0.85	4.89	R-19, R 12.4 ci	0.036	$ 1.79	2.32
7	R-19 batt	0.065	R-19+10 FC	0.041	$ 3.61	$ 0.85	4.25	R-19, R 12.4 ci	0.036	$ 1.79	2.02
8	R-19 batt	0.065	R-19+10 FC	0.041	$ 5.00	$ 0.85	5.88	R-19, R 12.4 ci	0.036	$ 1.79	2.79
9	R-19 batt	0.065	R-19+10 FC	0.041	$ 6.00	$ 0.85	7.06	R-19, R 12.4 ci	0.036	$ 1.79	3.35
10	R-19 batt	0.065	R-19+10 FC	0.041	$ 6.02	$ 0.85	7.08	R-19, R 12.4 ci	0.036	$ 1.79	3.36
11	R-19 batt	0.065	R-19+10 FC	0.041	$ 7.46	$ 0.85	8.78	R-19, R 12.4 ci	0.036	$ 1.79	4.17
12	R-19 batt	0.065	R-19+10 FC	0.041	$ 6.46	$ 0.85	7.60	R-19, R 12.4 ci	0.036	$ 1.79	3.61
13	R-19 batt	0.065	R-19+10 FC	0.041	$ 8.04	$ 0.85	9.46	R-19, R 12.4 ci	0.036	$ 1.79	4.49
14	R-19 batt	0.065	R-19+10 FC	0.041	$ 7.83	$ 0.85	9.21	R-19, R 12.4 ci	0.036	$ 1.79	4.37
15	R-19 batt	0.065	R-19+10 FC	0.041	$ 9.63	$ 0.85	11.33	R-19, R 12.4 ci	0.036	$ 1.79	5.38
16	R-19 batt	0.065	R-19+10 FC	0.041	$ 7.47	$ 0.85	8.79	R-19, R 12.4 ci	0.036	$ 1.79	4.17

Figure 6: Cost-effectiveness of proposed assembly by climate zone and of the highest efficiency assembly analyzed by climate zone for nonresidential metal building roofs.[9]

Even without counting the additional TDV savings of moving from U = 0.041 to 0.036, the benefit to cost ratios for a U=0.036 assembly are very high, ranging from 1.7 to 5.4 depending on the climate zone. This

[8] Calculated by dividing the TDV savings from U=0.041 by the incremental cost presented to reach U=0.036.
[9] Derived from information presented in Tables 23, 25, and 33 of the October 2014 CASE Report "Nonresidential Opaque Envelope".

indicates that further cost-effective savings are achievable. The CEC should analyze the ASHRAE 90.1-2013 assemblies from colder climate zones to see if they are cost-effective given the high benefit to cost ratios of the assemblies analyzed. Given the use of TDV, higher levels are likely to be cost-effective in CA than on a national average basis. Figure 7 summarizes the ASHRAE 90.1-2013 assemblies and U-factors for nonresidential metal building roofs. We recommend that the CASE report be amended to include an analysis of the ASHRAE assemblies in climate zones 6 through 8[10] and that the CEC adopt the most efficient assembly found to be cost-effective.

ASHRAE CZ 4 and 5 Assembly	ASHRAE CZ 4 and 5 U-Value	ASHRAE CZ 6 Assembly	ASHRAE CZ6 U-Value	ASHRAE CZ 7 Assembly	ASHRAE CZ7 U-Value	ASHRAE CZ 8 Assembly	ASHRAE CZ8 U-Value
R-19 + R-11 Ls or R-25 + R-8 Ls	0.037	R-25 + R-11 Ls	0.031	R-30 + R-11 Ls	0.029	R-25 + R-11+ R-11 Ls	0.026

Figure 7: ASHRAE 90.1-2013 assemblies and corresponding U-Values for ASHRAE climate zones 4 through 8 for nonresidential metal building roofs.[11]

High-rise Residential Metal Building Roofs

The CEC should increase the proposed efficiency requirements for high-rise residential metal building roofs. As for nonresidential metal building roofs, the proposed requirement is U-factor of 0.041 which corresponds to an R-19 + R-10 filled cavity assembly. The cost to benefit ratios are similar to those for nonresidential ranging from 2.2 to 7.8 depending on the climate zone. Again, the highest level analyzed was an R-19 + R-12.4 continuous insulation assembly (U-factor of 0.036), which, even without considering additional benefits, had a benefit to cost ratio of greater than 1 in every climate zone. We urge the CEC to at a minimum adopt the highest levels analyzed (U=0.036), but also to analyze additional assemblies used in ASHRAE climate zones 6 through 8 (see Figure 9).

