

Codes and Standards Consulting

California's 2016 Residential Energy Efficiency Standards: Compliance Cost & Design Impact

September, 2015



FUNDED THROUGH A GRANT FROM:



California
Homebuilding
Foundation®

Scholarship | Research | Education

Codes and Standards Consulting

California's 2016 Residential Energy Efficiency Standards: Compliance Cost & Design Impact

September, 2015

FUNDED THROUGH A GRANT FROM:



California
Homebuilding
Foundation®

Scholarship | Research | Education

1215 K Street, Ste. 1200
Sacramento, CA 95814
916-340-3340
mychf.org

The **California Homebuilding Foundation** invests in the future of homebuilding through: Endowments that provide scholarships and fund industry research; publishing current construction and new home statistics; presenting training seminars; and supporting high school courses that encourage young people to choose careers in the industry. The Foundation also hosts California's top industry award, Hall of Fame.

PREPARED BY:



5757 Pacific Avenue, Ste. 220
Stockton, CA 95207
209-473-5000
consol.ws

ConSol has been providing energy solutions for builders, government agencies, utilities, trade associations and developers since 1983. ConSol services include: energy efficiency, retrofit, and green program design and management; building audits; builder energy code training; and consulting services for the residential and commercial building industry. ConSol offers leading-edge research and energy consulting in systems, technologies and codes to improve sustainability of new and existing residential and commercial buildings and developments. ConSol is dedicated to helping our clients in the Western U.S. provide resource-efficient homes and buildings that are efficient, affordable and sustainable.



Codes and Standards Consulting

California’s 2016 Residential Energy Efficiency Standards: Compliance Cost & Design Impact

September, 2015

Table of Contents

- Executive Summary** 3
- Compliance Cost and Design Impact of the 2013 Building Energy Efficiency Standards 3
- Changes to Code Effective January 1, 2017 4
- Looking Ahead to 2020 and the Goal of Residential ZNE 4
- Compliance Cost Impact Summary** 4
- Incremental Cost Contributors..... 5
- Mandatory Features 5
- Prescriptive Requirements and Performance Budgets 5
- Statewide Average Compliance Cost..... 5
- Coastal Cost Impact..... 5
- Title 24 Compliance Credit for Renewable Energy Sources**..... 6
- Compliance Design Impact Summary** 6
- Prescriptive Measures** 6
- High Performance Attics 6
- High Performance Walls..... 7
- Instantaneous (Tankless) Water Heating 8
- Mandatory Features**..... 8
- Maximum 5% Duct Leakage 8
- Mandatory High Efficacy Lighting 8
- Appendix A - Incremental Costs and Increases in Stringency for the 2016 Standards** 9

Executive Summary

Compliance Cost and Design Impact of the 2016 Building Energy Efficiency Standards

This report examines the incremental costs to builders associated with changes to California’s Energy Efficiency Standards that have been adopted and will take effect on January 1, 2017. In addition to the traditional increases in stringency and introduction of new efficiency measures that have accompanied every update to Title 24, the 2016 Standards will, for the first time, offer a significant compliance credit for on-site rooftop solar photovoltaic (PV) energy systems in many California climate zones. This report also examines the structure of the proposed PV credit and how the introduction of PV as a compliance measure will likely affect compliance costs as the State moves towards the goal of Zero Net Energy (ZNE) for 2019.

Figure 1: California Energy Commission Climate Zones



Table 1: 2016 Cost Impact Summary

Climate Zone	Single Family Incremental Cost	Multifamily Incremental Cost
1	\$1,790	\$918
2	\$2,136	\$1,003
3	\$1,790	\$918
4	\$3,006	\$1,003
5	\$1,790	\$918
6	\$1,182	\$734
7	\$1,182	\$734
8	\$2,584	\$1,003
9	\$2,584	\$1,003
10	\$2,584	\$1,003
11	\$2,238	\$918
12	\$2,453	\$918
13	\$2,238	\$918
14	\$2,238	\$918
15	\$2,660	\$918
16	\$2,660	\$918
Weighted Statewide	\$2,353	\$944

There are four major changes to Title 24 that will be effective January 1, 2017, as detailed in the following section. The incremental cost to builders for single-family homes ranges from roughly \$2,800 per home for houses built in the State’s interior, climate zones which are affected by all four changes, to roughly \$1,300 per home for houses built in mild coastal climate zones – some of which are only affected by two of the four changes. For multi-family buildings, the incremental cost ranges from about \$900 per unit to about \$1,000 per unit in various climate zones (See Table 1).

