MEMORANDUM

DATE: November 4, 2016

TO: Planning Commission and
Open Space and Ecology Committee

FROM: Ken Johnson, Senior Planner

SUBJECT: State Building Code Update and Adoption

The City is in the process of updating its Building Code consistent with the State's triennial update of the California Building Code (CBC) which will take effect January 1, 2017. The Code update will be scheduled for City Council review in December 2016.

As occurs in every code update cycle, the 2017 update has implications on a series of City-adopted "reach codes", which are local ordinances that exceed state mandated requirements in specific topic areas. The City of Brisbane has building/development site related reach codes for indoor and outdoor water conservation, waste recycling and diversion, and green buildings.

The purpose of this memorandum is to address how City reach codes will be impacted by the 2017 CBC and to discuss how City environmental and sustainability-related goals associated with building construction will be addressed. One of the key proposed code amendments is to add a new energy generation/conservation reach code, which is to be included for Council's consideration. This is consistent with the City's Climate Action Plan (CAP) goal of reducing the City's carbon footprint to aid in reducing the future impacts of increased global warming.

Energy Generation/Conservation: As indicated above, consistent with the CAP and as has been expressed multiple times by members of the Planning Commission and OSEC, newly proposed energy generation and conservation ordinance provisions are proposed in conjunction with this CBC adoption.

By way of background, with the current 2013 CBC cycle, the estimated improvements in building energy efficiencies for new construction were to yield energy use reductions of 25 percent for new residential buildings over the previous CBC and 30 percent for non-residential buildings. With this 2016 cycle, it's estimated by the California Energy Commission (CEC) that residential buildings will use 28 percent less energy versus buildings constructed under the 2013 CBC. The state's goal, as expressed in these CBC code trends, is that all new residential construction will be zero net energy (ZNE) by 2020 and that non-residential will be ZNE by 2030. To date, energy use reductions are largely borne out by building envelop, HVAC and lighting efficiencies. Additionally, although solar readiness is required in the 2016 CBC, installation solar on new buildings is not.

It also important to note that any local jurisdiction energy code that goes beyond the state mandated minimums must have a Cost Effectiveness Study completed and approved by the California Energy Commission (CEC) prior to the effective date of the ordinance. Independently undertaking this process can be costly and time consuming. However, jurisdictions may use other jurisdiction's approved Cost Effectiveness Study for the same provisions within the same climate zone. Therefore, where reach code cost effectiveness data is available that is applicable to other jurisdictions and that fits with the Brisbane's own goals, it is prudent to utilize it.

With that in mind, staff has researched other potential energy reach codes that the City might use as a model to require solar energy generation and other companion measures. At the time of this writing, there is one jurisdiction listed with the CEC that is within our climate zone with a Cost Effectiveness study approved for an energy reach code and that is the City of San Mateo. San Francisco has a reach code in process, as does Portola Valley. San Mateo's ordinance includes cool roof requirements for low-pitched roofs and rooftop solar, for both residential and non-residential new construction, consistent with the Brisbane's CAP. These reach code requirements are fairly straightforward and modest. The cost effectiveness study showed that the added costs for the measures would be cost effective over time (see attached excerpts and for a complete cost effectiveness report see CEC's webpage: http://www.energy.ca.gov/title24/2016standards/ordinances/). Given that, San Mateo's ordinance provides a good model for Brisbane. Also, note that additional measures may be added as code amendments at the discretion of City Council and subject to CEC rules at any time.

Staff will be presenting an energy generation and conservation ordinance based on the San Mateo model to City Council, along with the adoption of the 2016 Edition of the CBC, in December. An outline of the key draft provisions are provided as an attachment to this memorandum and excerpts from the Cost Effectiveness Study are also attached.

Green Building Ordinance: The Green Building Ordinance, BMC 15.80, was originally adopted in 2007. In 2012, City Council directed that OSEC and the Planning Commission form a subcommittee, which was comprised of 2 members each, to provide recommendations on potential updates to the Green Building Ordinance (GBO). The subcommittee worked from 2012 to 2013 to provide recommendations for updates to that chapter. However, prior to providing their recommendation to City Council, the State's triennial update, 2013 Edition of the CBC, surpassed what the subcommittee's recommendations for the reach code would have implemented. Ultimately there were unresolved questions as to whether an updated GBO would be materially more effective than the updated state codes and no update to the GBO was recommended at that time. The subcommittee questioned the use of these third party systems and the apparently small incremental advantage over the state's mandatory requirements relative to the cost. This incremental green building advantage versus cost continues to be a moving target and may be immeasurable except on a project specific basis. The 2007 Green Building Ordinance remains in effect in Brisbane.

The Green Building ordinance still requires LEED silver equivalency for non-residential covered projects and Build-It-Green rating equivalency for covered residential projects. To date, no projects have been built that were subject to the ordinance, due to fairly large project size thresholds and construction in Brisbane being comprised of smaller projects since adoption of the ordinance in 2007.

When the 2016 CBC adoption ordinance is brought to Council in December, Council may choose to provide further direction as to whether it would like to revisit the City's Green Building Ordinance. In the meantime, the Green Building Ordinance remains effective and applicable to large residential and non-residential projects in Brisbane.

Water Conservation: In 2010, the City adopted the Water Conservation in Landscaping Ordinance and the Indoor Water Conservation Regulations, consistent with Bay Area Water Supply & Conservation Agency (BAWSCA) model ordinances, as BMC Chapters 15.70 and 15.72. In response to the ongoing drought, Governor Brown issued an executive order in April of 2015 directing state agencies to implement immediate measures to save water. The Dept. of Water Resources then adopted the State's Model Water Efficient Landscape Ordinance (MWELO) which became effective statewide last December. Around that same time, BAWSCA provided an update to the regional model ordinance which surpassed the state's ordinance and the City refined and adopted the regional model in early 2016.