[10] Note that the ASHRAE requirements for climate zones 4 and 5 are similar to the highest level analyzed in the CASE report already.
[11] ASHRAE 90.1-2013 Tables 5.5-4, 5.5-5, 5.5-6, 5.5-7 and 5.5-8

CZ	Current Assembly	Current U-Value	Current cost	Assembly Choosen	U-Value	TDV Benefit	Incremental Cost	B/C	Highest Assembly Analyzed	U-factor of highest Assembly Analyzed	Incremental Cost	B/C (not counting additional beneftis)
1	R-19 batt	0.065	$ 0.96	R-19+10 FC	0.041	$ 6.62	$ 0.85	7.79	R-19, R 12.4 ci	0.036	$ 1.79	3.70
2	R-19 batt	0.065	$ 0.96	R-19+10 FC	0.041	$ 5.82	$ 0.85	6.85	R-19, R 12.4 ci	0.036	$ 1.79	3.25
3	R-19 batt	0.065	$ 0.96	R-19+10 FC	0.041	$ 4.24	$ 0.85	4.99	R-19, R 12.4 ci	0.036	$ 1.79	2.37
4	R-19 batt	0.065	$ 0.96	R-19+10 FC	0.041	$ 4.63	$ 0.85	5.45	R-19, R 12.4 ci	0.036	$ 1.79	2.59
5	R-19 batt	0.065	$ 0.96	R-19+10 FC	0.041	$ 5.04	$ 0.85	5.93	R-19, R 12.4 ci	0.036	$ 1.79	2.82
6	R-19 batt	0.065	$ 0.96	R-19+10 FC	0.041	$ 2.81	$ 0.85	3.31	R-19, R 12.4 ci	0.036	$ 1.79	1.57
7	R-19 batt	0.065	$ 0.96	R-19+10 FC	0.041	$ 1.84	$ 0.85	2.16	R-19, R 12.4 ci	0.036	$ 1.79	1.03
8	R-19 batt	0.065	$ 0.96	R-19+10 FC	0.041	$ 3.13	$ 0.85	3.68	R-19, R 12.4 ci	0.036	$ 1.79	1.75
9	R-19 batt	0.065	$ 0.96	R-19+10 FC	0.041	$ 4.23	$ 0.85	4.98	R-19, R 12.4 ci	0.036	$ 1.79	2.36
10	R-19 batt	0.065	$ 0.96	R-19+10 FC	0.041	$ 4.57	$ 0.85	5.38	R-19, R 12.4 ci	0.036	$ 1.79	2.55
11	R-19 batt	0.065	$ 0.96	R-19+10 FC	0.041	$ 6.23	$ 0.85	7.33	R-19, R 12.4 ci	0.036	$ 1.79	3.48
12	R-19 batt	0.065	$ 0.96	R-19+10 FC	0.041	$ 5.79	$ 0.85	6.81	R-19, R 12.4 ci	0.036	$ 1.79	3.23
13	R-19 batt	0.065	$ 0.96	R-19+10 FC	0.041	$ 6.23	$ 0.85	7.33	R-19, R 12.4 ci	0.036	$ 1.79	3.48
14	R-19 batt	0.065	$ 0.96	R-19+10 FC	0.041	$ 6.50	$ 0.85	7.65	R-19, R 12.4 ci	0.036	$ 1.79	3.63
15	R-19 batt	0.065	$ 0.96	R-19+10 FC	0.041	$ 4.68	$ 0.85	5.51	R-19, R 12.4 ci	0.036	$ 1.79	2.61
16	R-19 batt	0.065	$ 0.96	R-19+10 FC	0.041	$ 7.64	$ 0.85	8.99	R-19, R 12.4 ci	0.036	$ 1.79	4.27

Figure 8: Cost-effectiveness of proposed assembly by climate zone and of the highest efficiency assembly analyzed by climate zone for high-rise residential metal building roofs.[12]

