Cost-Effectiveness Study for Residential and Nonresidential Energy and Water Efficiency Measures

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Last Modified: October 22, 2019

LEGAL NOTICE

This report was prepared by Pacific Gas and Electric Company and funded by the California utility customers under the auspices of the California Public Utilities Commission.

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1 Introduction

The California Codes and Standards (C&S) Reach Codes program provides technical support to local governments considering adopting a local ordinance (reach code) intended to support meeting local and/or statewide energy and greenhouse gas reduction goals. The program facilitates adoption and implementation of the code when requested by local jurisdictions by providing resources such as cost-effectiveness studies, model language, sample findings, and other supporting documentation. Local jurisdictions that are considering adopting such ordinances may contact the program for support through its website, LocalEnergyCodes.com.

This cost-effectiveness study was sponsored by Pacific Gas and Electric Company (PG&E). This report presents measures that local jurisdictions could consider adopting to achieve energy and water savings beyond what will be accomplished by enforcing California statewide building efficiency requirements. Reducing water use is beneficial to address California's ongoing water resource constraints, but it also results in energy savings associated with water supply, conveyance, treatment, and water heating.

The measures included in this report were originally developed by the Santa Clara County Water Efficient New Development Task Force in 2015-2016 and documented in the model Water Efficient New Development Ordinance (Sustainable Silicon Valley 2016). The Task Force included representatives from Santa Clara County, City of Cupertino, City of Morgan Hill, City of Mountain View, City of Palo Alto, City of Sunnyvale, Valley Water District, Sustainable Silicon Valley, and Joint Venture Silicon Valley. Staff at City of Morgan Hill had been leading the effort. Staff at Valley Water, a countywide wholesale water provider in the Santa Clara county, have been encouraging jurisdictions in Santa Clara County to adopt and implement the model Water Efficient New Development Ordinance. This report was developed to provide supporting cost-effectiveness analysis for the model ordinance developed by the Task Force.

This report presents one cost-effective measure (Measure 1 on Water Waste Reduction when Delivering Hot Water) that exceeds minimum 2019 California Building Energy Efficiency Standards (Title 24, Part 6) state requirements. Local jurisdictions have the authority to adopt local energy efficiency ordinances that exceed the minimum standards defined by Title 24, Part 6 as established by Public Resources Code Section 25402.1(h)2 and Section 10-106 of Title 24, Part 6. Local jurisdictions must demonstrate that the requirements of the proposed local energy standards are cost-effective and result in buildings consuming less energy than is permitted by Title 24, Part 6. In addition, the jurisdiction must obtain approval from the California Energy Commission (Energy Commission) and file the ordinance with the California Building Standards Commission (CBSC) for the ordinance to be legally enforceable. Therefore, the adoption of Measure 1 would require approval from the Energy Commission and filing with the CBSC to be legally enforceable. All other measures (Measures 2-17) documented in this analysis are not regulated by Title 24, Part 6 and can be adopted without involving the Energy Commission or the CBSC.

The model ordinance associated with this cost-effectiveness study is posted on the C&S Reach Codes Program website at LocalEnergyCodes.com. The version posted on the Program website is the October 2019 version of the model Water Efficient New Development Ordinance developed by the Task Force. However, the code related to onsite non-potable water reuse (part of Measure 6 on Alternate Water Sources) is excluded in the model ordinance posted on the Program website for ease of readability of all other measures. The code language for onsite non-potable water reuse is lengthy given measure complexity. Local jurisdictions interested in the provision requiring onsite treated non-potable water reuse are directed to use San Francisco Health Code (SFHC), Article 12C as a model code (SFDPH 2017). The model ordinance developed by the Task Force uses the language from the SFHC, Article 12C without significant modifications.

Local jurisdictions that are considering adopting any of the measures presented in this report may contact the program for further technical support.

1.1 Measures Addressed in Report and Recommendations

Table 1 lists measures addressed in this report and provides measure-specific recommendations for local jurisdictions considering these measures. Additional recommendations on refining the analysis are included in the Summary and Conclusions section of this report.

Table 1: List of Measures and Recommendations

Name	Scope	Key Recommendations (from authors of this report)
Measure 1 **- Water Waste Reduction when Delivering Hot Water** *Option A - Compact Hot Water Distribution Systems* Meet requirements for the Compact Hot Water Distribution System Expanded Credit, including verification from Home Energy Rating System (HERS) Rater in accordance with the 2019 Title 24, Part 6 Residential Reference Appendices section RA4.4.16. *Option B - Demand Recirculation with Drain Water Heat Recovery (DWHR)* Where a hot water recirculation system or electric trace heating system exists, limit the amount of water contained in each branch from the recirculating loop or electric trace heating element to the fixture to a maximum of 0.125 gallon of water. Recirculation systems must have a manual control (pushbutton). In addition, meet requirements of a DWHR system, installed in an equal flow configuration, with HERS verification in accordance with the 2019 Reference Appendices RA4.4.21.	New Construction Residential (Single Family)	As an alternative to this measure, consider mandating compact hot water distribution systems for certain dwelling sizes. **Rationale**: The overall package is too burdensome as a code requirement, the payback period for Measure 1B is long, and savings for Measure 1B are not guaranteed because the measure relies on user behavior to use manual control for a recirculation system.
Measure 2 - **Graywater-Ready Dwellings** Build graywater-ready dwellings with dedicated graywater collection and distribution plumbing. Sources of graywater collection include showers, baths, lavatory sinks, and laundry washing machines.	New Construction (with over 500 ft^2 of landscape) Residential (Single Family)	As an alternative to this measure, consider including only the provision for laundry-to-landscape graywater system. **Rationale**: Laundry-to-landscape graywater system is simpler to build, use, and maintain compared to more complex system covered by the measure.
Measure 3 - **Recycled Water for Common Landscaping** Construct a system to enable connecting common landscaping irrigation system to the source of recycled water once recycled water supply is available within 200 feet of the property line. The measure applies to single-family developments with common landscaping serving three or more homes managed by a homeowners' association. When recycled water is not available at the time of construction, the measure still applies as long as the recycled water is planned to be made available to the	New Construction Residential (Single Family)	None

development within ten years from the date of building permit issuance.		
Measure 4- **Pool and Spa Covers** Install covers on permanently installed outdoor in-ground swimming pools or spas not covered by Title 24, Part 6, including any swimming pool or spa that is non-heated or has electric resistance heating deriving at least 60 percent of the annual heating energy from site solar energy or recovered energy.	New Construction Additions and Alterations above $25,000 valuation Residential (Single Family)	None
Measure 5 - **Exterior Hose Bib Locks** Install locks on all publicly accessible exterior faucets and hose bibs.	New Construction Residential (Multifamily); Nonresidential	None
Measure 6 - **Alternate Water Sources** Include dual plumbing systems to facilitate and maximize the use of alternate water sources for irrigation, toilet flushing, cooling towers, and other uses suitable for non-potable water. The alternate water sources include a) recycled water when available (within 200 feet of the property line) at the time of construction or when anticipated to be available within ten years from the date of building permit issuance and b) onsite treated non-potable water, including graywater, rainwater, foundation drainage, and, optionally, blackwater.	New Construction Residential (Multifamily); Nonresidential	None
Measure 7 - **Landscape Irrigation Water Meters and Flow Sensors** Install water meters for landscape irrigation when required by DWR MWELO as well as for additions and alterations, with valuation of $200,000 or more, where the entire potable water system is replaced, including all underground piping to the existing meter. Include flow sensors for all landscaped areas.	New Construction Additions and Alterations above $200,000 valuation Residential (Single Family and Multifamily); Nonresidential	As an alternative to this measure, consider adopting 2015 Bay Area Water Supply and Conservation Agency (BAWSCA) MWELO that has a lower threshold of 1,000 ft^2 for permitted rehabilitated landscapes compared to the threshold of 2,500 ft^2 in 2015 Department of Water Resources Model Water Efficient Landscape Ordinance (DWR MWELO). As another alternative to this measure, consider mandating voluntary 2016 California Green Building Standards (CALGreen) requirements on landscape water meters (which are stricter than 2015 DWR/BAWSCA MWELO requirements). **Rationale**: 2015 BAWSCA MWELO sufficiently covers the intent of the measure. Aligning the code with 2015 BAWSCA MWELO and/or 2016 CALGreen improves consistency in regulations.

Measure 8 - **Irrigation Controllers** Install irrigation controllers that are weather- or soil moisture-based and that automatically adjust irrigation in response to changes in plants' needs as weather conditions change. A weather-based controller must have a rain sensor.	New Construction, Additions, and Alterations (all with over 500 ft^2 of landscape) Residential (Single Family and Multifamily); Nonresidential	As an alternative to this measure, consider adopting 2015 BAWSCA MWELO that has a lower threshold of 1,000 ft^2 for permitted rehabilitated landscapes compared the threshold of 2,500 ft^2 in 2015 DWR MWELO. **Rationale**: Aligning the code with 2015 BAWSCA MWELO improves consistency in regulations.
Measure 9 - **Maximum Precipitation Rate for Irrigation Nozzles** In landscaped areas, irrigation nozzles shall have a maximum precipitation rate of one inch per hour.	New Construction Residential (Single Family and Multifamily); Nonresidential	As an alternative to this measure, consider early adoption of Title 20 (California Appliance Efficiency Regulations) requirement that mandates pressure regulators in spray sprinkler bodies. As another alternative to this measure, consider stricter than one inch per hour value for maximum precipitation rate or requiring design of irrigation systems such that precipitation rate of an irrigation system matches soil infiltration rate. **Rationale**: Alternative strategies are more likely to address potential water runoff and over irrigation issues.
Measure 10 - **Irrigation Audits** For newly constructed landscaped areas, irrigation audit shall be administered by a local agency to verify the irrigation system complies with regulations. In case of noncompliance, identified deficiencies shall be addressed.	New Construction Residential (Single Family and Multifamily); Nonresidential	As an alternative to this measure, consider adopting 2015 BAWSCA MWELO that has a lower threshold of 1,000 ft^2 for permitted rehabilitated landscapes compared to the threshold of 2,500 ft^2 in 2015 DWR MWELO. **Rationale**: Aligning the code with 2015 BAWSCA MWELO improves consistency in regulations.
Measure 11 - **Indoor Water Meters** Install separate water meters or submeters to measure indoor water use a) for each individual leased, rented, or other tenant space within building projected to consume more than 100 gallons per day; b) for each building projected to use more than 100 gallons per day on a parcel containing multiple buildings; c) for potable water supplied for a) makeup water in cooling towers where flow is greater than 500 gallons per minute, b) for makeup water for evaporative coolers greater than six gallons per minute, and c) for steam and hot-water boilers with energy input greater than 500,000 Btu/h.	New Construction, Additions (both 50,000 ft^2 or more) Residential (Multifamily); Nonresidential	None
Measure 12 - **Cooling Towers**	New Construction	None

Newly installed cooling towers shall include devices to capture and reuse the blowdown water discharged from the cooling tower.	Residential (Multifamily); Nonresidential	
Measure 13 - **Manually Operated Toilets in Commercial Facilities** Install toilets and urinals with manual flush rather than sensor or automatic flush valves.	New Construction Nonresidential	None
Measure 14 - **Manually Operated Faucets in Commercial Facilities** Install faucets with manual rather than sensor operation. This measure does not apply to hospitals and airports.	New Construction Nonresidential	None
Measure 15 - **Commercial Kitchen Water Efficiency** Install new and replacement commercial dishwashers, food steamers, combination ovens, and food waste pulping systems that meet or exceed water efficiency standards under 2016 CALGreen (Title 24, Part 11, Section A6.303.3).	New and Replacement Equipment Nonresidential	None
Measure 16 - **Selling Compliant Fixtures and Fittings** Stores, outlets, and other retail establishments shall offer for sale plumbing fixtures and fittings compliant with Title 20.	Residential; Nonresidential	None
Measure 17 - **Installing Compliant Fixtures and Fittings** Plumbers, contractors, and other service providers shall install plumbing fixtures and fittings compliant with Title 20.	Residential; Nonresidential	None

Source: Energy Solutions.