The City's water conservation in landscaping ordinance is more conserving than the state's regulations in several ways. First, it would capture more projects in that it reduces the threshold for covered projects from the state's 2,500 sq ft to 1,000 sq ft on replacement landscapes. New development has a threshold of 500 sq ft of irrigated landscaping under both the City's and the state's regulations. Both the City and state have a prescriptive compliance option, or a water budget calculation option for compliance, with the permit application requirements being less rigorous with the prescriptive option. Under the prescriptive option the state allows for turf, but Brisbane's ordinance does not. It is also more restrictive in that it requires at least 80% of the irrigated landscape areas to be installed with native, low to very low water using plants for residential and 100% for commercial landscapes. The state's regulations require only 75% low water use plants under the residential prescriptive option. Given that the City's ordinance is already more water conserving than the state's regulations no changes are being proposed at this time.

The Indoor Water Conservation ordinance has not been updated since 2010 and now virtually all of the low flow water fixture requirements have been met by the state's minimum requirements, so those provisions are redundant. Amendments are being proposed as appropriate to remove the water use references that have now been surpassed or met by the state's regulations.

Waste Recycling and Diversion: Similar to the indoor water conservation ordinance, the City's waste recycling and diversion ordinance surpasses the state's new mandatory requirements in some areas but not in others and amendments will be presented to Council for consistency, while retaining requirements that will continue to surpass the state's.

The 2016 Edition of the CBC, CalGreen, covers only waste for new construction, whereas the City's ordinance covers demolition of 200 sq ft or more and reroofing of 500 square feet or more. These provisions would be retained. Although the City's ordinance is more conserving in covering more projects, it is still due for an update in this cycle to 1) ensure consistency of terms, 2) to address waste management plans requirements and 3) to increase the minimums amounts for recycling, salvage and reuse for covered projects from 50 to 65 percent, per state requirements.

Conclusion: This report is provided for the Planning Commission's and OSEC's consideration and staff will forward any of the Commission's and OSEC's recommendations to City Council as it considers code adoption in December 2016.

Attachments:

A. Summary of Preliminary Draft of Key Provisions for a New Brisbane Energy Conservation Code
B. Excerpts - City of San Mateo 2016 Building Energy Efficiency Reach Code, Cost Effectiveness Study, May 9, 2016, by TRC
C. California Energy Commission FAQ Sheets

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Attachment A

Summary of Preliminary Draft of Key Provisions for a New Brisbane Energy Conservation Code

The following would be in addition to state energy code requirements:

Cool Roof Draft Provisions:

1. **New Non-residential Buildings:**
   a. Low-sloped roofs shall have:

      i. A minimum aged solar reflectance of 0.70 and a minimum thermal emittance of 0.85; or

      ii. A minimun Solar Reflectance Index (SRI) of 85.

   Exceptions:
      i. Roof constructions that have a thermal mass with a weight of at least 25 pounds per square foot over the roof membrane are exempt from the minimum requirements for solar reflectance and thermal emittance or SRI.

      ii. An aged solar reflectance less than 0.70 is allowed provided the maximum roof/ceiling U-factor in Table 140.3-B of the Energy Code is not exceeded.

2. **New High-rise residential buildings, hotels and motels:**
   a. Low-sloped roofs shall have:

      i. A minimum aged solar reflectance of 0.70 and a minimum thermal emittance of 0.85; or

      ii. A minimum Solar Reflectance Index (SRI) of 85.

   Exceptions:
      iii. Roof constructions that have a thermal mass with a weight of at least 25 pounds per square foot over the roof membrane are exempt from the minimum requirements for solar reflectance and thermal emittance or SRI.

      iv. Roof area covered by building integrated photovoltaic panels and building integrated solar thermal panels is exempt from the minimum requirements for solar reflectance and thermal emittance or SRI.

3. **New Low-rise residential buildings**
   a. Low-sloped roofs shall have:

      i. A minimum aged solar reflectance of 0.70 and a minimum thermal emittance of 0.85 or a minimum SRI of 85:

Exceptions:

      ii. Roof constructions that have a thermal mass over the roof membrane with a weight of at least 25 pounds per square foot over the roof membrane are exempt from the minimum requirements for solar reflectance and thermal emittance or SRI.

iii. Roof area covered by building integrated photovoltaic panels and building integrated solar thermal panels is exempt from the minimum requirements for solar reflectance and thermal emittance or SRI.

Solar Installation Draft Provisions

A. Solar photovoltaic systems shall be installed on both non-residential and residential building types as follows:

1. **New Non-residential buildings:**

   a. Buildings with less than 10,000 square feet of gross floor area shall provide a minimum of a 3 kilowatt photovoltaic system.

   b. Buildings with 10,000 square feet or more of gross floor area shall provide a minimum of a 5 kilowatt photovoltaic system.

2. **New Residential Buildings:**

   a. Single-family buildings and duplexes shall provide a minimum of a 1 kilowatt photovoltaic system.

   b. Multifamily buildings of 3 to 16 units shall provide a minimum of a 2 kilowatt photovoltaic system.

   c. Multifamily buildings of 17 units or more shall provide a minimum of a 3 kilowatt photovoltaic system.

3. Exception: As an alternative to a solar photovoltaic system, all of the building types listed above may provide a solar hot water system (solar thermal) with a minimum collector of 40 square feet.

Infeasibility Exemption
If an applicant believes that circumstances exist that make it infeasible to meet the requirements of this chapter, the applicant may request an exemption via written request to the building official. In applying for the exemption, the burden is on the applicant to demonstrate infeasibility to the satisfaction of the building official.