ASHRAE CZ 4 and 5 Assembly	ASHRAE CZ 4 and 5 U-Value	ASHRAE CZ 6 Assembly	ASHRAE CZ6 U-Value	ASHRAE CZ 7 Assembly	ASHRAE CZ 7 U-Value	ASHRAE CZ 8 Assembly	ASHRAE CZ 8 U-Value
R-19 + R-11 Ls or R-25 + R-8 Ls	0.037	R-30 + R-11 Ls	0.029	R-30 + R-11 Ls	0.029	R-25 + R-11+R-11 Ls	0.026

Figure 9: ASHRAE 90.1-2013 assemblies and corresponding U-Values for ASHRAE climate zones 4 through 8 for high-rise residential metal building roofs.[13]

Nonresidential Wood Frame Roofs

For non-residential wood frame roofs, the CEC has proposed levels in the draft standards that are below the ASHRAE climate zone 3 levels despite the fact that the ASHRAE climate zone 3 levels were found to be cost-effective in almost all climate zones, even without considering additional benefits.[14] For climate zone 8 in particular, the CEC does not propose to change the required U-value at all (currently U=0.067) despite the fact that the CASE analysis found that a U-values of 0.027 would be cost-effective. At a minimum, the CEC should adopt the ASHRAE climate zone 3 level (U=0.027) in all climate zones where it is cost-effective.

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[12] Figure 8 summarizes the data presented for high-rise residential metal building roofs in Table 23, 29 and 37 of the October 2014 CASE Report "Nonresidential Opaque Envelope".

[13] ASHRAE 90.1-2013 Tables 5.5-4, 5.5-5, 5.5-6, 5.5-7 and 5.5-8

[14] It is not determinable from the analysis presented in the CASE report whether these levels would actually be cost-effective in all climate zones if the additional benefits were taken into account.

CZ	Current Assembly	Current U-Value	Current Cost	Assembly Choosen	U Value Choosen Assembly	Cost Chosen Assembly	TDV Benefit	Incremental Cost	B/C	Highest Assembly Analyzed	U-factor of Highest Assembly Analyzed	Incremental Cost	B/C (not counting additional beneftis)
1	R-19	0.049	\$ 1.08	R-30	0.034	\$ 2.60	\$ 2.01	\$ 1.38	1.46	R-38	0.027	\$ 2.55	0.8
2	R-25	0.039	\$ 2.16	R-30	0.034	\$ 2.60	\$ 3.18	\$ 1.38	2.30	R-38	0.027	\$ 1.47	2.2
3	R-25	0.039	\$ 2.16	R-30	0.034	\$ 2.60	\$ 2.07	\$ 1.38	1.50	R-38	0.027	\$ 1.47	1.4
4	R-25	0.039	\$ 2.16	R-30	0.034	\$ 2.60	\$ 2.90	\$ 1.38	2.10	R-38	0.027	\$ 1.47	2.0
5	R-19	0.049	\$ 1.08	R-30	0.034	\$ 2.60	\$ 1.90	\$ 1.38	1.38	R-38	0.027	\$ 2.55	0.7
6	R-11	0.075	\$ 0.81	R-19	0.049	\$ 1.58	\$ 4.51	\$ 0.42	10.80	R-38	0.027	\$ 2.82	1.6
7	R-13	0.067	\$ 1.01	R-19	0.049	\$ 1.58	\$ 2.71	\$ 0.21	13.10	R-38	0.027	\$ 2.62	1.0
8	R-25	0.039	\$ 2.16	R-25	0.039	\$ 2.16	\$ 3.13	\$ 1.38	2.27	R-38	0.027	\$ 1.47	2.1
9	R-25	0.039	\$ 2.16	R-30	0.034	\$ 2.60	\$ 3.75	\$ 1.38	2.72	R-38	0.027	\$ 1.47	2.6
10	R-25	0.039	\$ 2.16	R-30	0.034	\$ 2.60	\$ 3.76	\$ 1.38	2.73	R-38	0.027	\$ 1.47	2.6
11	R-25	0.039	\$ 2.16	R-30	0.034	\$ 2.60	\$ 4.66	\$ 1.38	3.38	R-38	0.027	\$ 1.47	3.2
12	R-25	0.039	\$ 2.16	R-30	0.034	\$ 2.60	\$ 4.04	\$ 1.38	2.93	R-38	0.027	\$ 1.47	2.7
13	R-25	0.039	\$ 2.16	R-30	0.034	\$ 2.60	\$ 5.02	\$ 1.38	3.64	R-38	0.027	\$ 1.47	3.4
14	R-25	0.039	\$ 2.16	R-30	0.034	\$ 2.60	\$ 4.89	\$ 1.38	3.55	R-38	0.027	\$ 1.47	3.3
15	R-25	0.039	\$ 2.16	R-30	0.034	\$ 2.60	\$ 6.02	\$ 1.38	4.36	R-38	0.027	\$ 1.47	4.1
16	R-25	0.039	\$ 2.16	R-30	0.034	\$ 2.60	\$ 4.67	\$ 1.38	3.38	R-38	0.027	\$ 1.47	3.2