1.2 Water-Energy Nexus and Policy Drivers

Supplying and treating water consumes a significant amount of electricity across the state. However, that energy is usually consumed off-site at a centralized pumping station or treatment plant. The relationship between water use and energy use is direct and inter-dependent, and the reduced energy use can help justify additional water efficiency standards. Nearly twenty percent of the electricity and thirty percent of non-power plant-related natural gas use in California is associated with meeting California's water supply needs (Energy Commission 2006).[1] California consumes about 2.9 trillion gallons of water per year for urban uses (Christian-Smith, Heberger and Allen 2012).[2] These 2.9 trillion gallons of water correspond to approximately 12.2 Gigawatt

[1] Water-related energy uses include energy consumed by water agencies for water collection, extraction, conveyance, treatment prior to use (e.g., potable), treatment and disposal after use (e.g., wastewater), and for distribution to end-users. It also includes energy used by the end-user after the water agency has delivered water, such as energy used to pump and heat water on-site.

[2] Urban uses include outdoor and indoor residential water use; water used in commercial, institutional, and industrial applications; and unreported water use, which is primarily attributed to leaks.

(GWh) of embedded electricity.[3] More than 4.4 GWh of electricity are used every year to supply and treat potable water that is used inside residential buildings. Conversely, water is required to produce electricity; if electricity demand increases so does the demand for water (California Sustainability Alliance 2013). The California Global Warming Action Plan, developed in response to Assembly Bill 32 (AB 32) in 2006, recognizes this water-energy nexus. The plan calls for the establishment of indoor and outdoor water efficiency standards, and water recycling initiatives to help achieve California state greenhouse gas (GHG) reduction goals.[4]

AB 1668 and Senate Bill 606 (SB 606), signed into law in 2018, directed the California State Water Resources Control Board (State Water Board), in coordination with the DWR, to adopt standards for the efficient water use by June 30, 2022. The bills established indoor water use goals (55 gallons per day per capita until 2025 and 50 gallons per day per capita starting in 2030) and specified reporting requirements. Fines to enforce upcoming regulations may be assessed starting November 1, 2027.

In 2017, AB 574 directed the State Water Board to adopt uniform water recycling criteria for direct potable reuse through raw water augmentation by December 31, 2023. The Policy for Water Quality Control for Recycled Water (Recycled Water Policy) adopted by the State Water Board in 2009 and last amended in 2018, supports the use of recycled water. The Recycled Water Policy provides guidance to protect public health and the environment when using recycled water and includes goals and mandates for the use of recycled water and stormwater as well as for increasing urban and industrial water conservation (State Water Board 2019).

AB 2282, signed into law in 2014, directed the CBSC and California Department of Housing and Community Development (HCD) to develop mandatory standards for using recycled water in new nonresidential and residential construction. During the 2016 Intervening Code Adoption Cycle, the California Plumbing Code (Title 24, Part 5) and the California Green Building Standards Code (Title 24, Part 11 or CALGreen) were amended to include the requirements to use tertiary treated recycled water from a centralized source for irrigation in new nonresidential and residential construction. These mandatory recycled water standards went into effect on July 1, 2018, but were invalidated in May 2019 by a court order that resulted from a lawsuit brought by a labor union. The court order invalidated the recycled water standards for substantial failure of CBSC and HCD to comply with the Administrative Procedure Act of Government Code during the adoption of the recycled water standards, specifically, requirements to assess economic impacts of new standards (HCD 2019).

1.3 Federal Preemption

The United States (U.S.) Department of Energy (DOE) sets minimum efficiency standards for equipment and appliances that are federally regulated under the National Appliance Energy Conservation Act (NAECA), including heating, cooling, and water heating equipment. State and local governments are prohibited from adopting higher minimum efficiencies than the federal standards require. This report presents measures that do not impose more stringent energy efficiency requirements on equipment that is covered by NAECA.

2 Methodology and Assumptions

This analysis uses a customer-based lifecycle cost (LCC) approach to evaluate cost-effectiveness of the proposed measures, whereas the Energy Commission LCC methodology uses Time Dependent Valuation (TDV) as the primary metric for energy savings benefits. Both methodologies require estimating and quantifying the energy

[3] Assumptions: Embedded energy factor of 4,848 kilowatt hours (kWh)/million gallons (MG) for residential indoor water use and unreported leaks; embedded energy factor of 3,565 kWh/MG for residential outdoor; embedded energy factor of 4,206 kWh/MG for commercial, institutional, and industrial.

[4] See Appendix E – Embedded Electricity Usage Methodology for information about the methodology used to calculate the embedded energy estimates presented in this report.

savings associated with energy efficiency measures, as well as quantifying the costs associated with the measures. The main difference between the methodologies is the way they value energy and, thus, the cost savings of reduced or avoided energy use. The Energy Commission LCC Methodology uses TDV that reflects the "societal value or cost" of energy including long-term projected costs of energy such as the cost of providing energy during peak periods of demand and other societal costs such as projected costs for carbon emissions (Energy & Environment Economics 2017). The customer-based LCC methodology values energy and water based upon estimated site energy and water usage and utility rate schedules to estimate cost savings to the customer. As TDV does not include a valuation of water savings, this metric would underestimate the value of most resources saved from these measures and is therefore not the most appropriate metric for determining cost-effectiveness of efficiency measures saving both energy and water.

2.1 Building Prototypes

For the measure (Measure 1 - Water Waste Reduction when Delivering Hot Water) that builds upon the 2019 Title 24, Part 6 requirements, the California Building Energy Code Compliance software for Residential Buildings (CBECC-Res) to evaluate energy impacts was used. The Energy Commission defines building prototypes that are used to evaluate the cost-effectiveness of proposed changes to Title 24, Part 6. There are two single family prototypes, whose basic characteristics are described in Table 2. Additional details on the prototypes can be found in the Alternate Calculation Method (ACM) Approval Manual (Energy Commission, 2018b).

Demand-initiated recirculation systems paired with DWHR in Measure 1 were simulated using both prototypes – 2,100 ft^2 and 2,700 ft^2, with results presented for a 2,430-square foot single family home. For compact hot water distribution systems in Measure 1, this analysis includes savings estimates from the Final 2019 CASE Report (Statewide CASE Team 2017a), which used a weighted average of the two Energy Commission single family prototypes (2,100 and 2,700 ft^2), with results presented for a 2,430-square foot single family home.

Table 2: Building Prototype Characteristics

	Single Family One-Story	Single Family Two-Story
Conditioned Floor Area	2,100 ft^2	2,700 ft^2
Number of Stories	1	2
Number of Bedrooms	3	4
Window-to-Floor Area Ratio	20%	20%

Source: Energy Commission 2018b.

For measures involving nonresidential buildings, building assumptions were based either on the three-story, 53,628-square foot medium sized office building prototype, 117,000-square foot large office prototype, or 498,589-square foot large office prototype depending on a measure. For measures involving multifamily buildings, building assumptions were based on a two-story, 6,960-square foot multifamily building prototype with four one-bedroom, 780-square foot units and four two-bedroom, 960-square foot units.

For irrigation measures, the landscape area for a residential landscape was assumed to be 2,648 ft^2, which was the median from an Aquacraft study on end use water profiles (Aquacraft 2011a). The landscape area for nonresidential landscape was assumed to be 8,826 ft^2. The area for a nonresidential landscape was calculated by scaling the residential landscape area of 2,648 ft^2 based on the comparison between 69,000 gallons per year used outdoors for single family homes (Aquacraft 2011b) and 230,000 gallons per year used outdoors for nonresidential buildings (Statewide CASE Team 2017c).

Measure-specific methodologies are presented in Appendix A – Measure-Specific Assumptions and Methodologies.

2.2 Lifecycle Cost-Effectiveness

Measure cost-effectiveness was evaluated for all sixteen climate zones (defined by the Energy Commission) and is presented based on lifecycle customer benefit-to-cost (B/C) ratio metric. The B/C ratio is a metric that represents the cost-effectiveness of energy and water efficiency over a 30-year period of analysis (for residential measures) or a 15-year period of analysis (for nonresidential measures). The metric takes into account discounting of future savings (real discount rate of three percent) and future incremental costs, including maintenance or replacement cost if replacement takes place prior to the end of the 15- or 30-year evaluation period. The B/C ratio is the incremental energy and water cost savings (net present value benefits) divided by the total incremental costs (net present value costs). A value of one indicates the cost savings over the period of analysis are equivalent to the incremental cost of measure. A measure is cost-effective if the B/C ratio is equal to or greater than one. Simple payback is also presented and is calculated using

Equation 1.

Equation 1:

$$\textit{Simple payback} = \textit{First incremental cost} \,/\, \textit{Net annual cost savings}$$

Where:

Equation 2:

$$\textbf{Net annual cost savings} = \textbf{Annual customer utility cost savings} - \textbf{Annual costs}$$

The water and energy utility rates in place at the time of this analysis were used to calculate cost savings associated with the water and energy savings of the considered measures. Table 3 presents the rates used in the analysis, which are the most commonly-used energy rates for each occupancy type. For this analysis, PG&E rates were used for gas and electricity in climate zones 1 through 5, 11 through 13, and 16. SCE electricity rates and SoCalGas rates were used for climate zones 6, 8 through 10, 14 and 15. SDG&E rates were used for electricity and gas for climate zone 7.

Water rates are summarized in Table 4 and Table 5. Appendix C – Energy Utility Rate Schedules includes the detailed rate schedules used for this study and Appendix D – Water and Wastewater Rates describes the methodology for determining average statewide water rates.

