Codes and Standards Consulting

California's 2013 Residential Energy Efficiency Standards: Compliance Cost & Design Impact

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About the Foundation

Founded in 1978, the California Homebuilding Foundation (CHF) invests in the future of the homebuilding industry through endowments that provide college and graduate school scholarships and fund research on key public policy issues; compiles and publishes timely construction and new home statistics; provides training seminars; and supports high school courses to encourage young people to choose careers in the industry. The Foundation is the presenter of California's top industry award, the Hall of Fame, which recognizes industry leaders and offers their career examples as an inspiration to others.

Executive Summary:
Compliance Cost & Design Impact of the 2013 Energy Efficiency Standards

Statewide Average Compliance Cost:
In terms of a statewide average, the California Energy Commission's 2013 Update of the Residential Energy Efficiency Standards incorporates an increase in stringency of approximately 27% (above the 2010 code) and results in additional costs of $2,800 per home and $800 per apartment unit. While these costs will vary by climate zone and actual design, the $2,800 estimate includes the $465 increase in cost attributed to the pending increase in the federal appliance efficiency standards for air conditioners and furnaces. NOTE: A breakdown of compliance cost by climate zone can be found in Tables 1 & 2.

Central Valley Cost Impact:
At the request of industry, the CEC made significant last-minute changes to the proposed Standards which resulted in substantial reductions in the compliance cost for the Sacramento and Central Valley regions (a reduction from $5,800 of additional cost per home down to $2,700). This included, among other things, the removal of a proposed first-time requirement for roof-deck insulation.

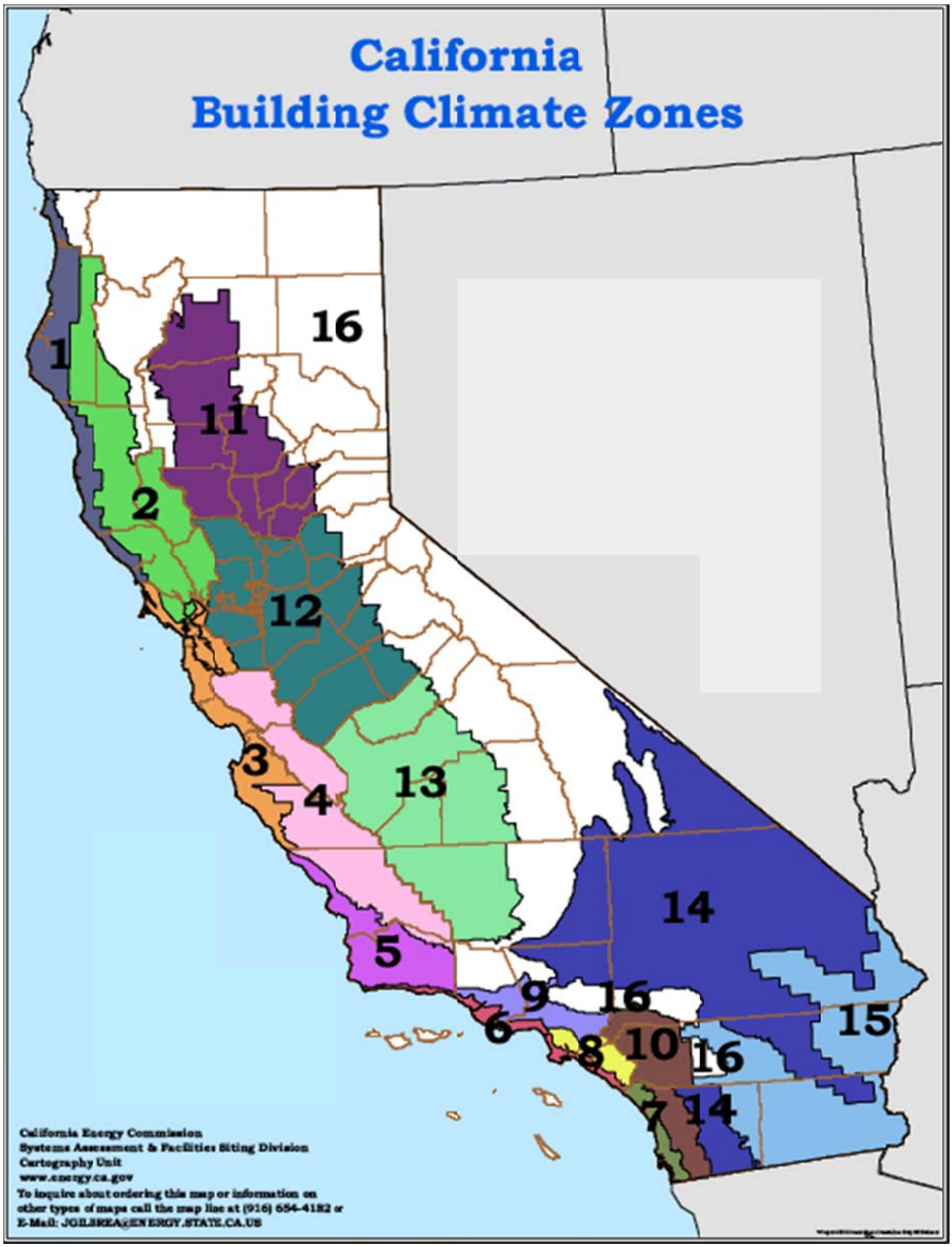
Diminishing Returns:
The 2013 Update marks the tenth time in thirty years that the CEC has adopted major revisions to their standards. During that 30-year period, the CEC has continued to focus their attention on the same design features (i.e.: HVAC, wall and ceiling insulation, windows and water heating) and the Standards have now reached a point where each new incremental increase in energy efficiency will cost significantly more than the last. Simply put, the low-cost "low-hanging fruit" is gone.