Also, since the amount of credit builders can claim for solar PV systems is directly tied to the two efficiency

measures that affect primarily interior climate zones, the impact of the credit varies between different regions of the State.

Changes to Code Effective January 1, 2017

The most significant changes to the Standards fall into four categories:

1. High Performance Attics – the following attic configurations qualify as high performance attics:
 - Insulation at the roof deck + insulation at the ceiling
 - Locating ducts in conditioned space + insulation at the ceiling
2. High Performance Walls – u-value of 0.051 which equates to 2x6” 16 IOC plus R-5 sheathing
3. Instantaneous Water Heaters (IWH) – 0.82 Energy Factor tankless water heater
4. High Efficacy Lighting (primarily LED) – hard-wired lighting to be LEDs throughout the dwelling unit

Looking Ahead to 2020 and the Goal of Residential ZNE

The California Energy Commission (CEC) must reconcile a relatively recent State policy goal¹ to achieve ZNE for all residential new construction by 2020 with a long-standing statutory requirement² that all new code requirements must meet cost-effectiveness thresholds. These thresholds determine whether or not a new energy efficiency requirement is cost effective by evaluating whether the incremental cost of the proposed requirement is lower or higher than the Net Present Value (NPV) of the energy savings expected to be accrued over the lifetime of the measure. Now that all of the “low hanging fruit”—or low-cost efficiency measures—has been integrated into the code, it is more and more difficult to identify measures that meet this cost-effectiveness test, especially in the mild coastal climates. In some cases, it may not be possible for the CEC to increase the stringency levels beyond the current code and meet the statutory mandate of being cost effective. An alternative to continuing to increase the efficiency of current measures is to work with the building industry to change standard practices as a means to achieve ZNE homes. Examples of this are the adopted high performance attics and high performance wall requirements for 2016. To reach ZNE, the amount of compliance credit available for rooftop solar PV systems will also play an important role in the 2019 code adoption cycle.

Compliance Cost Impact Summary

The cost data in the preceding summary comes from ConSol’s database of costs collected from suppliers, builders, distributors, vendors, and subcontractors throughout 2014, and reviewed for accuracy by CBIA members in the purchasing departments of large homebuilders. In order to produce a more accurate understanding of cost to the home buyer, the data includes the cost that a production builder would expect to pay for materials, labor, and a 30% overhead and profit component. These costs were vetted with CEC staff, CEC consultants and the IOU CASE team.

Multi-family costs are determined on a per-dwelling-unit basis. Envelope measures, which for the 2016 Standards are limited to high performance attics and high performance walls, are calculated on a per-building basis, and then divided by the number of units in the building. Lighting and water heating measures were calculated directly on a per-unit basis. Since the California Building Energy Code Compliance (CBECC) software assumes that ducts are located in conditioned space within the 2013 Standards, the introduction of the prescriptive options of ducts in conditioned space (DCS) is assumed to be a zero-cost measure, since it is assumed that multi-family builders will continue to locate ducts in conditioned space and incur no additional cost.

¹ 2010 CPUC Energy Efficiency Strategic Plan: Targets for ZNE buildings

² Warren-Alquist State Energy Resources Conservation and Development Act of 1974

Incremental Cost Contributors

Incremental costs are the estimated additional costs above those incurred when building just to meet (not exceed) the existing 2013 Standards. The incremental costs associated with the new 2016 Standards (effective Jan 1, 2017) can be separated into two categories: mandatory features and prescriptive features. The permit weighted increase in stringency between the 2013 and 2016 Standards is 23%. The average incremental cost to meet the 2016 Standards for single-family homes is \$2,353 and for multi-family units is \$944. These costs include the mandatory measures and prescriptive measures.

Mandatory Features

As the name implies, mandatory requirements apply to every dwelling unit built in California. Therefore, the costs associated with these features are applicable to all residential construction three stories or less. The mandatory feature with the greatest cost impact for 2016 is lighting.