Table 3: IOU Utility Tariffs Used Based on Climate Zone

Climate Zones	Electric / Gas Utility	Electricity (Standard)	Natural Gas	Electricity (Standard)	Natural Gas
		Residential		Commercial	
1-5, 11-13, 16	PG&E	E1	G1	A-10	G-NR1
6, 8-10, 14, 15	SCE/SoCalGas	D	GR	GS-2-A	G10
7	SDG&E	DR	GR	A	GN-3

Table 4: Water Rates - Potable

	Rate ($/1,000 gallons)	Rate ($/1,000 gallons)
	Residential	Commercial
Potable	$6.44	$4.82
Wastewater	$1.54	$5.19
Total	$7.98	$10.01

Table 5: Water Rates - Recycled

	Rate ($/1,000 gallons)	Rate ($/1,000 gallons)
	Residential	**Commercial**
Recycled	$5.80	$4.34
Wastewater	$1.54	$5.19
Total	$7.34	$9.53

2.3 Embedded Electricity Use

Energy is required for water supply, conveyance, treatment and distribution of potable water, and collection and treatment of wastewater. For this analysis, it was assumed that every million gallons (MG) of water used for an indoor application in California is attributable to 4,848 kWh of electricity use and every MG of water used for an outdoor application in California is attributable to 3,565 kWh of electricity use. These values were derived from a California Public Utilities Commission (CPUC) cost-effectiveness analysis of water and energy prepared by Navigant Consulting, Inc. (CPUC 2015b). The CPUC analysis was limited to evaluating the embedded electricity in water and does not include embedded natural gas in water. Since accurate estimates of the embedded natural gas in water were not available at the time of writing, the analysis in this report does not include estimates of embedded natural gas savings associated with water reductions.

See Appendix E – Embedded Electricity Usage Methodology for further discussion on the methodology used to develop the embedded energy factor.

2.4 Greenhouse Gas Emissions

Equivalent carbon dioxide (CO_2-e) emission reductions were calculated using the emission factors in Table 6. Electricity emission factors are specific to California electricity production.

Table 6: Equivalent CO_2 Emissions Factors

Energy Type	Emission Factor	Source
Electricity	0.724 lb. CO_2-e / kWh	U.S. Environmental Protection Agency's (EPA) 2007 eGRID data.[a]
Natural Gas	11.7 lb. CO_2-e / Therm	Emission rates for natural gas combustion as reported by the EPA GHG Equivalencies Calculator.[b]

[a] Source: https://www.epa.gov/ener4.9gy/ghg-equivalencies-calculator-calculations-and-references
[b] Source: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

3 Measure Description and Cost

This section presents detailed descriptions and background for measures addressed in this analysis. Table 7 at the end of the section summarizes assumed costs for all measures.

3.1 Measure 1 – Water Waste Reduction when Delivering Hot Water

Scope: New Construction; Single Family

Option A – Compact Hot Water Distribution Systems

Description: Meet requirements for the Compact Hot Water Distribution System Expanded Credit, including verification from Home Energy Rating System (HERS) Rater in accordance with the 2019 Title 24, Part 6 Residential Reference Appendices section RA4.4.16.

Background: The HERS-Verified Compact Hot Water Distribution System Expanded Credit was originally developed under the 2013 Title 24, Part 6 standards development and continued as a compliance credit under 2016 Title 24, Part 6 to encourage builders to locate hot water fixtures close to the water heater to save water and energy. As an optional compliance strategy, the credit has historically seen low uptake at around 0.1 percent (Statewide CASE Team 2017a). As a result, the compliance credit was updated in the 2019 Title 24, Part 6 Standards to allow for a basic credit option without HERS verification and an expanded credit option with HERS verification.

This measure option is one of two options to reduce water waste when waiting for hot water to arrive at the fixture. This option achieves this goal by reducing the length of pipe in the hot water distribution system in single family new construction.

Option B – Demand Recirculation with DWHR

Description: Where a hot water recirculation system or electric trace heating system exists, limit the amount of water contained in each branch from the recirculating loop or electric trace heating element to the fixture to a maximum of 0.125 gallon of water. Recirculation systems must have a manual control (pushbutton). In addition, meet requirements of a DWHR system, installed in an equal flow configuration, with HERS verification in accordance with the 2019 Reference Appendices RA4.4.21.

Background: In the Title 24, Part 6 Standards, recirculation systems are permitted but not required. Under the prescriptive approach to compliance, Title 24, Part 6 specifies that demand recirculation systems must have manual controls. Under the performance approach, both systems with manual controls or occupancy sensor controls are permitted. DWHR system is a new compliance credit under the 2019 Title 24, Part 6 Standards.

Installing a DWHR system in an equal flow configuration refers to the installation of the device with pre-heated water routed to both the water heater and the shower to maximize energy savings (Statewide CASE Team 2017b).

3.2 Measure 2 – Graywater-Ready Dwellings

Scope: New Construction; Single Family

Description: Build graywater-ready dwellings with dedicated graywater collection and distribution plumbing. Sources of graywater collection include showers, baths, lavatory sinks, and laundry washing machines. This measure does not apply to dwellings with less than 500 ft^2 of irrigated landscape.

Background: 2016 CALGreen includes a voluntary measure in Section A4.305.1 that addresses using graywater for irrigation. The CALGreen measure allows alternative plumbing piping to be installed to use water from clothes washers or other fixtures for an irrigation system so long as the piping system complies with the California Plumbing Code. Chapter 15 of the California Plumbing Code addresses requirements for alternate water sources.

This measure results in direct water savings and indirect (embedded) energy savings by offsetting the amount of potable water used in single family landscape irrigation.

3.3 Measure 3 – Recycled Water for Common Landscaping

Scope: New Construction; Single Family

Description: Construct a system to enable connecting common landscaping irrigation system to the source of recycled water once recycled water supply is available within 200 feet of the property line. The measure applies to single-family developments with common landscaping serving three or more homes managed by a homeowners' association. When recycled water is not available at the time of construction, the measure still applies as long as the recycled water is planned to be made available to the development within ten years from the date of building permit issuance.

Background: Pursuant to AB 2282, during the 2016 Intervening Code Adoption Cycle, the California Plumbing Code and CALGreen were amended to include the requirements to use tertiary treated recycled water from a centralized source for irrigation in new nonresidential and residential construction. These mandatory recycled water standards went into effect on July 1, 2018 but were invalidated in May 2019 by a court order that resulted from a lawsuit brought by a labor union. For newly constructed residential developments, the invalidated provision in the 2016 CALGreen stated that recycled water supply system for irrigation *may* be required, thus, making this provision non-mandatory unless the provision is adopted as a local ordinance by local jurisdictions.

The measure results in direct water savings and indirect (embedded) energy savings by offsetting the amount of potable water used in irrigating common landscape.

3.4 Measure 4 – Pool and Spa Covers

Scope: New Construction, Additions, Alterations; Single Family

Description: Install covers on permanently installed outdoor in-ground swimming pools or spas not covered by Title 24, Part 6, including any swimming pool or spa that is non-heated or has electric resistance heating deriving at least 60 percent of the annual heating energy from site solar energy or recovered energy. Additions or alterations to existing swimming pools and spas that are not covered by Title 24, Part 6, with a valuation not exceeding $25,000, are exempt.

Background: Title 24, Part 6 already requires covers on pools and spas heated with a gas or heat pump water heater. This measure expands the scope of Title 24, Part 6 coverage without altering Title 24, Part 6 requirements. This measure expands the scope to non-heated pools and spas or those using electric resistance heating combined with a solar thermal system providing at least 60 percent of the annual heating energy.

2015 Department of Water Resources Model Water Efficient Landscape Ordinance (DWR MWELO) has a provision that highly recommends pool and spa covers but does not mandate them (CCR 2019b). Bay Area Water Supply and Conservation Agency (BAWSCA), a regional coalition of cities, water districts, and private utilities, developed its own version of MWELO with a primary goal to simplify the language of the statewide version. 2015 BAWSCA version of MWELO mandates covers for new pools and spas.

This measure results in direct water savings and associated indirect (embedded) energy savings from reduced evaporation.

3.5 Measure 5 – Exterior Hose Bib Locks

Scope: New Construction; Multifamily and Nonresidential

Description: Install locks on all publicly accessible exterior faucets and hose bibs.

Background: The Reach Codes Team is not aware of regulations pertaining to locks on hose bibs. This measure results in direct water savings and indirect (embedded) energy savings by preventing water theft from publicly-accessible faucets.

3.6 Measure 6 – Alternate Water Sources

Scope: New Construction; Multifamily and Nonresidential

Description: Include dual plumbing systems to facilitate and maximize the use of alternate water sources for irrigation, toilet flushing, cooling towers, and other uses suitable for non-potable water. The alternate water sources include:

- recycled water when available at the time of construction or when anticipated to be available within ten years from the date of building permit issuance and
- onsite treated non-potable water, including graywater, rainwater, foundation drainage, and, optionally, blackwater.

For this measure, recycled water is considered available when a recycled water supply pipe is available within 200 feet of the property line.

Background: Pursuant to AB 2282, during the 2016 Intervening Code Adoption Cycle, the California Plumbing Code and CALGreen were amended to include the requirements to use tertiary treated recycled water from a centralized source for irrigation in new nonresidential and residential construction. These mandatory recycled water standards went into effect on July 1, 2018 but were invalidated in May 2019 by a court order that resulted from a lawsuit brought by a labor union. For newly constructed nonresidential developments, the invalidated provision in the 2016 CALGreen stated that recycled water supply system for irrigation is required when a recycled water supply pipe is located within 300 feet from a construction site boundary.

In 2012, City and County of San Francisco adopted a voluntary program, also known as Non-potable Water Ordinance, for onsite water reuse for commercial, multifamily, and mixed-use development. In 2016, the ordinance was amended to become mandatory for new development buildings with at least 250,000 square feet of gross floor area within the city boundary. This ordinance is being considered as a model code by local jurisdictions across the United States.

This measure results in water savings and associated embedded energy savings by offsetting the amount of potable water used for irrigation, toilet flushing, and cooling towers.

3.7 Measure 7 – Landscape Irrigation Water Meters and Flow Sensors

Scope: New Construction, Additions, Alterations; Residential and Nonresidential

Description: Install water meters for landscape irrigation when required by DWR MWELO as well as for additions and alterations, with valuation of $200,000 or more, where the entire potable water system is replaced, including all underground piping to the existing meter. Include flow sensors for all landscaped areas.

Background: 2015 DWR MWELO requires landscape water meters for nonresidential irrigated landscapes between 1,000 ft^2 and 5,000 ft^2 and for residential irrigated landscape of 5,000 ft^2 or greater. The water meters could be either provided by the local water provider or privately owned. 2015 DWR MWELO also mandates flow sensors for nonresidential landscapes (permitted new construction with at least 500 ft^2 of landscape and permitted rehabilitated projects that involve at least 2,500 ft^2 of landscape) and residential landscapes that are 5,000 ft^2 or greater (CCR 2019a,c).

For landscape water meters, 2015 BAWSCA MWELO has the same requirements as 2015 DWR MWELO. For flow sensors, 2015 BAWSCA MWELO also requires flow sensors that detect high flow conditions created by system damage or malfunction for nonresidential landscapes (permitted new construction with at least 500 ft^2 of landscape and permitted rehabilitated projects that involve at least 1,000 ft^2 of landscape) and residential landscapes of 5,000 ft^2 or larger. For flow sensors, 2015 BAWSCA MWELO has a lower threshold of 1,000 ft^2 for permitted nonresidential rehabilitated landscapes compared to 2015 DWR MWELO.

2016 CALGreen has a voluntary requirement to install water meters for new water service serving residential landscaped areas less than 5,000 ft^2 (Section A4.304.3 Landscape Water Meters) and serving nonresidential landscaped areas between 500 and 1,000 ft^2 in size (Section A5.304.2 Outdoor Water Use).