For example, achieving higher levels of wall insulation in those climate zones already requiring high levels of wall insulation requires a major change in standard design practice (i.e.: switching from standard 2x4 to either 2x6 or 2x8 wall construction) in order to allow for a deeper wall cavity, which provides more room for insulation at much higher compliance costs.

For this code cycle, these higher levels of wall insulation are being required in all climate zones with the result that the milder climate zones which have traditionally not borne a large burden in terms of increased cost are now being affected more heavily (Bay Area and Coastal Southern California).

Looking Ahead to 2020:
Looking forward, the issue of diminishing returns will become very problematic for both industry and the CEC in planning for the next two updates of the Standards (2016 and 2019). By law, any and all changes to the CEC's energy efficiency standards must be cost-effective. It some cases, it may not be possible for the CEC to increase the stringency levels required for many of the traditionally regulated features and still meet the statutory mandate of being "cost effective". As such, it is highly likely that the CEC will have to shift much of its focus to "appliance efficiency" and "plug load" reduction measures in order to continue to make significant, cost-effective reductions in the overall energy consumption of new homes.

Figure 1: California Climate Zones



Compliance Cost-Impact Summary

The data in the following summaries come from a survey of CBIA members (builders, subcontractors and consultants). In order to produce a more accurate understanding of the cost to the homebuyer the data includes the cost to the production builder, labor, and a 30% overhead and profit component. These costs were thoroughly vetted with CEC staff. It should be noted that the costs used by the CEC and CBIA were remarkably similar.

With regards to multifamily construction, the costs agreed upon between ConSol and the CEC to describe the increased costs of the standards are "scaled" based on the wall, roof, floor, and window areas of a prototype 16-plex building. The costs in the table below are the increased costs per individual dwelling unit, or 1/16 of the additional cost in the total building. Multifamily buildings do not require whole house fans, so compliance in Climate Zones 8-14 is not as costly compared to that seen in single family construction.

Incremental Cost Contributors

Incremental costs are the estimated additional costs above that incurred when building to just meet (not exceed) the existing 2010 Energy Efficiency Standards. The incremental costs associated with the new standards (effective 1/1/14) can be separated into three categories: mandatory features, prescriptive requirements, and the new federal appliance standards.

Mandatory Features

As the name implies, mandatory features must be adhered to for every home built in California. Therefore, the costs associated with these features are applicable to all construction.