Prescriptive Requirements and Performance Budgets

The energy efficiency requirements are based on a prescriptive package of energy features which vary by climate zone. These energy features can be traded off with other efficiency measures via the whole-building “computer performance” method, as long as the resulting design 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 computer model simulation software approved by the CEC.

This report focuses on the cost of meeting the 2016 Standards via the prescriptive path. In the past, builders could find substantially lower cost methods of achieving compliance using the performance path. However, the updated Standards, effective January 1, 2017, have become so stringent that nearly every cost-effective efficiency measure has already become part of the prescriptive standards, leaving fewer and fewer options for lower cost trade-offs. Therefore, prescriptive costs for the 2016 Standards will come very close to representing actual performance-based costs.

Statewide Average Compliance Cost

The single-family estimate is a blend of cost data developed for two separate prototypical home designs. The first design is a 2,100 square foot single-story design and the second is a two-story, 2,700 square foot design. Blending the costs prevents any one particular measure from skewing the cost towards one or two story designs. The multi-family cost estimates assume a 6,960 square foot, two-story building with 8 dwelling units.

The costs for both single-family and multi-family are weighted to reflect the relative amount of construction activity in each climate zone when developing a statewide average, which helps to avoid allowing an area with very low construction activity to skew cost data. Weighting is done using CIRB (Construction Industry Research Board, a service provided by the California Homebuilding Foundation (CHF)) permit data by climate zone (the most recent data is from 2013). Permit data was also sorted by single-family and multi-family construction, as the permits for the two types of housing are quite different from one another.

Coastal Cost Impact

The mild climates throughout much of coastal California create low demand for space conditioning, the

primary source of regulated energy consumption within the home. This leaves fewer opportunities to save significant amounts of energy through heating and cooling load reduction than the opportunities available inland. As a result, several mild, coastal regions have been exempted from the high performance attic and high performance wall requirements, reducing the cost of compliance in those regions.

Title 24 Compliance Credit for Renewable Energy Sources

Given the inevitable need to begin incorporating renewable energy into the Standards to meet California's ZNE goal for 2020, in 2013 the CEC opened the door to a very minor amount of compliance credit from solar PV. The solar industry and the homebuilding industry have had several discussions with the CEC about adding flexibility and capacity to the amount of Title 24 compliance credit from solar PV.

The current proposal for allowing a larger PV credit in the 2016 Standards sets minimum system sizes in order for a project to be eligible to take Title 24 compliance credit, as well as maximums for the amount of energy generated by the system that can be counted towards compliance. The minimum size is a 2kW system for homes up to 2,000 square feet, while homes over 2,000 square feet would have a larger minimum system size, as determined by a formula that will reside in the ACM Reference Manual. The CEC has released an "alpha" version of the CBECC software that calculates the PV credit for a home according to the currently proposed Reference Manual language.

Under the current proposal, the compliance credit will be determined by calculating the difference in the compliance total (kTDV/ft²) between a home with a high performance attic and high performance walls and a home without those features (attics and walls that comply with the 2013 Prescriptive Requirements). That difference is the PV maximum compliance credit, and it is expressed as a percentage of the 2016 standard design. The maximum amount of compliance credit that can be taken for any particular home is variable and will be of little or no benefit to builders in mild climate zones. Per Energy Commission staff, the statewide maximum PV compliance credit is 19.8%, weighted by housing starts and climate zone. If a home is constructed in a climate zone without new high performance attic and high performance wall requirements, it will not be allowed to claim any compliance credit for a PV system of any size.³

Compliance Design Impact Summary

Prescriptive Measures

High Performance Attics

The most significant change to the Standards for 2016, in terms of cost, statewide energy savings, and impact on traditional construction practice, is the introduction of the high performance attic requirement in California Climate Zones 4 and 8-16. The primary objective of this new prescriptive requirement is to reduce energy lost from ducts, which are typically located in attics of newly constructed California homes. There may be additional energy savings associated with the reduction of heat gained or lost in the interior of the home, but most of the savings will be associated with reduced duct losses. As such, an alternative

³ http://energy.ca.gov/title24/2016standards/postadoption/documents/15-BSTD-04_documents/2015-08-10_workshop/2016-08-21_Residential_PV_Credit_ACM_Reference.pdf.

prescriptive compliance option is to locate ducts in conditioned space. However, this approach requires reduction of interior (living space) volume or the development of sealed attic chases or other complex new methods to create limited conditioned space within the unconditioned attic. Given these drawbacks, ducts in conditioned space is likely to be a less popular prescriptive approach, so this cost research focuses on the prescriptive high performance attic options.