Attachment B

— Excerpts only —

City of San Mateo 2016 Building Energy Efficiency Reach Code

Cost Effectiveness Study

Final Report (May 9, 2016)

TRC
Results you can rely on

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EXECUTIVE SUMMARY

The City of San Mateo plans to implement a Reach code related to energy efficiency and solar energy. The California Energy Commission (CEC) require that a cost effectiveness study be completed to implement a Reach Code in the San Mateo Municipal Code. On behalf of the City, TRC investigated Reach Code options requiring that residential and nonresidential new construction use less energy than a building minimally compliant with 2016 Title 24 Building Energy Efficiency Standards (T24 Standards). The CEC Life Cycle Cost (LCC) Methodology was used to analyze potential cost effective energy efficiency measures. The LCC methodology involves estimating and quantifying the energy savings associated with measures using a Time Dependent Valuation (TDV) of energy savings.

TRC investigated cost effective energy efficiency and solar measures for single family residential, multifamily, and nonresidential office buildings. TRC leveraged previous energy savings, market research, and cost estimates when possible. Prototype buildings were developed for San Mateo based on feedback from City staff and simulated in Title 24 compliance software. TDV energy savings were developed through software simulations and CECPV Calculator.[1]

The benefit to cost ratio (B/C) is the indicator for cost effectiveness. A ratio greater than 1 indicates that the added cost of the measure is more than offset by the present value life cycle energy cost savings, and the measure is deemed to be cost effective. TRC found both cool roof and solar PV measures to be cost effective, as shown in Table 1 and Table 2. **Thus, TRC recommends that San Mateo implement a Reach Code ordinance to exceed the 2016 Title 24 Standards by requiring cool roofs on multifamily and nonresidential buildings with low-sloped roofs and photovoltaic measures on all buildings.**

Table 1. Cool Roofs Cost Effectiveness

Low-Sloped Cool Roof Measure				
Building Type	% Above Title 24	Present Value of Energy Savings	Cost	Benefit to Cost Ratio
Multifamily Residential	3.4%	$9,033	$1,843	4.9
Nonresidential Offices	0.1%	$2,788	$1,625	1.7

All PV system sizes up to 40 kW were found to be cost effective, including the sizes recommended for the San Mateo residential and nonresidential Reach Code.

[1] The CECPV Calculator was developed for use in the New Solar Homes Partnership. The calculator estimates monthly kWh and annual TDV production based on climate zone and system specifications. The tool is available online at: http://www.gosolarcalifornia.org/tools/nshpcalculator/index.php

Table 2. Solar PV Cost Effectiveness for Sizes in Reach Code Ordinance

Size (kW)	Cost	Residential Present Value of Energy Savings	Residential Benefit to Cost Ratio	Nonresidential Present Value of Energy Savings	Nonresidential Benefit to Cost Ratio
1	$2,193	$8,567	3.9	-	-
2	$4,386	$17,135	3.9	-	-
3	$6,578	$23,839	3.6	$12,250	1.9
5	-	-	-	$20,843	1.9

Based on the findings in this report, TRC recommends the San Mateo Municipal Code require new construction buildings exceed the 2016 Title 24 Standards by installing the following measures:

Cool Roofs

- Low-rise and high-rise multifamily residential new construction projects with low-sloped roofs, and nonresidential new construction projects with low-sloped roofs, shall install a cool roof with an ASR ≥ 0.70 and TE ≥ 0.85.

Solar Mandate

- Single family residential new construction projects shall install a ≥ 1 kW PV system.
- Low-rise and high-rise multifamily residential new construction projects:
  A. Buildings with 3-16 units shall install a ≥ 2 kW PV system.
  B. Buildings with ≥17 units shall install a ≥ 3 kW PV system.
- Nonresidential new construction projects shall comply with:
  A. Buildings <10,000 ft2 shall install a ≥ 3 kW PV system.
  B. Buildings ≥10,000 ft2 shall install a ≥ 5 kW PV system.
- All building types may comply by installing a solar hot water system with ≥ 40 ft^2 collector area.

Although solar thermal was not found to be cost effective for the San Mateo prototypes, this measure may be cost effective for space types with high hot water usage, such as gyms or spas. TRC recommends that San Mateo include a solar thermal system as an alternative compliance option to solar PV in the Reach Code.

1. INTRODUCTION

The City of San Mateo, located in California Climate Zone 3 (CZ3), plans to enact a Reach Code for the 2016 Title 24 Part 6 Building Energy Efficiency Standards (T24 Standards). The T24 Standards are the minimum energy efficiency requirements for building construction in California. San Mateo engaged TRC to provide a cost effectiveness study to support building Reach Code requirements above 2016 T24 Standards minimum requirements.

At the request of the City, TRC researched measures drawn from multiple sources in efforts to develop cost effective packages of measures. A full list of measures analyzed is included in Appendix B. Software modeling functionality or federally preemption very often limited which measures could be considered. Furthermore, the stringency of the 2016 Title 24 coupled with the mild climate of San Mateo reduced the energy savings impact of many measures.

Based on the results of TRC's analysis, the City decided to move forward with a Reach Code that would require that residential and nonresidential buildings install cool roofs, where applicable, to consume less energy than a building exactly compliant with the T24 Standards. Additionally, residential and nonresidential buildings would be required to install minimally-sized PV systems or solar thermal systems to offset some of the buildings energy consumption with a renewable energy source.

TRC found cool roofs to be technically and economically feasible for multifamily residential and nonresidential (office building) new construction with low-sloped roofs, and solar PV requirements to be technically and economically feasible for all residential and nonresidential (office building) new construction. TRC has prepared energy savings and cost effectiveness analyses for these measures to support the proposed Reach Code.

2. METHODOLOGY

TRC assessed the cost effectiveness of San Mateo's 2016 Reach Code by analyzing several measures applied to prototype buildings using the Life Cycle Cost (LCC) methodology approved and used by the California Energy Commission (CEC) to establish cost effective building energy standards (Title 24, Part 6).