Prescriptive Requirements

Prescriptive requirements vary by climate zone can be traded off with other efficiency measures via the whole building "computer performance" method as long as the resulting building uses no more energy than it would have if built to the prescriptive specifications for that climate zone. This approach provides increased design flexibility and requires the use of a computer model simulation using software approved by the California Energy Commission. The vast majority (>95%) of compliance with the energy efficiency requirements in California is done using this performance method. Please note that less costly compliance options may be available than those used in the "prescriptive requirement" portion of this analysis.

Federal (NAECA) Standards Requirements

The National Appliance Energy Conservation Act (NAECA) Standards are federal requirements regulating the efficiency of installed appliances such as air conditioners and furnaces. While these are not state requirements per se, the related compliance costs are included in this cost analysis. After all, from a compliance cost standpoint, whether a requirement is a federal or state mandate is irrelevant. More importantly, when the federal NAECA Standards take effect on 1/1/15, these provisions will be automatically incorporated into California's Standards, effectively increasing the stringency of the CEC's minimum energy efficiency standards that take effect on January 1, 2014. The NAECA Standards will require all air conditioners installed in California after 1/1/15 to be a minimum of 14.0 SEER and 12.2 EER. Previously there has been no EER minimum for air conditioners. The design implications of these staggered effective dates will be discussed further in the Compliance Design Impact Summary portion of this report.

Table 1: Single-Family Cost-Impact Summary

Climate Zone	Increased Stringency	Mandatory Feature Cost	Cost of prescriptive compliance	Cost of NAECA SEER/EER Increase	Total Cost to Builder
1	8.7%	$731	$-	$464	**$1,195**
2	28.8%	$731	$1,507	$464	**$2,702**
3	23.5%	$731	$1,199	$464	**$2,394**
4	22.8%	$708	$1,347	$387	**$2,441**
5	34.7%	$731	$1,199	$464	**$2,394**
6	14.5%	$722	$1,643	$387	**$2,751**
7	22.0%	$745	$1,643	$464	**$2,852**
8	38.7%	$722	$2,224	$387	**$3,332**
9	41.3%	$731	$2,224	$464	**$3,419**
10	34.9%	$735	$2,224	$541	**$3,500**
11	24.2%	$735	$1,524	$541	**$2,801**
12	26.0%	$731	$1,524	$464	**$2,720**
13	23.2%	$731	$1,524	$464	**$2,720**
14	17.4%	$735	$1,320	$541	**$2,597**
15	20.1%	$778	$508	$619	**$1,905**
16	10.3%	$708	$443	$387	**$1,538**
Permit Weighted Average	**27.5%**	**$730**	**$1,647**	**$463**	**$2,840**

Table 2: Multifamily Cost-Impact Summary

Climate Zone	Increased Stringency	Mandatory Feature Cost	Cost of prescriptive compliance	Cost of NAECA SEER/EER Increase	Total Cost to Builder
1	9.9%	$364	$108	$206	**$679**
2	10.4%	$364	$414	$206	**$984**
3	14.7%	$364	$473	$206	**$1,044**
4	17.1%	$364	$414	$206	**$984**
5	14.7%	$364	$473	$206	**$1,044**
6	11.9%	$377	$473	$206	**$1,056**
7	16.4%	$377	$473	$206	**$1,056**
8	36.4%	$377	$414	$206	**$997**
9	35.5%	$364	$414	$206	**$984**
10	31.9%	$164	$414	$206	**$784**
11	28.6%	$164	$167	$206	**$537**
12	32.4%	$164	$167	$206	**$537**
13	28.1%	$164	$167	$206	**$537**
14	24.4%	$164	$108	$206	**$479**
15	23.2%	$164	$108	$206	**$479**
16	13.3%	$364	$108	$206	**$679**
Permit Weighted Average	**26.2%**	**$271**	**$324**	**$206**	**$801**

Compliance Design Impact Summary

Mandatory Features

Wall Insulation

Under the 2013 Standards, builders will now be required to completely fill the wall cavity between studs with insulation (except when using spray-foam insulation). This applies to all exterior wall assemblies regardless of whether the builder is using 2x4, 2x6 or 2x8 studs. However, it should also be noted that the builder will receive additional (insulation) compliance credit if that exterior wall assembly is comprised of 2x6 or 2x8 studs because the CEC's base-case energy model assumes 2x4 wall design. This is the first time that there has been a mandatory feature that can also result in compliance credit.