The 2016 Standards will offer two prescriptive methods for constructing high performance attics, both of which will be ventilated attic designs. Both of the prescriptive options either retain or increase the amount of ceiling insulation in addition to requiring roof deck insulation, depending on climate zone. In Climate Zones 4 and 8-16, builders will have the option to include above-deck R-6 rigid foam insulation on roofs with air space between the roof deck and the roofing material—the typical design for tile roofs. If the roof has no air space (the typical design for composition shingles) the prescriptive requirement will be R-8. In either case, if above-deck rigid insulation is selected as the prescriptive compliance path, a radiant barrier will be required as well.

In contrast, if builders choose to follow the other prescriptive high performance attic option—below deck insulation—no radiant barrier will be required. However, the required R-values will be higher for below-deck insulation—R-13 for roof systems with air space and R-18 for those without. These higher R-values account for the fact that the insulation will only fill cavities and will still allow a substantial amount of thermal bridging through rafters, as opposed to continuous above-deck insulation.

The cost and performance of R-6/R-8 above deck plus radiant barrier will be similar to R-13/R-18 insulation below deck. However, below deck insulation will be a less expensive method and will also save slightly less energy on a statewide basis. It will be the prescriptive option that is used to set the standard design budget for the performance approach for compliance, and therefore, it is the system that was used to develop incremental cost estimates in this report.

In Climate Zones 2, 4, and 8-10 the prescriptive R-value for ceiling insulation will increase from R-30 to R-38. All other climate zones will retain the same prescriptive values from 2013. However, it should be noted that the minimum mandatory R-value for attic insulation (either at the ceiling, roof deck, or a combination of the two) will be reduced from R-30 to R-22. This reduction will allow installers to reach the minimum value using one application of spray foam, saving time and money when using this performance approach.

High Performance Walls

In all climate zones aside from 6 and 7, the U-factor for exterior walls will be reduced from 0.065 to 0.051. Unlike previous versions of the Standards, the adopted code language does not include references to specific rigid foam and cavity insulation combinations (e.g., R-15+4) that can achieve this performance value. However, for the purpose of costing and evaluating the new high performance wall requirement, this analysis assumes that the builder will use 2"x6" construction (rather than 2"x4") in order to create a wall cavity large enough for R-19 insulating batts. In addition, the exterior of the building will need to be sheathed with an R-5 rigid board to arrive at an overall U-factor of 0.051, or "R-19+5".

Achieving any lower (more stringent) U-factor than 0.051 (as originally proposed by the CEC) would require either the use of substantially more costly materials, or foam sheathing exceeding 1.25" in thickness. The building industry is highly resistant such a change since it would cause problems with supporting weight of windows, could allow moisture penetration and accumulation, and might create other unforeseen construction challenges or defects.

Even meeting the 0.051 prescriptive requirement will require the use of 2x6 construction or finding other measures to trade-off against this stringent new wall U-factor. However, advanced framing techniques using 24" O.C. 2x6 construction can further reduce U-factors, providing opportunities for additional compliance credit for builders willing to embrace advanced framing.

Instantaneous (Tankless) Water Heating

Following earlier changes to Title 24 that required “readiness” for instantaneous water heaters (IWHs), the 2016 code will include a prescriptive requirement for water heaters to have an Efficiency Factor (EF) of 0.82 or higher, which in essence requires an IWH since conventional tank water heaters cannot meet this EF. This requirement will apply to all California climate zones, but will represent a much larger percentage of the energy budget in mild, coastal climate zones where heating and cooling demand is low and envelope measures do not offer substantial savings. Since the 2013 code already requires “readiness”, moving to IWHs should not mark a substantial change in building practice. Despite a steady decline in cost and improvement in quality since their introduction to the market, IWHs are still more expensive than conventional water heaters and some questions remain regarding maintenance and lifespan. In an effort to address the maintenance issues, the CEC has also proposed a new mandatory requirement for an isolation valve to be installed in the water supply line serving the water heater. If done at the time of installation, including an isolation valve will add negligible cost, and was not included in incremental costs shown above.