2.1 Life Cycle Cost and Time Dependent Valuation

TRC used the CEC LCC Methodology to demonstrate cost effectiveness of the proposed Reach code.[2] The LCC methodology involves estimating and quantifying the energy savings associated with measures using a Time Dependent Valuation (TDV) of energy savings.[3]

TDV is a normalized format for comparing electricity and natural gas savings that takes into account the cost of electricity and natural gas consumed during different times of the day and year. The TDV values are based on long term discounted costs (30 years for all residential measures and nonresidential envelope measures and 15 years for all other nonresidential measures). TDV energy estimates are based on the present value of cost savings, but are presented in terms of "TDV kBTUs." TDV kBTUs allows savings to be evaluated in terms of energy units, and measures with different periods of analysis can be combined into a single value.[4]

The CEC developed the TDV values that were used in the analyses for this report, and are representative of San Mateo's climate zone.

2.2 Measure Analysis

TRC investigated measures for single family, low-rise multifamily, high-rise multifamily and nonresidential (office) buildings, with the goal of establishing cost effective packages of measures or individual measures above 2016 Title 24. With guidance from the City of San Mateo, TRC adjusted standard CEC prototypes to customized prototype buildings that represent

[2] Architectural Energy Corporation (January 2011) Life-Cycle Cost Methodology. California Energy Commission. Available at: http://www.energy.ca.gov/title24/2013standards/prerulemaking/documents/general_cec_documents/2011-01-14_LCC_Methodology_2013.pdf

[3] E3 (July 2014) Time Dependent Valuation of Energy for Developing Building Efficiency Standards: 2016 Time Dependent Valuation (TDV) Data Sources and Inputs. California Energy Commission. Available at: http://www.energy.ca.gov/title24/2016standards/prerulemaking/documents/2014-07-09_workshop/2017_TDV_Documents/

[4] kBTUs = thousands of British Thermal Units.

new construction buildings typically built in San Mateo. These will be referred to as the San Mateo prototypes to differentiate from the CEC prototypes.

TRC used CBECC-Res 2016.1.0 (build 801) to simulate the residential San Mateo prototypes and CBECC-Com 2016.1.0 (build 803) for the nonresidential San Mateo prototypes.[5] CBECC is a free public-domain software developed by the CEC for use in complying with the Title 24 Standards. The software is currently used for the 2013 Standards, and preliminary versions for use with the 2016 Standards have been released. The 2016 software algorithms will be updated occasionally until the implementation date of the 2016 Standards (January 1st, 2017). CBECC-Com uses EnergyPlus v8.3 as the simulation engine to perform the analysis. Multifamily buildings are simulated in either the residential or nonresidential software depending on the number of residential stories; buildings with four or more stories are regulated by the nonresidential code. TRC simulated all San Mateo prototypes in Climate Zone 3, and initialized them to be exactly compliant with the minimum 2016 T24 requirements (0% compliance margin), or as close as possible. The TDV of energy savings for energy efficiency measures were derived by implementing the measure in a code compliant San Mateo prototype, as described in the *Measure Descriptions and Costs*.

2.2.1 Residential Prototypes

The residential San Mateo prototypes are based on the CEC prototypes fully defined by the CEC in the Residential Alternative Calculation Method reference manual.[6] The San Mateo prototypes are slightly revised in order to meet San Mateo typical building construction and to have equal geometry oriented facing north, east, south, and west. Two residential San Mateo prototypes were simulated:

- 2,700 ft^2 single family two-story home
- 10,440 ft^2 low-rise multifamily residential building, with three stories, twelve dwelling units, and an attached garage

Further San Mateo prototype details are provided in Table 3. Low-rise residential covers all residential construction that is three stores or less, including single and multifamily. TRC developed a low-rise multifamily residential prototype with a slightly varied roof construction from the CEC prototype for the cool roof analysis. The default roof is a steep-sloped asphalt shingle roof; the adjusted roof is a low-sloped gravel roof. This low-sloped roof prototype was only used for the low-sloped cool roof analysis. Details of this analysis are provided in Section 3.

It is important to note that CEC considers mid-rise and high-rise multifamily buildings four stories or greater to be non-residential buildings.

[5] More information on CBECC-Res available at: http://www.bwilcox.com/BEES/BEES.html. More information on CBECC-Com available at: http://bees.archenergy.com/software.html

[6] 2016 Residential Alternative Calculation Method, California Energy Commission. Available at: http://www.energy.ca.gov/2015publications/CEC-400-2015-024/CEC-400-2015-024-CMF.pdf

Table 3. Residential San Mateo Prototypes Summary

Building Type	Two-Story Single Family	Low-Rise Multifamily
Dwelling Units	1	12
Area (ft^2)	2,700	10,440
Ceiling Area (ft^2)	1,450	3,480
Roof Area (ft^2)	1,740	3,480[1]
# of floors	2	3
Window-to-Floor Area Ratio	20%	15%
Attic/Roof Assembly	Tile Roof, Wood Sheathing, R13 Below Roof Deck Insulation (air space), 2x4 @ 16" OC	
Roof Reflectance	Steep-Sloped: SR = 0.10, TE = 0.85	Low-Sloped: SR = 0.10, TE = 0.85[1]
Above Grade Wall Assembly	R-19 Cavity Insulation, R5 Synthetic Stucco, 0.051 U-factor	
Cooling System	Split Air Conditioner, 14 SEER	
Heating System	Gas Furnace, 78% AFUE	Gas Furnace , 80% AFUE
HVAC Distribution System	Ducts in Attic	Ducts in Conditioned Space
Thermal Zones	2	4
Domestic Water Heating Prescriptive Baseline 1	Natural Gas Instantaneous Water Heater, 0 Gallon Tank, EF=0.82	12x Natural Gas Instantaneous Water Heater, 0 Gallon Tank, EF=0.82
Domestic Water Heating Prescriptive Baseline 2[2]	Natural Gas Small Storage, 50 Gallon Tank, EF = 0.6, plus HERS Measures	Central Natural Gas Small Storage, 50 Gallon Tank, EF = 0.6, 40 MBH Input Rating, 0.20 Solar Fraction

[1] The CEC low-rise residential multifamily prototype typically has a steep-sloped roof. TRC developed a low-rise multifamily prototype with a low-sloped roof to test the impact of cool roofs on this prototype.