For flow sensors, this measure is stricter than 2015 DWR MWELO or 2015 BAWSCA MWELO since the measure requires a flow sensor for a landscaped area of any size. For landscape water meters, this measure is stricter than 2015 DWR MWELO, 2015 BAWSCA MWELO, and 2016 CALGreen since this measure applies to additions and alterations, with a valuation of $200,000 or more, where the entire potable water system is replaced.

This measure results in water savings and associated embedded energy savings.

3.8 Measure 8 – Irrigation Controllers

Scope: New Construction, Additions, Alterations; Residential and Nonresidential

Description: Install irrigation controllers and sensors in new construction, building additions, or alterations with over 500 ft^2 of cumulative landscaped area. Irrigation controllers shall be weather- or soil moisture-based and shall automatically adjust irrigation in response to changes in plants' needs as weather conditions change. A weather-based controller without an integral rain sensor or a communication system that accounts for local rainfall must have a separate wired or wireless rain sensor that connects or communicates with the controller.

Background: As of this report's development in October 2019, the California Energy Commission includes irrigation controllers in the list of appliance categories that are in the Title 20 pre-rulemaking stage.

2015 DWR MWELO requires rain sensors and irrigation controllers that use evapotranspiration or soil moisture data for the following landscape projects:

- new construction projects, with an aggregate landscape equal to or greater than 500 ft^2, requiring a building or landscape permit, plan check or design review and
- rehabilitated landscape projects, with an aggregate landscape area equal to or greater than 2,500 ft^2, requiring a building or landscape permit, plan check or design review (CCR 2019a,c).

2015 BAWSCA MWELO also requires irrigation controllers but uses a lower threshold of 1,000 ft^2 for permitted rehabilitated landscapes compared to 2015 DWR MWELO's threshold of 2,500 ft^2.

For additions and alterations, this measure is stricter than both 2015 DWR MWELO and 2015 BAWSCA MWELO since this measure covers additions and alterations with over 500 ft^2 of cumulative landscaped area (significantly lower than the threshold of 2,500 ft^2 in 2015 DWR MWELO and 1,000 ft^2 in 2015 BAWSCA MWELO). It is assumed that addition and alteration projects would involve rehabilitating landscapes.

This measure results in water savings and associated embedded energy savings from reduced irrigation.

3.9 Measure 9 – Maximum Precipitation Rate for Irrigation Nozzles

Scope: New Construction; Residential and Nonresidential

Description: In landscaped areas, irrigation nozzles shall have a maximum precipitation rate of one inch per hour.

Background: 2015 DWR MWELO mandates that slopes greater than 25 percent are irrigated with an irrigation system with an application rate (also known as precipitation rate) not exceeding 0.75 inches per hour (CCR 2019c). Also, 2015 DWR MWELO mandates to design irrigation systems to prevent runoff, or overspray (CCR 2019c).

The California Energy Commission passed a resolution in August 2019 to adopt Title 20 efficiency standards for spray sprinkler bodies (Energy Commission 2019a). The standards require manufacturers to include pressure regulators in spray sprinkler bodies, test and submit key performance metrics on spray sprinkler bodies to Modernized Appliance Efficiency Database System, and label spray sprinkler bodies. The adopted standards apply to newly manufactured products sold or offered for sale in California on or after October 1, 2020. The adopted standards provide another way to avoid overirrigation due to excessing water flow rates.

This measure results in direct water savings and associated embedded energy savings from improved irrigation efficiency.

3.10 Measure 10 – Irrigation Audits

Scope: New Construction; Residential and Nonresidential

Description: For newly constructed landscaped areas, irrigation audit shall be administered by a local agency to verify the irrigation system complies with regulations. In case of noncompliance, identified deficiencies shall be addressed.

Background: 2015 DWR MWELO requires submission of an irrigation audit report as part of the Certificate of Completion package (CCR 2019d,e) for the following landscape projects:

- new construction projects, with an aggregate landscape equal to or greater than 500 ft^2, requiring a building or landscape permit, plan check or design review and
- rehabilitated landscape projects, with an aggregate landscape area equal to or greater than 2,500 ft^2, requiring a building or landscape permit, plan check or design review (CCR 2019a,c).

Per 2015 DWR MWELO, a local agency can approve or deny the Certificate of Completion, thus, providing a way for the local agency to enforce proper irrigation system design.

2015 BAWSCA MWELO also requires an irrigation audit but uses a lower threshold of 1,000 ft^2 for permitted rehabilitated landscapes compared to 2015 DWR MWELO's threshold of 2,500 ft^2.

For new construction, this measure is stricter than 2015 DWR MWELO or 2015 BAWSCA MWELO since both versions of MWELO apply to permitted new construction projects, with an aggregate landscape equal to or greater than 500 ft^2. In contrast, this measure applies to newly constructed landscapes of any size.

3.11 Measure 11 – Indoor Water Meters

Scope: New Construction, Additions; Multifamily and Nonresidential

Description: Install separate water meters or submeters to measure indoor water use for the following:

- for each individual leased, rented, or other tenant space within building projected to consume more than 100 gallons per day;
- for each building projected to use more than 100 gallons per day on a parcel containing multiple buildings;
- for potable water supplied for a) makeup water in cooling towers where flow is greater than 500 gallons per minute, b) for makeup water for evaporative coolers greater than six gallons per minute, and c) for steam and hot-water boilers with energy input greater than 500,000 Btu/h.

This measure applies to new multifamily residential and new nonresidential buildings with a total gross floor area of 50,000 ft^2 or more and to additions of 50,000 ft^2 or more.

Background: 2016 CALGreen (Section 5.303.1 Meters) requires separate submeters for new nonresidential buildings or additions larger than 50,000 ft^2 as follows:

- for each individual leased, rented, or other tenant space within building projected to consume more than 100 gallons per day;
- where separate submeters for individual building tenants are unfeasible, for water supplied for a) makeup water for cooling towers where flow is greater than 500 gallons per minute, b) for makeup water for evaporative coolers greater than six gallons per minute, and c) for steam and hot-water boilers with energy input greater than 500,000 Btu/h.

While the scope of this measure encompasses 2016 CALGreen requirements, this measure applies in more cases than the 2016 CALGreen code. The measure applies to multifamily buildings (not only nonresidential buildings). Also, this measure applies to parcels containing multiple buildings, when each building is projected to use more than 100 gallons per day, thus, covering non-leased buildings using more than 100 gallons per day. Furthermore, this measure covers cooling towers, evaporative coolers and steam and hot-water boilers as long as a new multifamily or nonresidential building meets the size threshold. In contrast, 2016 CALGreen applies to cooling towers, evaporative coolers and steam and hot-water boilers not only when a nonresidential building meets the size threshold, but also when separate submeters for individual building tenants are unfeasible.

California Water Code (Section 531.1) requires metering water for each residential dwelling in all new multifamily construction as of January 1, 2018 (California Water Code 2019). For multifamily buildings, the Water Code's provision is stricter than the measure since Water Code does not exempt multifamily buildings below a certain building size threshold or units below a certain water use.

This measure results in direct water savings and associated indirect (embedded) energy savings when a building owner takes additional steps to improve the efficiency of sub-metered equipment.

3.12 Measure 12 – Cooling Towers

Scope: New Construction; Multifamily and Nonresidential

Description: Newly installed cooling towers shall include devices to capture and reuse the blowdown water discharged from the cooling tower.

Background: Cooling towers are regulated under Title 24, Part 6, however, blowdown treatment and reuse are not regulated by Title 24, Part 6. Water efficiency of cooling towers is addressed by Title 24, Part 6 through requirements to install conductivity controllers and automated chemical feed systems, which intend to maximize cycles of concentration for cooling towers.

This measure results in additional water savings and associated embedded energy savings beyond Title 24, Part 6 requirements by reusing blow down water.

3.13 Measure 13 – Manually Operated Toilets in Commercial Facilities

Scope: New Construction; Nonresidential

Description: Install toilets and urinals with manual flush rather than sensor or automatic flush valves.

Background: Toilets must meet Title 20 efficiency standards; however, Title 20 dos not specify automatic versus manual operation.

Manually operated toilets have the potential to save water and associated embedded energy due to avoiding the "phantom flush" phenomenon, or activation of the flush valve when not required, that can occur with sensor operated toilets.

3.14 Measure 14 – Manually Operated Faucets in Commercial Facilities

Scope: New Construction; Nonresidential

Description: Install faucets with manual rather than sensor operation. This measure does not apply to hospitals and airports.

Background: Faucets must meet Title 20 efficiency standards; however, Title 20 does not specify automatic versus manual operation.

Manually operated faucets have the potential to save water and associated embedded energy, as well as direct energy from reduced hot water consumption, because of avoiding accidental activation that may be associated with sensor-controlled faucets and from the faucet not being turned on at the maximum flow rate (sensor-controlled faucets operate at full capacity).

3.15 Measure 15 – Commercial Kitchen Water Efficiency

Scope: New and Replacement Equipment; Nonresidential

Description: Install new and replacement commercial dishwashers, food steamers, combination ovens, and food waste pulping systems that meet or exceed water efficiency standards under 2016 CALGreen (Title 24, Part 11, Section A6.303.3).

Background: 2016 CALGreen contains voluntary measures for increased efficiency. Several measures included in 2016 CALGreen, Section A6.303.3 are for federally-regulated products (commercial pre-rinse spray valves and ice makers). As local jurisdictions are federally preempted from adopting more stringent standards for products with federal efficiency regulations, this measure can only apply to the installation of high efficiency products that are not preempted, i.e., commercial dishwashers, food steamers, combination ovens, and pulpers.

3.16 Measure 16 – Selling Compliant Fixtures and Fittings

Scope: Residential and Nonresidential

Description: Stores, outlets, and other retail establishments shall offer for sale plumbing fixtures and fittings compliant with Title 20.

Background: Fixtures and fittings sold or offered for sale must already meet Title 20 efficiency standards. This measure does not result in any additional energy or water savings, rather, its redundancy serves to reiterate Title 20 requirements.

3.17 Measure 17 – Installing Compliant Fixtures and Fittings

Scope: Residential and Nonresidential

Description: Plumbers, contractors, and other service providers shall install plumbing fixtures and fittings compliant with Title 20.

Background: Fixtures and fittings installed by plumbers, contractors, or other service providers must already meet Title 20 efficiency standards. This measure does not result in any additional energy or water savings, rather, its redundancy serves to reiterate Title 20 requirements.

3.18 Cost Assumptions

Table 7 lists the incremental costs assumed for each measure. Consistent with the Energy Commission's methodology to calculate impacts of proposed changes to Title 24, Part 6, design costs are not included in the incremental first cost.