Mandatory Features

Maximum 5% Duct Leakage

Under the 2016 Standards, the mandatory maximum duct leakage will be reduced from 6% to 5%. In most cases this reduction will be achieved by using a low-leakage air handler. Although the addition of a low-leakage air handler will create additional cost, the builder will also be able to claim compliance credit above and beyond the mandatory 5% duct leakage. This additional compliance credit will offset the additional cost, so this change to mandatory requirements will not be viewed as an incremental cost.

Mandatory High Efficacy Lighting

Under the Standards proposed for 2016, all lighting will be required to meet the definition for “high-efficacy,” as defined by the CEC’s Joint Appendices document, section JA-8. This change will reduce the emphasis on lighting controls as a way of saving energy in residential applications, and instead focus on the light source itself, which can no longer be incandescent. Although the Standards do not specifically require LED, it will likely be the only lighting technology that meets all JA-8 requirements for flicker, dimability, color rendering index (CRI) and efficacy (lumens-per-watt). The 2016 Standards will focus on the bulb, or lamp, rather than restricting the type of mount (base) for the majority of residential lighting fixtures. This means that standard fixtures will be allowed to use “Edison” (screw-based) traditional bulb mounts. The efficacy, light quality, lifespan, and several other metrics will be closely regulated by JA-8, and enforced through labeling requirements. The presumption is



Figure 2: Recessed LED with Quick Connect

that by requiring top-quality lamps to be installed at the time of inspection will virtually eliminate the risk that consumers would replace the lamps with screw-based incandescent bulbs.

Screw-based mounts will not be allowed for recessed lighting due to concerns about heat dissipation. Instead, the new regulations will require “integral” LEDs or other JA-8 compliant light sources that connect to the can through “quick connect” wiring, as pictured in Figure 2. Although the recessed lighting requirements are more restrictive than the code language surrounding standard fixtures, the market already offers many choices of quick-connect recessed LED products. These products are primarily aimed at the retrofit market and include a screw-based adaptor as well as a quick-connect. Present-day pricing for integral LED recessed lights is also around \$13 each, which equates to an incremental cost of \$263 for a typical home. However, the design of these products eliminated the need for a trim kit, which costs \$5, for a total savings of \$132 per home. Altogether the incremental cost increase from the lighting code changes is estimated to be \$359, which is virtually identical to the figure developed by the CEC and IOU CASE team.

Appendix A - Incremental Costs and Increases in Stringency for the 2016 Standards

The CEC’s goal of “code simplification” means a shift away from uniquely tailored prescriptive packages for each climate zone and toward a system in which a large number of climate zones share the same prescriptive package. However, determining the incremental cost of the increased stringency in each climate zone requires understanding of not just the cost of materials and labor to meet the current standards—which are relatively uniform—it is also necessary to understand the cost of meeting the previous (2013) Standards, which are less so.

Tables 2, 3, and 4 show the prescriptive and mandatory measures for each climate zone in each code cycle—2013 and 2016—for single-family homes. Those climate zones that have the same requirements as each other for both 2013 and 2016 (e.g. Climate Zones 3 and 5) have been grouped together. The climate zones are separated based on whether or not they include a whole house fan requirement. There are nine climate zones with no prescriptive requirement for whole house fans and seven climate zones in which they are required. Although the climate zones to which the requirement applies have not changed between the code cycles, the CEC has changed two requirements related to whole house fans, both of which result in cost savings to the builder. These changes include:

1. Reducing the rate of airflow for the whole house fan from a ratio of 2 Cubic Feet per Minute (CFM) per square foot to 1.5CFM/sq. ft., which reduces the cost of the fan.
2. Reducing the amount of Net Free Vent Area (NFVA) for attics with whole house fans from a ratio of 1 square foot of vent area to every 375CFM of fan volume to 1 square foot of vent area to 750CFM of fan volume, which reduces the number of ridge and soffit vents that need to be installed.⁴

In the climate zones with new high performance attic requirements, the cost of improved duct insulation and ceiling insulation were grouped together with roof deck insulation to develop a cost estimate for the high performance attic as a whole, so these costs are shown as a single figure (e.g. Climate Zone 4). In

⁴ This new requirement more closely aligns with the 1:300 attic vent ratio requirement that applies to all vented attics.

climate zones without a high performance attic requirement, changes to ceiling and duct insulation costs are broken out separately (e.g. Climate Zone 2). Tables 5 and 6 show the multifamily cost increase for all climate zones.