Figure 10: Cost-effectiveness of proposed assembly by climate zone and of the highest efficiency assembly analyzed by climate zone for nonresidential wood-frame roofs.[15]

ASHRAE CZ 4,5 ,6 Assembly	ASHRAE CZ4,5,6 U-Value	ASHRAE CZ 7 , 8 Assembly	ASHRAE CZ7, 8 U-Value
R-49	0.021	R-60	0.017

Figure 11: ASHRAE 90.1-2013 assemblies and corresponding U-Values for ASHRAE climate zones 4 through 8 for nonresidential wood-frame roofs.[16]

2. Outdoor Lighting Requirements

NRDC supports the proposed update to the outdoor lighting power allowance requirements. Given the advancements in lighting technology, in particular the progress in LEDs, the lighting power allowances are due for an update. The proposed values are feasible, cost-effective and will result in significant energy savings.

3. Indoor Lighting

NRDC supports the proposal to update the nonresidential indoor lighting requirements. In general, the CEC is proposing to bring the lighting requirements up to the levels required by ASHRAE 90.1-2013. However, there are certain space types that do not align with the ASHRAE categories for which LPD values have not been updated since at least the 2001 Title 24 Standards. Specifically, the values for general commercial/industrial work buildings, grocery stores, and theaters under the complete building method (Table 140.6-B) and commercial and industrial storage, corridors, restrooms, stairs and support

[15] October 2014 CASE Report "Nonresidential Opaque Envelope".
[16] ASHRAE 90.1-2013 Tables 5.5-4, 5.5-5, 5.5-6, 5.5-7 and 5.5-8

areas, exercise centers and gymnasiums, library stacks, and theaters (motion picture and performance) under the area category method (Table 140.6-C) have not been updated since 2001. These values are most likely no derived from the most recent technologies and therefore should be updated to reflect current technologies (high-performance T-8s and associated efficient ballasts, and LEDs for some applications that were based on technologies other than linear fluorscent). Additionally, NRDC generally supports the proposed changes to the lighting control language presented in the October 2014 CASE Report "Nonresidential Lighting Controls: Clarification and Control Credits." However we recommend that daylight dimming controls require that lighting is switched all the way off when the space is fully lit, as required by ASHRAE.

4. Elevator Ventilation and Cab Lighting, Escalator and Moving Walkway Speed Controls, Direct Digital Controls, and Operable Window/Door Switch Requirements

NRDC continues to support the proposed requirements for elevator ventilation and cab lighting, speed controls for escalators and moving walkways, direct digital controls, and the HVAC switch requirements for operable doors and windows.

5. HVAC and Water Heating Equipment

NRDC supports updating the Title 24 HVAC and water heating equipment levels to those adopted in ASHRAE 90.1-2013. DOE is currently reviewing its standards for ASHRAE equipment and will consider whether to update the standards to the ASHRAE levels or higher levels if warranted. NRDC, ASAP, NEEA and ACEEE submitted comments to DOE arguing that higher levels than those adopted in ASHRAE 90.1-2013 would lead to significant energy savings.[17] If DOE adopts higher efficiency levels in its final rule, CEC should update the requirements in Title 24 accordingly, as soon as possible.
We appreciate the opportunity to submit these comments and welcome further discussion on any of these comments.

Sincerely,

Meg Waltner
Manager, Building Energy Policy
Natural Resources Defense Council

[17] See ASAP et al comments: http://www.regulations.gov/#!documentDetail;D=EERE-2014-BT-STD-0015-0021