Table 7: Cost Assumptions by Measure

Measure	Incremental First Cost – Per Building			Sources and Notes
	Single Family	Multifamily	Nonresidential	
Measure 1A - Water Waste Reduction when Delivering Hot Water, Compact Hot Water Distribution Systems	$113	n/a	n/a	• (\$11.42) – 16.8' reduction in ¾" PEX tubing. • (\$30.78) – 34.2' reduction of 1" steel pipe. • \$30.78 – 34.2' increase of 1.25" steel pipe. • \$24.66 – 13.7' increase of 3" diameter, 1/16" thick wall steel vent. • Pricing for materials is sourced from online stores. Pipe and vent length changes are sourced from the 2019 CHWDS CASE Report (Statewide CASE Team 2017a). • \$0 – labor (considered a wash between reduced time to install plumbing pipes and increased time to install water heater venting materials). • \$100 – HERS verification (source: local HERS rater).

Measure 1B - Water Waste Reduction when Delivering Hot Water, Demand Recirculation with DWHR	$1,792	n/a	n/a	Recirculation system (total of $1,065.14): • $500 – pump with on demand controls. • $50 – check valve and fittings. • $240 – labor for recirculation system installation (assuming 3 hours of additional work to put in dedicated return line @$80/hr). • $12.60 – 42' of ¾" PEX tubing for recirculation loop at $0.30/ft (internet pricing). • $162.54 – pipe insulation (including labor) for 42' of pipe length (https://www.cityofpaloalto.org/civicax/filebank/documents/52054). • $100 – HERS Verification (source: local HERS rater). Assumed HERS Verification will cover both insulation and DWHR. 3" DWHR (total of $727.01): • $377.04 – DWHR unit price. • $52.03 – (60') of ¾" PEX. • $5.43 – (8) PEX couplings. • $3.26 – ABS couplings. • $102.15 – labor. • $111.35 – plumbing overhead and profit. • $35.02 – sales tax @ 8% of materials. • $40.73 – location adjustment factor markup (Statewide CASE Team 2017b, converted to $2018).
Measure 2 - Graywater-Ready Dwellings	$1,964	n/a	n/a	• $1,633 – average cost of installed system (EcoAssistant 2017; NAP 2016). • $100 - average cost of additional circuit breaker from Fixr (https://www.fixr.com/costs/electrician). • $156 – average cost of hose bib (internet pricing). • $75 – estimated permit price; based on cost in Davis, CA.
Measure 3 - Recycled Water for Common Landscaping	$1,079	n/a	n/a	• $201.27 – cost of additional piping required to connect from the property line to recycled water source, including: $172 for 200' of NSF certified polyvinyl chloride (PVC) reclaimed water pipe at $0.86/ft, (10) PVC couplings for total of $3.90, $5.75 per half pint of solvent cement, $19.62 per pint of primer (internet pricing). • $350 – backflow prevention assembly. • $137.50 – backflow prevention assembly average installation cost (https://home.costhelper.com/backflow-preventers.html). • $90 – permit cost (best available estimate, https://www.tucsonaz.gov/water/consider-reclaimed). • $100 – separate water meter for reclaimed water. • $0 – meter connection fee, typically not assessed for dedicated irrigation meters serving small common area landscaping when managed by a homeowner's association.

				• $200 – labor to trench and install 200 feet of added pipe (https://www.fixr.com/costs/sprinkler-system). • Costs do not include signage denoting that recycled water is in use.
Measure 4 - Pool and Spa Covers	$243	n/a	n/a	• $95.66 – average cost of solar blanket pool cover. • $147.62 – average cost of manual reel. • Pricing for materials is sourced from online stores. • $0 – average installation cost (typically completed by owner, per pool industry contact).
Measure 5 - Exterior Hose Bib Locks	n/a	$112	$56	• Used average lock cost (internet pricing). Typical prices range from $7 to $37 per lock. • Assumed 4 publicly accessible units for multifamily buildings and 2 for nonresidential buildings.
Measure 6 - Alternate Water Sources	n/a	$38,594	$233,208	Multifamily: • $26,796 – average cost of alternate water source system (used median cost of $3.85/ft2; assumed 6,960-square foot multifamily prototype). • $11,798 – cost of drainage system ($50/ft of building perimeter, assuming perimeter of 235.96 ft) • Annual maintenance cost was not included due to lack of readily available data. Nonresidential: • $206,468 – average cost of alternate water source system (used median cost of rainwater harvesting system plus graywater system of $3.85/ft^2 for a commercial building (SFPUC 2018), assumed a nonresidential building prototype of 53,628 ft^2). • $26,740 – cost of drainage system ($50/ft of building perimeter, assuming perimeter of 534.8 ft). • Calculations also account for a maintenance cost of 2.36 percent based on the average annual cost from available nonresidential case studies. This cost is applied over the life of the system and not included in initial installation cost (SFPUC 2018).
Measure 7 - Landscape Irrigation Water Meters and Flow Sensors	$479	$479	$3,259	Residential (Single Family and Multifamily): • $122.74 – residential water meter (internet pricing). • $176.66 – flow sensor (internet pricing). • $90 – installation cost for a water meter, assuming 1.5 hours of work at $60/hour for a plumber (U.S. HUD 2002). • $90 – installation cost for a flow sensor, assuming 1.5 hours of work at $60/hour for a plumber (U.S. HUD 2002). • Assumed installation of one water meter (assumed to be managed by a water provider for billing purposes) and one flow sensor (for owner's use to monitor leaks and overirrigation issues) per single family building or multifamily complex. • $200 – annual meter service fee is not reflected in the first incremental cost but is included in benefit-cost calculations.

				Nonresidential: • $1,667.21 – commercial grade water meter (internet pricing). • $516 – commercial grade flow sensor (internet pricing). • $2,307.08 – hydrometer (internet pricing). • Assumed 50 percent of installations use a flow sensor and 50 percent use a hydrometer • $90 – installation cost for a water meter, assuming 1.5 hours of work at $60/hour for a plumber (U.S. HUD 2002). • $90 – installation cost for a flow sensor, assuming 1.5 hours of work at $60/hour for a plumber (U.S. HUD 2002). • Assumed installation of one water meter (assumed to be managed by a water provider for billing purposes) as well as one flow sensor or one hydrometer (for owner's use to monitor leaks and overirrigation issues) per nonresidential building. • $200 – annual meter fee; the fee is not reflected in the first incremental cost but is included in benefit-cost calculations.
Measure 8 - Irrigation Controllers	$141	$141	$1,265	Residential (Multifamily): • $136.81 - price difference between a residential weather-based controller and a basic irrigation controller ($100), plus a separate rain sensor ($36.81) (Statewide CASE Team 2017c). Assumed 18 percent of weather-based controllers are purchased at this price since 18 percent of weather-based controllers do not have rain sensors (Aquacraft 2009). • $106.02 – price difference between a residential weather-based controller with integrated rain sensor and a basic irrigation controller (Statewide CASE Team 2017c). Assumed 82 percent of weather-based controllers are purchased at this price. • $70.90 – price difference between a residential soil moisture-based controller and a basic irrigation controller (Statewide CASE Team 2017c). • $50 – incremental installation cost to program more advanced features of a weather-based or soil moisture-based controller (Statewide CASE Team 2017c). • Assumed 50 percent of applications use weather-based and 50 percent use soil-moisture based controllers. Nonresidential: • $604.35 - price difference between a commercial weather-based controller and a basic commercial irrigation controller ($567.54), plus a separate rain sensor ($36.81) (internet pricing). Assumed 18 percent of weather-based controllers are purchased at this price.

				• $859.98 – price difference between a commercial weather-based controller with integrated rain sensor and a basic commercial irrigation controller (internet pricing). Assumed 82 percent of weather-based controllers are purchased at this price. • $1,615.29– price difference between a commercial soil moisture-based controller and a basic irrigation controller (internet pricing). • $50 – incremental installation cost to program more advanced features of a weather-based or soil moisture-based controller (Statewide CASE Team 2017c). • Assumed 50 percent of applications use weather-based and 50 percent use soil moisture-based controllers.
Measure 9 - Maximum Precipitation Rate for Irrigation Nozzles	$38	$38	$130.24	• $38.48 - incremental cost for 26 irrigation nozzles for residential application (internet pricing). • $130.24 – incremental cost for 88 irrigation nozzles for nonresidential application (internet pricing). • Base case cost was assumed to be $2 per nozzle; a measure case cost - $3.48 per nozzle (internet pricing).
Measure 10 - Irrigation Audits	$1,763	$1,763	$5,288	• $117.5 – average hourly rate for irrigation audit from personal communication with California Landscape Contractors Association. • Assumed 15 hours for residential and 45 hours for nonresidential, based on estimate of time to complete for average landscape size, report development, and follow-up.
Measure 11 - Indoor Water Meters	n/a	Not considered in the analysis	$2,925	• $900 – meter cost and $562.50 – installation cost, converted to $2018 (Sher 2016). • Assumed two additional water meters needed beyond 2016 CALGreen code (one for a cooling tower and another one for a boiler).
Measure 12 - Cooling Towers	n/a	Not considered in the analysis	$19,101 - $42,842	• Capital costs: $690 ($500 - 500 feet piping, $50 – pipe fittings, $50 – pipe cement, $50 – check valve, $40 – 3-way valve) (internet pricing). • Treatment system capital cost (reverse osmosis): this cost ranges from $18,411 to $42,152 depending on the climate zone because blowdown discharge varies by climate zone and this cost is based on $/gallon/day (http://www.conservationmechsys.com/wp-content/uploads/2016/11/TDS-reclaimed-water.pdf). • $500 - membrane replacement every 3 years; the replacement is not reflected in the first incremental cost but is included in benefit-cost calculations.
Measure 13 - Manually Operated Toilets in Commercial Facilities	n/a	n/a	$0	Conservative approach; manually-operated toilets are typically less expensive than sensor-operated toilets.

Measure 14 - Manually Operated Faucets in Commercial Facilities	n/a	n/a	$0	Conservative approach; manually-operated faucets are typically less expensive than sensor-operated faucets.
Measure 15 - Commercial Kitchen Water Efficiency	n/a	n/a	$1,819	• $377 – dishwashers, $653 – food steamers, $789 – combination ovens (Statewide CASE Team 2015). • The cost of a pulping system is not included in the analysis. Assumed that a pulping system is not installed in a typical commercial kitchen.
Measure 16 - Selling Compliant Fixtures and Fittings	n/a	n/a	n/a	There is no incremental cost for selling compliant fixtures and fittings. Retail stores are already required to sell Title 20 compliant fixtures and fittings.
Measure 17 - Installing Compliant Fixtures and Fittings	n/a	n/a	n/a	There is no incremental cost for installing compliant fixtures and fittings. Contractors are already required to install Title 20 compliant fixtures and fittings.

4 Results

Cost-effectiveness results are shown for each climate zone in tabular form along with energy and GHG reductions for each measure. Measures that are not cost-effective are shaded. Results represent the weighted average energy, water, and cost impacts for each of California's 16 climate zones. Costs and savings are presented on a per-building basis.

4.1 Measure 1 – Water Waste Reduction when Delivering Hot Water

Option A – Compact Hot Water Distribution Systems

As presented in Table 8, compact hot water distribution systems were found to be cost-effective in all climate zones. This analysis uses the electricity, gas, and water annual savings estimates from the 2019 Compact Hot Water Distribution CASE Report, which assumes that most homes will achieve the Compact Hot Water Distribution System Expanded Credit by re-locating the water heater. Costs and savings are presented on a per-building basis.