R-4 continuous insulation (one-coat stucco) is now a part of the prescriptive requirement in all climate zones, and therefore the standard design for performance-based compliance.

Fan Watt Draw or Return Duct Sizing

Background: when a forced-air HVAC unit is turned on, a fan blows air through the system. This fan draws electricity and a "fan watt draw" test measures how much electricity the fan uses at full power. Reducing the wattage draw of the fan can significantly reduce the energy consumption attributed to the HVAC system.

Fan watt draw testing has become a mandatory measure in the 2013 code cycle. Unfortunately, this test takes place **after** the system is fully installed. Since many builders will not want to rely on a test that happens "post-construction" for compliance, the regulations allow the builder the option of increasing the size of the return duct intake grill to that specified in ***CEC Table 150.0-C*** (provided below) in lieu of completing fan watt draw testing. The table below requires return duct sizes that are double the size of (typical) current construction practice.

CEC TABLE 150.0-C: Return Duct Sizing for Single Return Duct Systems

Return duct length shall not exceed 30 feet and shall contain no more than 180 degrees of bend. If the total bending exceeds 90 degrees, one bend shall be a metal elbow. Return grille devices shall be labeled in accordance with the requirements in section 150.0(m)12A to disclose the grille's design airflow rate and a maximum allowable clean-filter pressure drop of 12.5 Pa (0.05 inches water) for the air filter media as rated in accordance with AHRI Standard 680 for the design airflow rate for the return grille.		
System Nominal Cooling Capacity (Ton)*	**Minimum Return Duct Diameter (inch)**	**Minimum Total Return Filter Grille Gross Area(inch^2)**
1.5	16	500
2.0	18	600
2.5	20	800
***Not applicable to systems with nominal cooling capacity greater than 2.5 tons or less than 1.5 ton		

Thermostats

Under the 2013 Standards, thermostats will be required to be capable of converting to an Occupant Controlled Smart Thermostat (OCST), meaning they have support for an internal communications device or for an expansion port that will allow for the installation of a removable module to enable communications with the thermostat. In other words, the thermostat does not have to communicate with the utility provider for Demand Response program purposes, but it must have the capability for such a feature to be installed at a later date.

Pipe Insulation

Pipe insulation thickness as outlined in ***CEC Table 120.3-A*** has increased, and the pipe diameters referenced have changed.

CEC TABLE 120.3-A PIPE INSULATION THICKNESS

FLUID TEMPERATURE RANGE (°F)	CONDUCTIVITY RANGE (in Btu-inch per hour per square foot per °F)	INSULATION MEAN RATING TEMPERATURE (°F)	NOMINAL PIPE DIAMETER (in inches)				
			1 and less	1 to <1.5	1.5 to < 4	4 to < 8	8 and larger
			INSULATION THICKNESS REQUIRED (in inches)				
Space heating, Hot Water systems (steam, steam condensate and hot water) and Service Water Heating Systems							
Above 350	0.32-0.34	250	4.5	5.0	5.0	5.0	5.0
251-350	0.29-0.31	200	3.0	4.0	4.5	4.5	4.5
201-250	0.27-0.30	150	2.5	2.5	2.5	3.0	3.0
141-200	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
105-140	0.22-0.28	100	1.0	1.5	1.5	1.5	1.5
Space cooling systems (chilled water, refrigerant and brine)							
40-60	1.21-0.27	75	0.5	0.5	1.0	1.0	1.0
Below 40	0.20-0.26	50	1.0	1.5	1.5	1.5	1.5

NAECA Standards

Air Conditioners

The latest revision of the National Appliance Energy Conservation Act (NAECA) Standards for air conditioner efficiency (14.0 SEER, 12.2 EER) takes effect on January 1, 2015; twelve months after the CEC's Standards take effect on January 1, 2014. To avoid the myriad of design, construction and compliance difficulties related to changing energy efficiency design within a 12-month period, it is highly recommended that compliance with the pending national change in air-conditioning efficiency be incorporated into energy compliance design at the same time all of the other state provisions that take effect on January 1, 2014. This will allow use of the same compliance design package for a full 3-year period. At the request of industry, the CEC has agreed to insure that the compliance software will be able to include (at the builder's request) the more stringent requirement early, so that the resulting design and compliance documentation will be able to be used throughout the full 3-year code cycle.