[2] TRC only used the natural gas storage hot water system for the solar thermal cost effectiveness analysis. All other measures were analyzed with a natural gas instantaneous water heater.

2.2.2 Nonresidential Prototypes

The nonresidential San Mateo prototypes are based on CEC prototypes detailed in the Nonresidential Alternative Calculation Method reference manual.[7] The prototypes are slightly revised in order to meet San Mateo typical building construction.

- 75,050 ft^2 high-rise multifamily building, with four stories, 79 units, an attached garage, and 3,000 ft^2 retail

[7] 2016 Nonresidential Alternative Calculation Method, California Energy Commission. Available at: http://www.energy.ca.gov/2015publications/CEC-400-2015-025/CEC-400-2015-025-CMF.pdf

- 85,000 ft² five-story medium office building with 5,000 ft² retail
- 195,060 ft² four-story large office building with 5,000 ft² retail

Results using these San Mateo prototypes are intended to represent findings for all nonresidential buildings. Further details are provided in Table 4.

Table 4. Nonresidential Prototypes Summary

Building Type	High-Rise Multifamily		Medium Office	Large Office
Total Conditioned Floor Area (ft²)	84,360		85,000	192,060
Retail Floor Area (ft²	3,040		5,550	5,442
# of floors	4		5	4
Window-to-Floor Area Ratio	7%		13%	9%
Roof Construction	1/16" Metal Standing Seam, R-29 Continuous Insulation Board			
Roof Reflectance (Low-sloped)	No Requirement[1]		SR=0.63, TE = 0.85	
Cooling System	Direct Expansion, 13 SEER		Direct Expansion, 9.8 EER	Chiller and Cooling Tower
Heating System	Boiler, 80% Thermal Efficiency			
HVAC Distribution System	Packaged VAV System		5 Packaged VAVs (1 per story) with Economizer and Hot Water Reheat	4 VAVs (1 per story) with Economizer and Hot Water Reheat
Conditioned Thermal Zones	22		30	24
Domestic Water Heating[2]	79x Natural Gas Instantaneous Water Heater, 0 Gallon Tank, EF=0.82	Central Natural Gas Small Storage, 122 Gallon Tank, 78 Thermal Efficiency, 0.20 Solar Fraction	Gas Storage, 95 Gallons, 78% Thermal Efficiency	Gas Storage, 45 Gallons, 61% Thermal Efficiency
Regulated Lighting Power Density	(Retail Only) 1.20 W/ft²		0.75 Watts/ft²	
Daylighting Controls	(Retail Only) Continuous, 0.20 Dimming Light/Power Fraction		Continuous, 0.20 Dimming Light/Power Fraction	
Occupancy Sensors	(Retail Only) Not Required		Required in Private Offices, Conference Rooms, and Multipurpose Rooms. Not Required in Open Offices	

[1] Although there is no prescriptive requirement in CZ3 for high-rise residential, the model assumes ASR=0.08 and TE=0.75 as per section 110.8(i)1 of the Title 24 Standards.
[2]TRC only used the natural gas storage hot water system for the solar thermal cost effectiveness analysis. All other measures were analyzed with a natural gas instantaneous water heater.

2.2.3 Energy Efficiency Measures

TRC investigated potential energy efficiency measures to apply to the San Mateo residential and nonresidential prototypes. TRC utilized the 2016 Title 24 Codes and Standards Enhancement (CASE) reports developed on behalf of the IOUs as the basis of our measure analysis and selection. The CASE studies to support Title 24 proposed updates contain detailed energy savings, market research, and cost estimates for measures, and serve as comprehensive data sources for the Reach Code analysis. For measures where no CASE study exists, such as HVAC fan efficiency increase or drain water heat recovery, TRC conducted internal market research to assess measure feasibility, costs, and potential energy impact. Additionally, TRC identified measures that are potential topics for the 2019 CASE process and, lastly, measures being investigated for green building codes such as CALGreen (Title 24, Part 11) and ASHRAE Standard 189.1.

A full list of energy efficiency measures that TRC reviewed is provided in *Appendix B – Energy Efficiency Measure List.*

2.2.4 Solar Measures

The California Public Utilities Commission (CPUC) set goals that California residential new construction will be Zero Net Energy (ZNE) by 2020[8] and nonresidential new construction by 2030[9]. The state will realize these goals partly through more stringent Building Energy Efficiency Standards and partly through renewable energy policy. TRC investigated the cost effectiveness and feasibility of photovoltaics (PV) and solar thermal water heating for residential and nonresidential new construction.

2.3 Cost Effectiveness

Using the CEC's LCC methodology, TRC determined cost effectiveness by assessing the incremental costs of a measure and comparing them to the energy cost savings. Incremental costs represent the construction and maintenance costs of the proposed measure relative to the 2016 Title 24 Standards minimum requirements.

The Benefit to Cost (B/C) Ratio is the incremental TDV energy costs savings divided by the total incremental costs. When the B/C ratio is greater than 1.0, the added cost of the measure is more than offset by the discounted energy cost savings and the measure is deemed to be cost effective.