Table 8: Cost-Effectiveness Results Per Building – Compact Hot Water Distribution Systems

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
Water Waste Reduction when Delivering Hot Water, Compact Hot Water Distribution Systems (New Construction, Single Family)									
CZ1	0	5	962	5	63	$113	$15	7.7	2.5
CZ2	0	5	962	5	57	$113	$14	8.1	2.4
CZ3	0	5	962	5	57	$113	$14	8.1	2.4
CZ4	0	5	962	5	54	$113	$14	8.3	2.4
CZ5	0	5	962	5	58	$113	$14	8.1	2.4
CZ6	0	4	962	5	52	$113	$12	9.7	2.0
CZ7	0	4	962	5	51	$113	$13	8.7	2.3
CZ8	0	4	962	5	48	$113	$11	9.9	2.0
CZ9	0	4	962	5	48	$113	$11	9.9	2.0
CZ10	0	4	962	5	48	$113	$11	9.9	2.0
CZ11	0	4	962	5	50	$113	$13	8.6	2.3
CZ12	0	5	962	5	53	$113	$13	8.4	2.3
CZ13	0	4	962	5	48	$113	$13	8.7	2.3
CZ14	0	4	962	5	52	$113	$12	9.8	2.0
CZ15	0	3	962	5	35	$113	$10	10.9	1.8
CZ16	0	5	962	5	63	$113	$15	7.7	2.5

Option B – Demand Recirculation with DWHR

As indicated in Table 9, demand recirculation with manual control paired with DWHR was found to be cost-effective in all climate zones. Costs and savings are presented on a per-building basis.

Hot water recirculation systems reduce the amount of water discharged from the plumbing branch prior to the arrival of hot water and result in direct water savings and accompanying indirect (embedded) energy savings. As a standalone design, recirculation systems save water; however, the amount of energy used to operate a hot water recirculation system may exceed the amount of direct energy saved from reduced hot water use and therefore results in an increase in energy consumption. This option is therefore paired with DWHR system to offset the increased energy consumption. DWHR system saves energy by capturing the waste heat in the drain line during shower events and using that reclaimed heat to pre-heat cold water to be delivered to the shower or the water heater.

When pursuing the performance approach to comply with Title 24, Part 6, both manual and sensor controls are allowed for demand recirculation systems. To evaluate the energy impact of demand recirculation systems and determine whether pairing with DWHR results in energy savings, the analysis team modeled recirculation systems using both Demand Control Manual (manual control) with HERS verification and Demand Control Occupancy (sensor control) with HERS verification and found that sensor control systems use more energy in all 16 climate zones than manual control systems. As a result, only manual control systems when combined with DWHR results in compliance for all 16 climate zones. Therefore, this measure requires manual control recirculation system combined with DWHR. The results for sensor control recirculation system combined with DWHR are not presented in this report.

Table 9: Cost-Effectiveness Results Per Building – Demand Recirculation with DWHR

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
Water Waste Reduction when Delivering Hot Water, Demand Recirculation with DWHR (New Construction; Single Family)									
CZ1	-23	18	15,185	74	211	$1,792	$140	12.8	1.5
CZ2	-23	18	15,185	74	211	$1,792	$137	13.1	1.5
CZ3	-23	16	15,185	74	176	$1,792	$137	13.1	1.5
CZ4	-23	16	15,185	74	189	$1,792	$135	13.2	1.5
CZ5	-23	15	15,185	74	166	$1,792	$138	13.0	1.5
CZ6	-23	16	15,185	74	189	$1,792	$130	13.8	1.4
CZ7	-23	14	15,185	74	154	$1,792	$132	13.6	1.4
CZ8	-23	14	15,185	74	144	$1,792	$129	13.9	1.4
CZ9	-23	13	15,185	74	132	$1,792	$129	13.9	1.4
CZ10	-23	13	15,185	74	144	$1,792	$129	13.9	1.4
CZ11	-23	13	15,185	74	132	$1,792	$134	13.4	1.5
CZ12	-23	13	15,185	74	154	$1,792	$135	13.3	1.5
CZ13	-23	14	15,185	74	154	$1,792	$133	13.5	1.5
CZ14	-23	13	15,185	74	144	$1,792	$130	13.8	1.4
CZ15	-23	14	15,185	74	154	$1,792	$125	14.3	1.4
CZ16	-23	8	15,185	74	88	$1,792	$139	12.9	1.5

As summarized in Table 10, pairing DWHR with manual controlled demand recirculation systems sufficiently offsets both the additional gas use from the water heater and the additional electricity use from the recirculation pump, resulting in overall energy savings in all climate zones. Additional gas use is related to water heat loss from pipes when water is circulating for a short period of time before being used at the fixture. The additional gas use from a recirculation system is minimal.

Table 10: Energy Consumption – Demand Recirculation with DWHR

Climate Zone	Standard Design Gas (therms)	Standard Design Net Electricity (kWh)	Proposed Design Gas (therms)	Proposed Design Net Electricity (kWh)	Additional Water Heating Energy, Including Pumps (kTDV)	Total Net Energy Savings (kTDV)
CZ1	581	0	562	23	-2,974	2,998
CZ2	421	0	405	23	-2,493	2,518
CZ3	348	0	332	23	-2,493	2,518
CZ4	347	0	332	23	-2,290	2,323
CZ5	331	0	314	23	-2,615	2,649
CZ6	249	0	235	23	-2,129	2,153
CZ7	196	0	182	23	-2,003	2,037
CZ8	206	0	193	23	-1,979	2,003
CZ9	229	0	216	23	-2,003	2,037
CZ10	239	0	226	23	-1,979	2,013
CZ11	378	0	365	23	-2,028	2,052
CZ12	390	0	376	23	-2,183	2,207
CZ13	352	0	339	23	-1,955	1,989
CZ14	371	0	357	23	-2,110	2,134
CZ15	149	0	140	23	-1,121	1,154
CZ16	605	0	588	23	-2,950	2,984

4.2 Measure 2 – Graywater-Ready Dwellings

As shown in Table 11, graywater collection and distribution systems were not found to be cost-effective in any climate zone. The measure requires homes to be built graywater-ready so that they can be prepared to use appropriately treated graywater in the future. The cost of constructing buildings graywater-ready during new construction is much lower than retrofitting a building later to accommodate graywater reuse. A significant component of a graywater-ready unit, dual plumbing, would essentially require installation of another plumbing system throughout the building, which is significantly more expensive and more challenging in a retrofit scenario. Thus, this measure enables newly constructed buildings to add a graywater system in the future with minimal cost and effort.

This measure does not require the graywater system to be connected to landscape irrigation system; having graywater-ready home will not result in savings unless homeowners voluntarily connect and use the graywater plumbing. To provide a conservative estimate of the achievable water savings, the project team calculated water savings per home assuming only graywater from the laundry washing machines is used for landscape irrigation. If other fixtures are also connected to the graywater system, the savings will be larger. Since the amount of graywater provided by a laundry-to-landscape system does not entirely offset the landscape irrigation needs in any climate zone, savings are the same in each climate zone. Costs and savings are presented on a per-building basis.

Table 11 presents results using the full costs to make a dwelling graywater-ready.

Table 11: Cost-Effectiveness Results Per Building – Graywater-Ready Dwellings

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
Graywater-Ready Dwellings (New Construction; Single Family)									
CZ1-CZ16	0	0	8,563	31	0	$1,964	$68	28.7	0.68

Table 12 presents results using the costs to install a laundry-to-landscape system only, without a permit. This alternative is cost-effective in all climate zones.

Table 12: Cost-Effectiveness Results Per Building – Laundry-to-Landscape Systems

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
Laundry-to-Landscape Systems (New Construction; Single Family)									
CZ1-CZ16	0	0	8,563	31	0	$1,200	$68	17.6	1.1

4.3 Measure 3 – Recycled Water for Common Landscaping

As shown in Table 13, using recycled water in single family common landscaping was not found to be cost-effective in any climate zone. While this measure results in significant potable water savings from offsetting consumption of non-recycled water with recycled water, from the customer's perspective it is assumed that the amount of water consumption does not change based on whether the water is potable or recycled. To this regard, the on-bill savings only include the difference in cost between potable and recycled water rates, consequently, the water cost savings used in the analysis come only from this price difference. Costs and savings are presented on a per-building basis.

Table 13: Cost-Effectiveness Results Per Building – Recycled Water for Common Landscaping

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Potable Water Offset (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
Recycled Water for Common Landscaping (New Construction; Single Family)										
CZ1	0	0	0	26,515	0	0	$1,078	-$57	N/A	0.13
CZ2	0	0	0	47,429	0	0	$1,078	-$43	N/A	0.24
CZ3	0	0	0	48,620	0	0	$1,078	-$43	N/A	0.24
CZ4	0	0	0	56,549	0	0	$1,078	-$38	N/A	0.28
CZ5	0	0	0	59,922	0	0	$1,078	-$35	N/A	0.30
CZ6	0	0	0	52,870	0	0	$1,078	-$40	N/A	0.26
CZ7	0	0	0	61,132	0	0	$1,078	-$35	N/A	0.31
CZ8	0	0	0	61,452	0	0	$1,078	-$34	N/A	0.31
CZ9	0	0	0	57,010	0	0	$1,078	-$37	N/A	0.28
CZ10	0	0	0	75,820	0	0	$1,078	-$25	N/A	0.38

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Potable Water Offset (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
CZ11	0	0	0	61,299	0	0	$1,078	-$35	N/A	0.31
CZ12	0	0	0	65,735	0	0	$1,078	-$32	N/A	0.33
CZ13	0	0	0	66,906	0	0	$1,078	-$31	N/A	0.33
CZ14	0	0	0	92,250	0	0	$1,078	-$15	N/A	0.46
CZ15	0	0	0	100,971	0	0	$1,078	-$9	N/A	0.50
CZ16	0	0	0	41,322	0	0	$1,078	-$47	N/A	0.21

4.4 Measure 4 – Pool and Spa Covers

As shown in Table 14, requiring pool and spa covers on non-heated pools is cost-effective in all climate zones. The costs modeled as part of this analysis include the average cost of the least expensive available pool cover, a solar bubble cover, and a manual reel. Cost of installing other types of manual or automated covers would be significantly higher but are not required.

This analysis also does not account for additional potential savings from reduced chemical usage, nor does it attempt to quantify other benefits offered by pool covers such as reduced cleaning, potential reduced maintenance costs, and safety benefits. Costs and savings are presented on a per-building basis.