Caution: If this option is not chosen, any compliance documents generated on 1/1/14 will most likely be out of compliance after 1/1/15, when the new federal standard takes effect. Thus, new compliance documents will need to be generated at additional cost and resubmitted for local plan check approval.

Furnaces

The NAECA Standards for furnace Annual Fuel Utilization Efficiency (AFUE) will change to 80% at the national level on May 1, 2013. Unlike the NAECA standards for air conditioners, the CEC was able to incorporate this national change into the state standards that will take effect on January 1, 2014.

Lower air infiltration

In recognizing that builders have been building "tighter homes" in recent years, the CEC has made it more difficult for a builder to receive compliance credit for something the state now views as "standard practice". Specifically, the infiltration default in the standard design has been reduced from 3.5 SLA (equivalent to 7 ACH 50) to 2.5 SLA (or 5 ACH 50). This means that testing for a tighter home is unlikely to result in credit that can offset other costly features. The ASHRAE 62.2 mandatory ventilation requirement from the 2010 Standards has been carried forward in the 2013 Standards. It is good building science to ventilate the "tight" buildings the energy code demands.

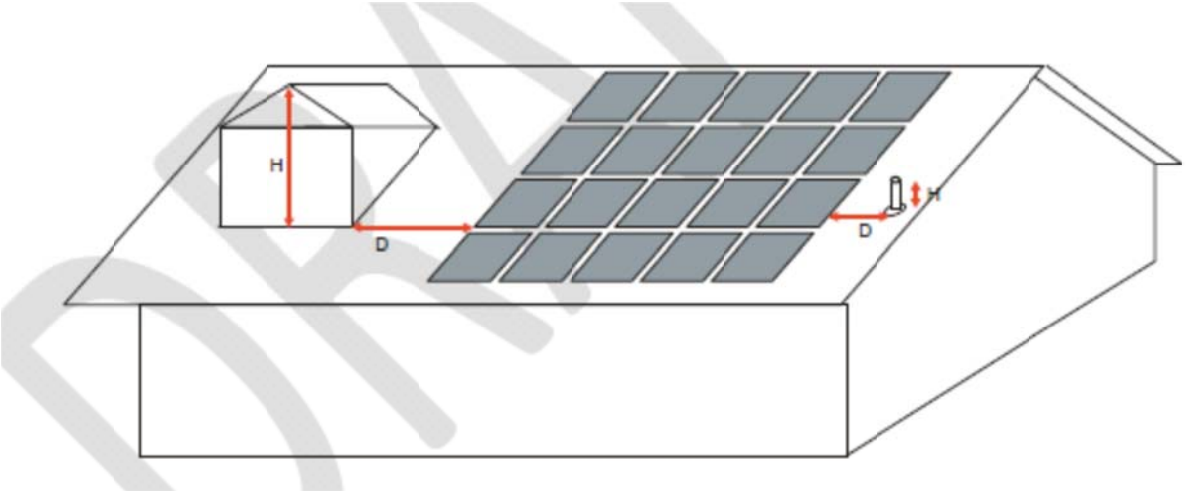
Solar Ready

Solar Ready requirements are new for the 2013 Standards. They include:

- Solar Zone – minimum area of 250 ft^2 reserved for solar, if multiple sections make up the solar zone, no section should be smaller than 80 ft^2 and no dimension smaller than 5 ft.
- Orientation – solar zone on slope 2:12 or greater must be oriented between 110 degrees and 270 degrees of true north
- Shading – Obstructions on the roof must be a distance of 2x the height of the obstruction from the zone, with the exception of obstructions to the north of all parts of the solar zone.
- Documentation
  - A location specified for inverters and metering equipment
  - A pathway for routing conduit from solar zone to point of connection
  - A pathway for routing plumbing from the solar zone to the water heating system
- Main Electrical Service Panel – (single family only) minimum busbar rating of 200 amps and a reserved space for the installation of a double pole circuit breaker.