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[8] CA Energy Efficiency Strategic Plan: New Residential Zero Net Energy Action Plan 2015 – 2020, CPUC and CEC. June 2015. Available online at: http://www.cpuc.ca.gov/General.aspx?id=4125

[9] CA Energy Efficiency Strategic Plan: Zero Net Energy Commercial Building Sector 2010-2012. Engage 360. June 2011. Available online at: http://www.cpuc.ca.gov/General.aspx?id=4125

4. Energy Savings and Cost Effectiveness Results

The results for the cool roof and solar measures are presented below for single family, multifamily, and nonresidential San Mateo prototypes. Results include measure compliance margin, present value of energy savings, costs, and benefit to cost (B/C) ratio. When the B/C ratio is greater than 1.0, the added cost of the measure is more than offset by the discounted energy cost savings and the measure is deemed to be cost effective.

4.1 Energy Efficiency Measures

4.1.1 Cool Roofs

As shown below in Table 13, low-sloped cool roofs have relatively small incremental costs and are cost effective for multifamily and nonresidential buildings in Climate Zone 3. The low-sloped multifamily residential results are an average for the low-rise and high-rise prototypes. Based on this analysis, steep-sloped cool roofs are not cost effective for San Mateo.

Table 13. Low-Sloped Cool Roof Cost Effectiveness

Cool Roof Measure					
Building Type	**Roof Slope**	**% Above Title 24**	**Present Value of Energy Savings**	**Cost**	**Benefit to Cost Ratio**
Single Family Residential	Steep-Sloped	0%	$0	$400	0
Low-Rise Multifamily Residential	Steep-Sloped	1.8%	$850	$867	0.98
Multifamily Residential	Low-Sloped	3.4%	$9,033	$1,843	4.9
Nonresidential Office	Low-Sloped	0.1%	$2,788	$1,625	1.7

4.2 Solar Measures

Solar PV was found to be cost effective at all sizes. Solar thermal hot water was not found to be cost effective for the building types analyzed.

4.2.1 Solar PV

Solar PV is cost effective at all sizes as shown in Table 14 below. Nonresidential benefit-to-cost ratios are lower than residential because the NPV factor for nonresidential is lower than residential, as described in Section 2.3.1.

Table 14. Solar PV Cost Effectiveness

Size (kW)	Cost	Residential Present Value of Energy Savings	Residential Benefit to Cost Ratio	Nonresidential Present Value of Energy Savings	Nonresidential Benefit to Cost Ratio
1	$2,193	$8,567	3.9	-	-
2	$4,386	$17,135	3.9	-	-
3	$6,578	$23,839	3.6	$12,250	1.9
5	-	-	-	$20,843	1.9

4.2.2 Solar Thermal

Solar hot water (thermal) is not cost effective under any scenario analyzed, as shown in Table 15, even in multifamily buildings with a pre-existing solar hot water system. However, solar hot water may be cost effective in buildings with high hot water demands, such as gyms or spas.

Table 15. Solar Thermal Cost Effectiveness

Building	Baseline	Cost	Present Value of Energy Savings	Benefit to Cost Ratio
Single Family	Instantaneous Water Heater	$4,876	$2,004	0.4
	Storage Water Heater	$3,777	$1,649	0.4
Multifamily	Instantaneous Water Heater	$49,970	$2,153	0.0
	Storage Water Heater + 0.20 Solar Fraction	$6,691	$1,205	0.2
Nonresidential	Storage Water Heater	$4,076	$3,783	0.9

4.3 Reach Code Recommendation

Cool roof requirements and solar PV proved cost effective for prototypes in the City of San Mateo. Although solar thermal was not found to be cost effective for the San Mateo prototypes, this measure may be cost effective for space types with high hot water usage, such as gyms or spas. TRC recommends that San Mateo include a solar thermal system as an alternative compliance option to solar PV in the Reach Code.

TRC recommends the San Mateo Municipal Code require new construction buildings exceed the 2016 Title 24 Standards by installing the following measures:

Cool Roofs

- Low-rise and high-rise multifamily residential new construction projects with low-sloped roofs, and nonresidential new construction projects with low-sloped roofs, shall install a cool roof with an ASR ≥ 0.70 and TE ≥ 0.85.

Solar Mandate

- Single family residential new construction projects shall install a ≥ 1 kW PV system.
- Low-rise and high-rise multifamily residential new construction projects:
  - C. Buildings with 3-16 units shall install a ≥ 2 kW PV system.
  - D. Buildings with ≥17 units shall install a ≥ 3 kW PV system.
- Nonresidential new construction projects shall comply with:
  - C. Buildings <10,000 ft2 shall install a ≥ 3 kW PV system.
  - D. Buildings ≥10,000 ft2 shall install a ≥ 5 kW PV system.
- All building types may comply by installing a solar hot water system with ≥ 40 ft^2 collector area.

4.3.1 Compliance

Compliance can be checked both on construction documents as well as compliance software reports. The compliance software output reports that are submitted to the building department identify the slope, ASR and TE of a proposed building's roof assembly and the proposed PV system size.

4.4 Greenhouse Gas Savings

New construction complying with the proposed Reach Code will result in greenhouse gas (GHG) savings through saving electricity and natural gas. Electricity and natural gas usage are estimated in CBECC simulations for each prototype building. Saved energy is multiplied by a factor of 0.65 lbs of CO_2 equivalent (CO_2e) per kWh, and 11.7 lbs of CO_2e per therm, as per Environmental Protection Agency research.[22] As shown in Table 16:

- 14% GHG savings are achieved for each newly constructed single family building
- 1% GHG savings are achieved for each newly constructed multifamily building
- 1% GHG savings are achieved for each newly constructed nonresidential building

[22] United States Environmental Protection Agency. 2015. "Emission Factors for Greenhouse Gas Inventories." Available at: https://www.epa.gov/sites/production/files/2015-12/documents/emission-factors_nov_2015.pdf

Attachment C

2016 BUILDING ENERGY EFFICIENCY STANDARDS

FREQUENTLY ASKED QUESTIONS

What are Building Energy Efficiency Standards?

Building Energy Efficiency Standards are designed to ensure new and existing buildings achieve energy efficiency and preserve outdoor and indoor environmental quality. These measures (Title 24, Part 6) are listed in the California Code of Regulations.