Table 14: Cost-Effectiveness Results Per Building – Pool and Spa Covers

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
Pool and Spa Covers (New Construction, Additions, Alterations; Single Family)									
CZ1	0	0	6,276	22	0	$243	$50	4.9	1.9
CZ2	0	0	11,094	40	0	$243	$89	2.7	3.3
CZ3	0	0	12,357	44	0	$243	$99	2.5	3.7
CZ4	0	0	17,032	61	0	$243	$136	1.8	5.1
CZ5	0	0	13,926	50	0	$243	$111	2.2	4.2
CZ6	0	0	7,339	26	0	$243	$59	4.2	2.2
CZ7	0	0	12,649	45	0	$243	$101	2.4	3.8
CZ8	0	0	8,403	30	0	$243	$67	3.6	2.5
CZ9	0	0	8,781	31	0	$243	$70	3.5	2.6
CZ10	0	0	14,272	51	0	$243	$114	2.1	4.3
CZ11	0	0	12,663	45	0	$243	$101	2.4	3.8
CZ12	0	0	13,860	49	0	$243	$111	2.2	4.1
CZ13	0	0	19,226	69	0	$243	$154	1.6	5.7
CZ14	0	0	20,374	73	0	$243	$163	1.5	6.1
CZ15	0	0	16,911	60	0	$243	$135	1.8	5.0
CZ16	0	0	12,178	43	0	$243	$97	2.5	3.6

4.5 Measure 5 – Exterior Hose Bib Locks

Due to lack of data, there is no strong defensible way to estimate per-building savings. The conservative approach is to assume zero water savings for most buildings. However, given the low measure cost, the annual per-building water savings required for the measure to be cost-effective are only approximately 1,650 gallons for multifamily buildings and 1,075 gallons for nonresidential buildings. For a 25-foot hose, 1,650 gallons can be roughly equivalent to 33 minutes of usage per year, or approximately one minute of usage every 11 days.[5]

It is difficult to approximate the frequency of water theft from publicly-available faucets to support calculations of average per-building savings value. However, anecdotal instances of water theft suggest that, when it occurs, 1,650 gallons of savings are achievable.

Table 15: Cost-Effectiveness Results Per Building – Exterior Hose Bib Locks

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
Exterior Hose Bib Locks (New Construction; Multifamily)									
CZ1 - CZ16	0	0	0	0	0	$112	$0	N/A	0
Exterior Hose Bib Locks (New Construction; Nonresidential)									
CZ1 - CZ16	0	0	0	0	0	$56	$0	N/A	0

4.6 Measure 6 – Alternate Water Sources

For multifamily application, as shown in Table 16, requiring installation of onsite treated non-potable system is cost-effective in climate zones 14 and 15. While results are not included in this report, cost-effectiveness was calculated for the alternative scenario of a multifamily building only installing dual plumbing and connecting to a recycled water line located 200 feet from the property line. This alternative approach was found to be cost-effective in climate zones 2 through 15.

For nonresidential application, as shown in Table 17, requiring installation of rainwater, graywater, and foundation drainage collection, treatment, and reuse systems in nonresidential buildings is not cost-effective in any climate zone. While results are not included in this report, cost-effectiveness was calculated for the alternative scenario of a nonresidential building only installing dual plumbing and connecting to a recycled water line located 200 feet from the property line. This alternative scenario was also not found to be cost-effective in any climate zone.

In the case of using recycled water, this measure results in significant potable water savings from offsetting potable water consumption with recycled water, however, from the customer's perspective it is assumed that the amount of water consumption does not change based on whether the water is potable or recycled. In the case of using recycled water, on-bill savings include the savings due to the difference in cost associated with using potable and recycled water rates when recycled water offsets potable use.

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[5] Using a Washington State University garden hose flow tool, this statement assumes a 5/8 inch hose size (https://www.lowes.com/projects/gardening-and-outdoor/garden-hose-buying-guide/project) and water pressure of 50 psi (https://www.plumbingsupply.com/residential-water-pressure-explained.html).

In the case of onsite non-potable water reuse, on-bill savings include the savings associated with rainfall, graywater, and foundation drainage offsetting the need to purchase potable water. Costs and savings are presented on a per-building basis.

Rainwater collection occurs when irrigation demand is lowest and rainwater cannot be stored for long periods of time to last through dry seasons. This mismatch of supply and demand is particularly an issue in climate zones with extended rainy periods and overall lower irrigation demand. This analysis uses a daily rainwater model to track the available stored supply relative to the size of the water tank. However, as this can vary significantly across climate zones, water budgets for each individual project will have to be precisely predicted to fully utilize the combination of the rainwater collection system, the graywater collection system, and the foundation drainage system without having to add in additional systems or oversized storage capacity.

Water demands could potentially be met by requiring additional collection and treatment systems such as stormwater retention and blackwater treatment and reuse, but these additional system components would increase project costs. Buildings with little or no irrigation demand will be more readily able to match water supply from onsite reuse with building water demand.

Finally, while onsite non-potable water reuse systems can help reduce costs related to delivery and treatment of water, results are presented from the customer perspective and, therefore, upstream and downstream savings are not calculated.

Table 16: Cost-Effectiveness Results Per Building – Multifamily Alternate Water Sources

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
Alternate Water Sources, including rainwater, graywater, and foundation drainage (New Construction; Multifamily)									
CZ1	0	0	67,915	242	0	$38,594	$586	65.9	0.57
CZ2	0	0	88,829	317	0	$38,594	$766	50.4	0.75
CZ3	0	0	90,020	321	0	$38,594	$777	49.7	0.76
CZ4	0	0	97,949	349	0	$38,594	$845	45.7	0.83
CZ5	0	0	101,322	361	0	$38,594	$874	44.1	0.85
CZ6	0	0	94,270	336	0	$38,594	$813	47.4	0.80
CZ7	0	0	102,532	366	0	$38,594	$885	43.6	0.87
CZ8	0	0	102,851	367	0	$38,594	$887	43.5	0.87
CZ9	0	0	98,410	351	0	$38,594	$849	45.5	0.83
CZ10	0	0	116,987	417	0	$38,594	$1,009	38.2	0.99
CZ11	0	0	100,581	359	0	$38,594	$868	44.5	0.85
CZ12	0	0	104,017	371	0	$38,594	$897	43.0	0.88
CZ13	0	0	105,286	375	0	$38,594	$908	32.5	0.89
CZ14	0	0	123,714	441	0	$38,594	$1,067	36.2	1.04
CZ15	0	0	129,813	463	0	$38,594	$1,120	34.5	1.10
CZ16	0	0	82,589	294	0	$38,594	$713	54.2	0.70

Table 17: Cost-Effectiveness Results Per Building – Nonresidential Alternate Water Sources

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
Alternate Water Sources, including rainwater, graywater, and foundation drainage (New Construction; Nonresidential)									
CZ1	0	0	71,268	254	0	$233,208	-$4,076	N/A	0.12
CZ2	0	0	72,984	260	0	$233,208	-$4,042	N/A	0.13
CZ3	0	0	74,352	265	0	$233,208	-$4,015	N/A	0.13
CZ4	0	0	79,446	283	0	$233,208	-$3,913	N/A	0.14
CZ5	0	0	90,153	321	0	$233,208	-$3,698	N/A	0.16
CZ6	0	0	88,873	317	0	$233,208	-$3,724	N/A	0.15
CZ7	0	0	91,273	325	0	$233,208	-$3,676	N/A	0.16
CZ8	0	0	92,469	330	0	$233,208	-$3,652	N/A	0.16
CZ9	0	0	87,569	312	0	$233,208	-$3,750	N/A	0.15
CZ10	0	0	91,128	325	0	$233,208	-$3,679	N/A	0.16
CZ11	0	0	79,008	282	0	$233,208	-$3,921	N/A	0.14
CZ12	0	0	79,694	284	0	$233,208	-$3,908	N/A	0.14
CZ13	0	0	81,672	291	0	$233,208	-$3,868	N/A	0.14
CZ14	0	0	85,839	306	0	$233,208	-$3,785	N/A	0.15
CZ15	0	0	81,221	290	0	$233,208	-$3,877	N/A	0.14
CZ16	0	0	76,537	273	0	$233,208	-$3,971	N/A	0.13

4.7 *Measure 7 – Landscape Irrigation Water Meters and Flow Sensors*

Requiring landscape irrigation meters and flow sensors was not found to be cost-effective for multifamily applications in any climate zone. The measure was found to be cost-effective for nonresidential applications in only climate zone 15.

Table 18: Cost-Effectiveness Results Per Building with Landscape – Landscape Irrigation Water Meters and Flow Sensors

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
Landscape Irrigation Water Meters and Flow Sensors (New Construction, Additions, Alterations; Residential)									
CZ1	0	0	3,977	14	0	$479	-$168	N/A	0.13
CZ2	0	0	7,114	25	0	$479	-$143	N/A	0.24
CZ3	0	0	7,293	26	0	$479	-$142	N/A	0.24
CZ4	0	0	8,482	30	0	$479	-$132	N/A	0.28
CZ5	0	0	8,988	32	0	$479	-$128	N/A	0.30
CZ6	0	0	7,931	28	0	$479	-$137	N/A	0.27
CZ7	0	0	9,170	33	0	$479	-$127	N/A	0.31
CZ8	0	0	9,218	33	0	$479	-$126	N/A	0.31
CZ9	0	0	8,551	31	0	$479	-$132	N/A	0.29

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
CZ10	0	0	11,373	41	0	$479	-$109	N/A	0.38
CZ11	0	0	9,195	33	0	$479	-$127	N/A	0.31
CZ12	0	0	9,860	35	0	$479	-$121	N/A	0.33
CZ13	0	0	10,036	36	0	$479	-$120	N/A	0.34
CZ14	0	0	13,838	49	0	$479	-$90	N/A	0.46
CZ15	0	0	15,146	54	0	$479	-$79	N/A	0.51
CZ16	0	0	6,198	22	0	$479	-$151	N/A	0.21
Landscape Irrigation Meters and Flow Sensors (New Construction, Additions, Alterations; Nonresidential)									
CZ1	0	0	13,256	47	0	$3,259	-$67	N/A	0.28
CZ2	0	0	23,713	85	0	$3,259	$37	87.0	0.50
CZ3	0	0	24,308	87	0	$3,259	$43	75.1	0.51
CZ4	0	0	28,272	101	0	$3,259	$83	39.2	0.60
CZ5	0	0	29,958	107	0	$3,259	$100	32.6	0.63
CZ6	0	0	26,433	94	0	$3,259	$65	50.4	0.56
CZ7	0	0	30,564	109	0	$3,259	$106	30.7	0.65
CZ8	0	0	30,723	110	0	$3,259	$108	30.3	0.65
CZ9	0	0	28,503	102	0	$3,259	$85	38.1	0.60
CZ10	0	0	37,907	135	0	$3,259	$180	18.1	0.80
CZ11	0	0	30,647	109	0	$3,259	$107	30.5	0.65
CZ12	0	0	32,865	117	0	$3,259	$129	25.2	0.70
CZ13	0	0	33,451	119	0	$3,259	$135	24.1	0.71
CZ14	0	0	46,122	164	0	$3,259	$262	12.4	0.98
CZ15	0	0	50,482	180	0	$3,259	$306	10.7	1.07
CZ16	0	0	20,660	74	0	$3,259	$7	N/A	0.44

4.8 *Measure 8 – Irrigation Controllers*

For new construction, requiring Irrigation controllers was found to be cost-effective in all climate zones for both residential and nonresidential applications. This measure results in a small increase in annual electricity consumption due to the increased energy consumption of smart irrigation controllers. As cold-water measure, this measure does not result in direct energy savings associated with heating water to offset this additional consumption.