Exceptions

- No zone required if a permanent solar electric system no less than 1000 watts is installed at construction
- No zone required if a domestic solar water heating system is installed at construction complying with the criteria in RA4
- Only 150 ft^2 required if 3 stories or more and 2000 ft^2 or less of total floor area
- Only 150 ft^2 required if there is a whole house fan and the residence is within the Wildland-Urban Interface Fire Area. This exception is to accommodate attic and roof venting requirements in these fire areas.
- Solar zone can be reduced to 50% of the potential solar zone area, meaning the total area of the roof where annual solar access is 70% or greater.
- The solar zone may be reduced to no less than 150 square feet if all thermostats in the residence are Occupant Controlled Smart Thermostats (OCST).



Appendix A:

An argument for a variable solar PV credit

As part of the 2013 Update, the CEC is for the first time allowing the installation of renewable energy to be used as a compliance "trade-off" with the energy efficiency standards. CBIA strongly supported the adoption of this as a compliance trade-off option. However, the CEC has placed significant limitations on the use of this new credit:

1. **The credit can only be used in climate zones 9-15**

2. The credit is allowed only when using the performance method of compliance

3. The credit can only be used in cases where Federal Air Conditioning (NAECA) standards are incorporated into the standard design (can occur prior to 1/1/15 by builder's choice)

4. The user enters minimum installed kWdc into compliance software. In accordance with Residential Appendix RA4.6.1(b), this must be **2 kWdc or larger**

5. The compliance software calculates the PV Credit (kTDV/ft^2) which is equal to <u>whichever is less</u> of PV installed (Equation 1) or PV maximum (Equation 2)

6. The PV Credit (kTDV/ft^2) is subtracted from the proposed design energy

Equation 1:
PV installed (kTDV/ft^2) = PV Generation Rate (kTDV/kWdc) * minimum installed kWdc / conditioned floor area (ft^2)

Equation 2:
PV maximum (kTDV/ft^2) = PV Cooling Credit * Standard Design Cooling Energy (kTDV/ft^2) / 100

Therefore, Climate Zones 1-8 and 16 will not benefit from the solar credit. It is not true that there is no benefit to adding solar in these areas, or solar ready mandatory requirements would not apply to these climate zones. As Table 3 and 4 below shows, PV production in Climate Zones 4 and 7 are very similar to in the other climate zones. As such, it does not make sense to not extend the credit to all climate zones.

Table 3 PV production in five key climate zones

Climate Zone		4 Sunnyvale	7 San Diego	10 Riverside	12 Sacramento	14 China Lake
Total Home TDV of 2013 compliant home		74,819	53,972	66,199	81,755	87,071
Solar PV system of size ___ Production in kBtu	1.2 kW	5,603	5,811	5,360	5,633	5,852
	2.4 kW	11,359	11,887	11,243	11,543	12,478
	3.6 kW	17,156	17,855	16,528	17,340	18,002
	4.8 kW	22,997	23,867	22,028	23,120	24,007

The large, bold numbers in Table 4 (below) represent the three of these five climate zones for which the CEC is proposing to allow credit. In addition to the climate zone restriction, the CEC's proposed credit offers the same amount of credit regardless of the size of the system, as long as it is above 2kW. Below 2kW, the CEC offers no credit. Although as shown in Table 4, larger system sizes continue to make a difference in the net energy use, without creating more energy than the home can use, the credit does not offer any additional incentive. With regards to "compliance credit", there is no reason under this system for a builder to add a system larger than 2kW, even if it would be beneficial.

Table 4 Effect of PV in five key climate zones

Climate Zone		4 Sunnyvale	7 San Diego	10 Riverside	12 Sacramento	14 China Lake
% TDV energy 2013 code compliant home uses compared to 2008 budget		77%	78%	65%	74%	83%
% of 2008 energy budget used by 2013 compliant house with PV system of size ___	1.2 kW	70%	67%	57%	67%	76%
	2.4 kW	62%	56%	**48%**	**60%**	**68%**
	3.6 kW	54%	45%	40%	53%	62%
	4.8 kW	46%	34%	32%	46%	55%
approximate % of regulated load that can be offset in the CEC proposal		-	-	**8%**	**6%**	**10%**