An example of the process used to arrive at the per-measure-costs is shown in Table 7 below. The cost of the labor and material required to meet 2013 code was compared to the cost of the labor and material to meet 2016 code on a per-unit basis. Units were in some cases per-square-foot, as used for insulation, and in other cases per-item, as used for ridge and soffit vents in the example. The unitary costs were then multiplied by the appropriate quantity or dimension for each of the two homes. Finally, the costs were averaged to develop a “blended” cost for a typical home.

Table 2: 2013 vs. 2016 Code Requirements and Associated Cost Increases in Climate Zones without Prescriptive Whole House Fan⁵

CZ	1			2			3 and 5		
Code Year	2013	2016		2013	2016		2013	2016	
Roof Deck Insulation		NA			NA			NA	
Ceiling Insulation	R-38	R-38		R-30	R-38	\$ 346	R-30	R-30	
Radiant Barrier	NR	NR		REQ	REQ		REQ	REQ	
Wall U-Value	0.065	0.051	\$ 608	0.065	0.051	\$ 608	0.065	0.051	\$ 608
Duct Insulation	R-6	R-8	\$ 215	R-6	R-8	\$ 215	R-6	R-8	\$ 215
Duct Leakage Target	6%	5%		6%	5%		6%	5%	
Lighting			\$ 359			\$ 359			\$ 359
Water Heating (Type / EF)	50 gal / 0.58	IWH / 0.82	\$ 608	50 gal / 0.58	IWH / 0.82	\$ 608	50 gal / 0.58	IWH / 0.82	\$ 608
	\$ 1,790			\$ 2,136			\$ 1,790		

Table 3: 2013 vs. 2016 Code Requirements and Associated Cost Increases in Climate Zones without Prescriptive Whole House Fan

CZ	4			6 and 7			15 and 16		
Code Year	2013	2016		2013	2016		2013	2016	
Roof Deck Insulation		R13	\$ 1,431		NA			R13	\$ 1,085
Ceiling Insulation	R-30	R-38		R-30	R-30		R-38	R-38	
Radiant Barrier	REQ	NR		REQ	REQ		REQ	NR	
Wall U-Value	0.065	0.051	\$ 608	0.065	0.065		0.065	0.051	\$ 608
Whole House Fan	NR	NR		NR	NR		NR	NR	
Duct Insulation	R-6	R8	Incl. w/	R-6	R-8	\$ 215	R-8	R8	Incl. w/
Duct Leakage Target	6%	5%	Above	6%	5%		6%	5%	Above
Lighting			\$ 359			\$ 359			\$ 359
Water Heating (Type / EF)	50 gal / 0.58	IWH / 0.82	\$ 608	50 gal / 0.58	IWH / 0.82	\$ 608	50 gal / 0.58	IWH / 0.82	\$ 608
	\$ 3,006			\$ 1,182			\$ 2,660		

⁵ If Ducts in Conditioned Space is selected as the prescriptive option, duct insulation and minimum leakage values are relaxed, since it is presumed that any leakage or energy lost will be lost into conditioned space and not be “wasted”.

Table 4: 2013 vs. 2016 Code Requirements and Associated Cost Increases in Climate Zones with Prescriptive Whole House Fan

CZ	8, 9 and 10			11, 13, and 14			12		
Code Year	2013	2016		2013	2016		2013	2016	
Roof Deck Insulation		R13	\$ 1,431		R13	\$ 1,085		R13	\$ 1,085
Ceiling Insulation	R-30	R-38		R-38	R-38		R-38	R-38	
Radiant Barrier	REQ	NR		REQ	NR		REQ	NR	
Wall U-Value	0.065	0.051	\$ 608	0.065	0.051	\$ 608	0.065	0.051	\$ 608
Whole House Fan	2 CFM/sqft	1.5 CFM/sqft	\$ (100)	2 CFM/sqft	1.5 CFM/sqft	\$ (100)	2 CFM/sqft	1.5 CFM/sqft	\$ (100)
Sqft. Of Attic Vent Free Area/CFM	1:375	1:750	\$ (322)	1:375	1:750	\$ (322)	1:375	1:750	\$ (322)
Duct Insulation	R-6	R8		R-6	R8		R-6	R8	\$ 215
Duct Leakage Target	6%	5%		6%	5%		6%	5%	
Lighting			\$ 359			\$ 359			\$ 359
Water Heating (Type / EF)	50 gal / 0.58	IWH / 0.82	\$ 608	50 gal / 0.58	IWH / 0.82	\$ 608	50 gal / 0.58	IWH / 0.82	\$ 608
			\$ 2,584			\$ 2,238			\$ 2,453