The California Energy Commission is responsible for adopting, implementing and updating building energy efficiency. Local city and county enforcement agencies have the authority to verify compliance with applicable building codes, including energy efficiency.

Why are energy standards important?

Since 1978, Energy Efficiency Standards make buildings more comfortable, lower energy costs and reduce greenhouse gas emissions. Standards ensure that builders use the most energy efficient technologies and construction.

Why do the standards need to be updated?

The Energy Commission is required by law to adopt standards every three years that are cost effective for homeowners over the 30-year lifespan of a building. The standards are updated to consider and incorporate new energy efficient technologies and construction methods. The standards save energy, increase electricity supply reliability, increase indoor comfort, avoid the need to construct new power plants and help preserve the environment.

The effective date of the Standards is January 1, 2017.

How much will these standards add to the cost of a new home?

On average, the 2016 Building Energy Efficiency Standards will increase the cost of constructing a new home by about $2,700, but will save $7,400 in energy and maintenance costs over 30 years. In other words, when factored into a 30-year mortgage with a 5 percent interest rate, the standards will add about $11 per month for the average home, but will save consumers roughly $31 on monthly heating, cooling, and lighting bills.

How much energy will the 2016 standards save?

Single family homes built to the 2016 standards will use about 28 percent less energy for lighting, heating, cooling, ventilation, and water heating than those built to the 2013 standards. In 30 years, California will have saved enough energy to power 2.2 million homes, reducing the need to build 12 additional power plants.

Do the 2016 residential standards get us to zero net energy?

In 2008, California set bold energy-use reduction goals, targeting zero net energy (ZNE) use in all new homes by 2020 and commercial buildings by 2030. The ZNE goal means new buildings must use a combination of improved efficiency and distributed renewable energy generation to meet 100 percent of their annual energy need.

The 2016 standards will not get us to ZNE. However, they do get us very close to our goal and make important steps toward changing residential building practices in California. The 2019 standards will take the final step to achieve ZNE for newly constructed residential buildings throughout California.

Who supports the standards?

The California Building Industry Association supports the adopted standards as does the Natural Resources Defense Council and other environmental groups, investor owned utilities such as Pacific Gas & Electric and Southern California Edison, and publically owned utilities such as the Sacramento Municipal Utility District.

What buildings are covered by the standards?

All new construction of, and additions and alterations to, residential and nonresidential buildings are covered except hospitals, nursing homes, correctional centers, jails, and prisons.

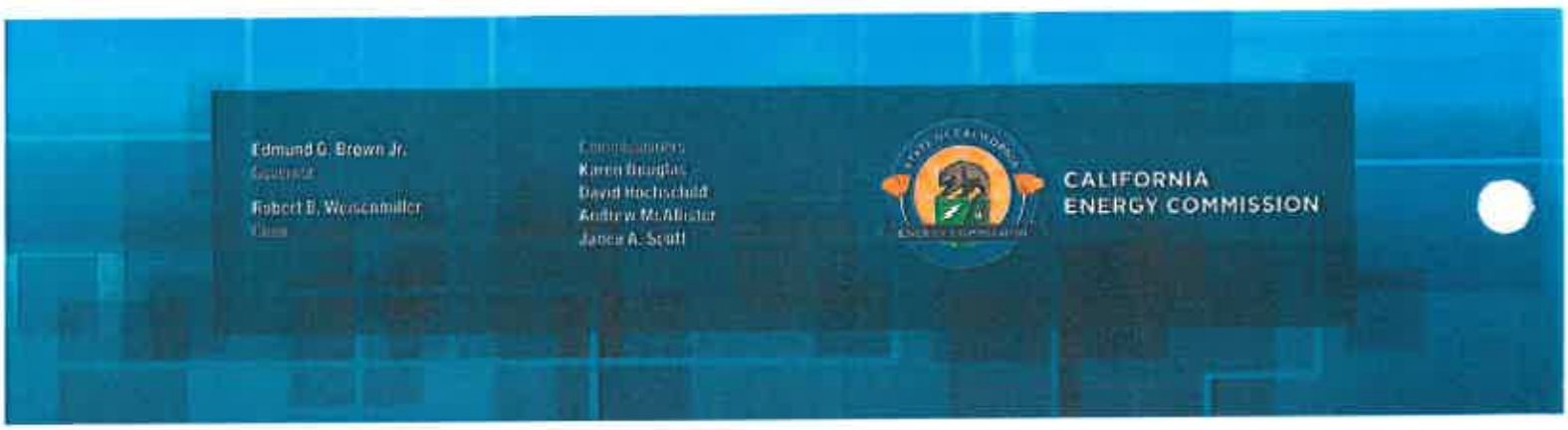
Why do the standards vary by climate zone?

Measures that are cost effective in more extreme climates may not be cost effective in milder climates. Requiring measures by climate zone ensure that a building will have the most energy efficient features for that area. There are 16 climate zones in the state (www.energy.ca.gov/maps/renewable/building_climate_zones.html).

How can I learn more about the Standards?

Contact the Energy Commission's Energy Standards Hotline toll-free at (800) 772-3300 or (916) 654-5106 or email title24@energy.ca.gov.