Table 5: 2013 vs. 2016 Code Requirements and Associated Cost Increases for Multifamily Units

CZ	1, 3 and 5			2 and 4			6 and 7		
Code Year	2013	2016		2013	2016		2013	2016	
Roof Deck Insulation		N/A			N/A	\$ 85		N/A	
Ceiling Insulation	R-30	R-38		R-38	R-38		R-38	R-38	
Radiant Barrier	NR	NR		REQ	NR		REQ	NR	
Wall U-Value	0.065	0.051	\$ 184	0.065	0.051	\$ 184	0.065	0.051	
Duct Insulation	R-6	R8		R-6	R8		R-6	R8	
Duct Leakage Target	6%	5%		6%	5%		6%	5%	
Lighting			\$ 171			\$ 171			\$ 171
Water Heating (Type / EF)	50 gal / 0.58	IWH / 0.82	\$ 563	50 gal / 0.58	IWH / 0.82	\$ 563	50 gal / 0.58	IWH / 0.82	\$ 563
			\$ 918			\$ 1,003			\$ 734

Table 6: 2013 vs. 2016 Code Requirements and Associated Cost Increases for Multifamily Units

CZ	8, 9 and 10			11 through 16		
Code Year	2013	2016		2013	2016	
Roof Deck Insulation		R13	\$ 85		R13	
Ceiling Insulation	R-30	R-38		R-38	R-38	
Radiant Barrier	REQ	NR		REQ	NR	
Wall U-Value	0.065	0.051	\$ 184	0.065	0.051	\$ 184
Duct Insulation	R-6	R8		R-6	R8	
Duct Leakage Target	6%	5%		6%	5%	
Lighting			\$ 171			\$ 171
Water Heating (Type / EF)	50 gal / 0.58	IWH / 0.82	\$ 563	50 gal / 0.58	IWH / 0.82	\$ 563
			\$ 1,003			\$ 918

Table 7: Example of Data Used to Estimate Incremental Costs—High Performance Attic for Single and Multifamily Home

Vented Attic -- Prescriptive Option "B"		Vented attic with netting and R-13 blown fiberglass insulation below roof deck.				
Item	From (2013 Code)	To (Proposed for 2016)	Incremental Unit Cost-- Materials	Incremental Unit Cost-- Labor	Blended Net Cost -- Typical California Single Family Home	Blended Net Cost -- Typical California Multifamily Home
Ceiling Insulation	R-30 at Ceiling	R-38 at Ceiling	\$0.15	\$0.00	\$ 346	
Roof Deck Insulation	No Insulation at Roof Deck	Draped Netting for R-13 Below Deck	\$0.13	\$0.15	\$ 689	
Roof Deck Insulation	No Insulation at Roof Deck	Cellulose fill for R-13 Below Deck	\$0.18	\$0.15	\$ 812	
HERS Verification	No Verification Requirements	Roof Deck QII	\$50.00	\$0.00	\$ 65	
Radiant Barrier	Radiant Barrier at Roof Deck	No Radiant Barrier	-\$0.09	\$0.00	\$ (221)	
Attic Ridge Vents (Reduction in NFVA)	1:150	1:300	\$22.00	\$20.00	\$ (322)	
Attic Soffit Vents (-NFVA)	1:150	1:300	\$22.00	\$20.00		
Increase Duct Insulation	R-6	R-8	\$0.66	\$0.00	\$ 212	
Reduce WHF	2 cfm/s.f.	1.5 cfm/s.f.	\$100.00	\$0.00	\$ (100)	
*All costs include 30% markup to cover builder overhead and profit				TOTAL	\$ 1,481	\$679 (\$85/unit)