Additionally, the Energy Commission's Blueprint newsletter is available at: www.energy.ca.gov/efficiency/blueprint/



Based on CBC Mandatory Provisions

CALIFORNIA'S 2016 — RESIDENTIAL BUILDING ENERGY EFFICIENCY STANDARDS

CALIFORNIA ENERGY COMMISSION

$7,400 SAVINGS OVER A 30 YR. MORTGAGE | INITIAL COST $2,700

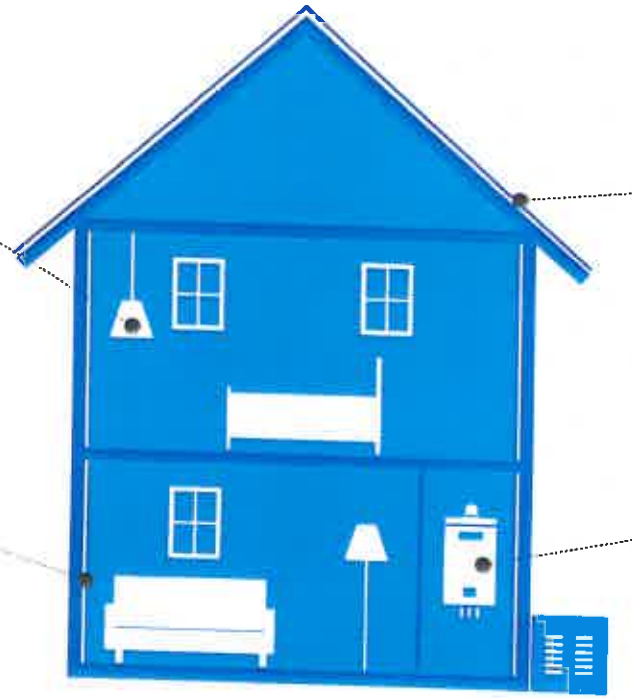
The state's energy efficiency standards for new buildings and appliances have saved consumers billions in reduced electricity and natural gas bills. The building standards include better windows, insulation, lighting, air conditioning systems and other features that reduce energy consumption in homes and businesses. Since 1978 these standards have helped protect the environment by reducing more than 250 million metric tons of greenhouse gas emissions (or the equivalent of removing 37 million cars off California roads)

HIGH EFFICACY LIGHTING

All lighting in new homes must be efficient. Installation of high quality lighting with controls that nearly halve the energy required for lights in new homes.

HIGH PERFORMANCE WALLS

Increased wall insulation keeps the sun's heat out of your home during hot summer months and warm air in during winter months, improving comfort and reducing energy consumption.



HIGH PERFORMANCE ATTICS

Attics with additional insulation at the roof deck keep attic temperatures closer to ambient, improving the home's heating and cooling performance. Extra insulation at the roof deck, in addition to the ceiling insulation, will reduce the attic temperature by 35 degrees or more during hot summer days.

IMPROVED WATER HEATING SYSTEM EFFICIENCY

Installing tankless water heating technology and better distribution systems reduces the energy needed to provide hot water to the home by about 35 percent.

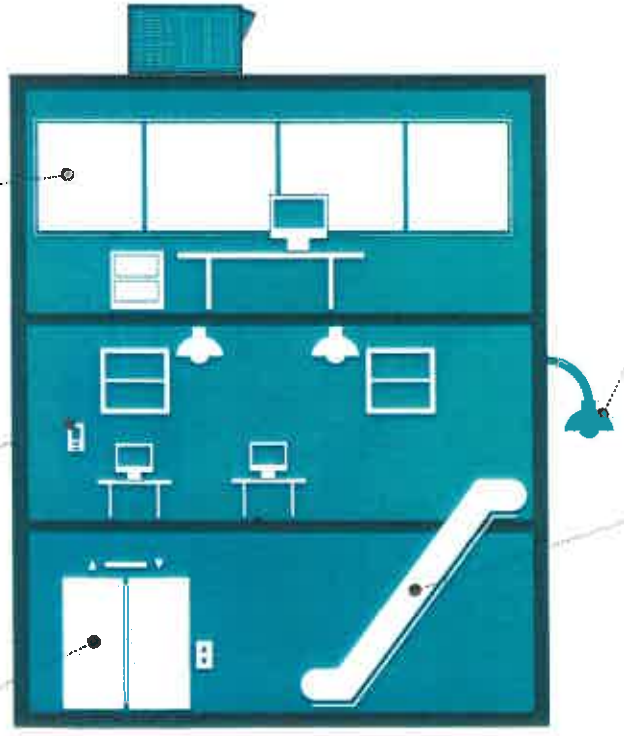
These are cost effective measures that home builders may consider to achieve new levels of efficiency. They can be traded for other efficient technologies such as higher efficiency HVAC units, higher efficiency water heaters, etc.

Based on CBC Mandatory Provisions

CALIFORNIA'S 2016 – NONRESIDENTIAL
BUILDING ENERGY EFFICIENCY STANDARDS

CALIFORNIA ENERGY COMMISSION

The state's energy efficiency standards for new buildings and appliances have saved consumers billions in reduced electricity and natural gas bills. The building standards include better windows, insulation, lighting, air conditioning systems and other features that reduce energy consumption in homes and businesses. Since 1978 these standards have helped protect the environment by reducing more than 250 million metric tons of greenhouse gas emissions (or the equivalent of removing 37 million cars off California roads)



DOOR AND WINDOW INTERLOCKS

Sensors on doors and windows adjust the thermostat to turn off the heating or cooling if a door or window is left open for more than five minutes. This allows occupants to take advantage of outside temperatures and save on heating and cooling costs.

DIRECT DIGITAL CONTROLS

For larger heating, ventilation and air conditioning systems, installing digital controls enables communication with building energy management systems, allowing managers to tailor the building's heating and cooling demands and prevent waste.

ELEVATORS

Efficient ventilation fans and lighting sources installed within the elevator, along with controls that turn off the cab lighting and fans when the elevator is empty, save energy both when the elevator is in use and when empty.

OUTDOOR LIGHTING

The general power allowance for outdoor lighting has been lowered to include newer, more efficient luminaires which are widely available and commonly used for outdoor lighting applications.

ESCALATORS

Requires escalators and moving walkways in transit areas to run at a lower, less energy-consuming speed when not in use.

These are cost effective measures that builders may consider to achieve new levels of efficiency. They can be traded for other efficient technologies such as higher efficiency HVAC units, higher efficiency water heaters, etc.