Table 19: Cost-Effectiveness Results per Building with Landscape – Irrigation Controllers

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
Landscape Irrigation Controllers (New Construction; Residential)									
CZ1	-18	0	7,027	25	-13	$141	$52	2.7	3.2
CZ2	-18	0	12,569	45	-13	$141	$97	1.5	6.0

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
CZ3	-18	0	12,884	46	-13	$141	$99	1.4	6.1
CZ4	-18	0	14,986	53	-13	$141	$116	1.2	7.2
CZ5	-18	0	15,879	57	-13	$141	$123	1.1	7.6
CZ6	-18	0	14,011	50	-13	$141	$109	1.3	6.7
CZ7	-18	0	16,200	58	-13	$141	$125	1.1	7.7
CZ8	-18	0	16,285	58	-13	$141	$127	1.1	7.8
CZ9	-18	0	15,108	59	-13	$141	$117	1.2	7.3
CZ10	-18	0	20,092	72	-13	$141	$157	0.9	9.7
CZ11	-18	0	16,244	58	-13	$141	$126	1.1	7.8
CZ12	-18	0	17,420	62	-13	$141	$135	1.0	8.4
CZ13	-18	0	17,730	63	-13	$141	$138	1.0	8.5
CZ14	-18	0	24,446	87	-13	$141	$192	0.7	11.9
CZ15	-18	0	26,757	95	-13	$141	$210	0.7	13.0
CZ16	-18	0	10,950	39	-13	$141	$84	1.7	5.2
Landscape Irrigation Controllers (New Construction; Nonresidential)									
CZ1	-18	0	23,420	83	-13	$1,265	$232	5.5	1.3
CZ2	-18	0	41,892	149	-13	$1,265	$417	3.0	2.3
CZ3	-18	0	42,944	153	-13	$1,265	$427	3.0	2.3
CZ4	-18	0	49,948	178	-13	$1,265	$497	2.5	2.7
CZ5	-18	0	52,927	189	-13	$1,265	$527	2.4	2.9
CZ6	-18	0	46,669	166	-13	$1,265	$466	2.7	2.6
CZ7	-18	0	53,996	192	-13	$1,265	$537	2.4	2.9
CZ8	-18	0	54,278	194	-13	$1,265	$542	2.3	3.0
CZ9	-18	0	50,355	180	-13	$1,265	$503	2.5	2.8
CZ10	-18	0	66,969	239	-13	$1,265	$669	1.9	3.7
CZ11	-18	0	54,143	193	-13	$1,265	$539	2.3	3.0
CZ12	-18	0	58,062	207	-13	$1,265	$579	2.2	3.2
CZ13	-18	0	59,096	211	-13	$1,265	$589	2.1	3.2
CZ14	-18	0	81,482	290	-13	$1,265	$815	1.6	4.5
CZ15	-18	0	89,184	318	-13	$1,265	$892	1.4	4.9
CZ16	-18	0	36,499	130	-13	$1,265	$363	3.5	2.0

4.9 Measure 9 – Maximum Precipitation Rate for Irrigation Nozzles

Conservatively, savings for this measure were assumed to be zero. Infiltration rate of soils vary from one inch per hour (upper threshold) for coarse sands to 0.1 inch per hour (lower threshold) for clay loam soils (Irrigation Association 2011). The measure sets a maximum precipitation rate for nozzles to one inch per hour. The cap on the precipitation rate of nozzles is fairly high given the range of infiltration rates by soil type, hence, it is assumed that this cap will not be effective in addressing potential water runoff and over irrigation issues.

4.10 Measure 10 – Irrigation Audits

The analysis takes a conservative approach for landscape audit cost and benefits and assumes that there are no associated savings from the audit since the audit's intent is to ensure the other required landscape efficiency measures are properly incorporated into the irrigation design and those savings are already accounted for under their respective provisions. While additional savings from audits are possible, the audit itself does not result in savings; rather, repairs or adjustments made to the system will impact overall savings. Therefore, assuming savings from audits may improve the lifecycle B/C ratio but may or may not be cost-effective depending on the costs of the improvements.

4.11 Measure 11 – Indoor Water Meters

As shown in Table 20, requiring a separate indoor water submeter for makeup water for a cooling tower and a water submeter for a boiler in large office buildings was found to be cost-effective in all climate zones.

Table 20: Cost-Effectiveness Results Per Building – Indoor Water Meters

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
Indoor Water Meters (New Construction, Additions; Nonresidential)									
CZ1	0	0	59,814	290	0	$2,925	$599	4.9	1.5
CZ2	0	0	98,860	479	0	$2,925	$990	3.0	2.5
CZ3	0	0	137,906	669	0	$2,925	$1,381	2.1	3.4
CZ4	0	0	206,726	1,002	0	$2,925	$1,381	2.1	3.4
CZ5	0	0	275,545	1,336	0	$2,925	$1,381	2.1	3.4
CZ6	0	0	275,545	1,336	0	$2,925	$2,070	1.4	5.1
CZ7	0	0	275,545	1,336	0	$2,925	$2,759	1.1	6.9
CZ8	0	0	275,545	1,336	0	$2,925	$2,759	1.1	6.9
CZ9	0	0	275,545	1,336	0	$2,925	$2,759	1.1	6.9
CZ10	0	0	275,545	1,336	0	$2,925	$2,759	1.1	6.9
CZ11	0	0	275,545	1,336	0	$2,925	$2,759	1.1	6.9
CZ12	0	0	275,545	1,336	0	$2,925	$2,759	1.1	6.9
CZ13	0	0	275,545	1,336	0	$2,925	$2,759	1.1	6.9
CZ14	0	0	216,643	1,050	0	$2,925	$2,169	1.3	5.4
CZ15	0	0	336,454	1,631	0	$2,925	$3,369	0.9	8.4
CZ16	0	0	155,273	753	0	$2,925	$1,555	1.9	3.9

4.12 Measure 12 – Cooling Towers

As shown in Table 21, capturing cooling tower blowdown water, treating it, and reusing it in cooling towers was not found to be cost-effective in any climate zone in large office buildings. Cost and savings were only calculated for climate zones 3, 4, 6, 7, 8, 9, 10, 12, and 13 because the nine climate zones analyzed contain 90 percent of large buildings that are forecasted to be built in the future.

As this measure is presented and analyzed separately from Measure 6 Alternate Water Sources, savings include only the reuse of blowdown for cooling tower makeup water and that the remaining makeup water still needs to be delivered to the system by the water provider. Cost savings could increase if a building provides sufficient treated rainwater or graywater to replace the remaining makeup water in the cooling tower.

Table 21: Cost-Effectiveness Results Per Building – Cooling Towers

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
Cooling Towers (New Construction; Nonresidential)									
CZ3	-88	0	54,052	262	-64	$19,101	$361	52.9	0.19
CZ4	-123	0	75,277	365	-89	$22,720	$569	40.0	0.23
CZ6	-132	0	81,169	394	-96	$22,226	$636	35.0	0.25
CZ7	-147	0	90,149	437	-106	$33,015	$704	46.9	0.19
CZ8	-168	0	103,156	500	-122	$34,676	$853	40.6	0.21
CZ9	-179	0	109,803	532	-130	$34,676	$919	37.7	0.23
CZ10	-199	0	122,339	593	-144	$37,198	$1,043	35.7	0.24
CZ12	-145	0	88,990	431	-105	$32,858	$703	46.8	0.19
CZ13	-198	0	121,519	589	-143	$42,842	$1,020	42.0	0.20

4.13 Measure 13 – Manually Operated Toilets in Commercial Facilities

As shown in Table 22, manually operated toilets are cost-effective in all climate zones due to the lack of first incremental cost and significant water savings. The analysis assumes zero incremental costs, resulting in a conservative modeling approach, as manual flush toilets typically have a negative incremental cost compared to sensor-operated toilets.

Table 22: Cost-Effectiveness Results Per Building – Manually Operated Toilets

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
Manually Operated Toilets in Commercial Facilities (New Construction; Nonresidential)									
CZ1 – CZ16	0	0	24,217	117	0	$0	$243	0	-

4.14 *Measure 14 – Manually Operated Faucets in Commercial Facilities*

Similar to manually operated toilets, as shown in Table 23, manually operated faucets are cost-effective in all climate zones due to the lack of first incremental cost and significant water savings. The conservative approach was taken to modeling incremental cost, as manual faucets typically have a negative incremental cost compared to sensor-operated faucets. While this analysis assumes a 30 percent reduction in faucet water consumption from using manual rather than sensor-operated fixtures, it should be noted that there is debate in the plumbing industry as to whether some sensor-operated fixtures may result in either no net change or in increased savings.

Table 23: Cost Effectiveness Results – Manually Operated Faucets

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Savings (lb. CO_2-e)	First Incremental Cost	Annual Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio

Manually Operated Faucets in Commercial Facilities (New Construction; Nonresidential)									
CZ1 – CZ16	35	16	4,764	23	216	$0	$70	0	-

4.15 Measure 15 – Commercial Kitchen Water Efficiency

As shown in Table 24, the commercial kitchen water efficiency package of non-preempted measures is cost-effective in all climate zones, with a B/C ratio much larger than the threshold of 1. Per-unit savings are presented by equipment type in Appendix A – Measure-Specific Assumptions and Methodologies, Table 26. Commercial dishwashers, food steamers, combination ovens, and food waste pulping systems contribute approximately 15 percent, 76 percent, eight, and zero percent of the total water savings, respectively.

Table 24: Cost-Effectiveness Results Per Building – Commercial Kitchen Water Efficiency

Climate Zone	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Annual Water Savings (gallons)	Annual Embedded Energy Savings (kWh)	Annual GHG Reductions (lb. CO_2-e)	First Incremental Cost	Net Annual Cost Savings	Simple Payback	Lifecycle B/C Ratio
Commercial Kitchen Water Efficiency (New and Replacement Equipment; Nonresidential)									
CZ1	1,851	919	125,550	609	12,091	$1,819	$2,503	0.7	7.3
CZ2	1,851	919	125,550	609	12,091	$1,819	$2,503	0.7	7.3
CZ3	1,851	919	125,550	609	12,091	$1,819	$2,503	0.7	7.3
CZ4	1,851	919	125,550	609	12,091	$1,819	$2,503	0.7	7.3
CZ5	1,851	919	125,550	609	12,091	$1,819	$2,503	0.7	7.3
CZ6	1,851	919	125,550	609	12,091	$1,819	$2,241	0.8	6.6
CZ7	1,851	919	125,550	609	12,091	$1,819	$2,295	0.8	6.6
CZ8	1,851	919	125,550	609	12,091	$1,819	$2,241	0.8	6.6
CZ9	1,851	919	125,550	609	12,091	$1,819	$2,241	0.8	6.6
CZ10	1,851	919	125,550	609	12,091	$1,819	$2,241	0.8	6.6
CZ11	1,851	919	125,550	609	12,091	$1,819	$2,503	0.7	7.3
CZ12	1,851	919	125,550	609	12,091	$1,819	$2,503	0.7	7.3
CZ13	1,851	919	125,550	609	12,091	$1,819	$2,503	0.7	7.3
CZ14	1,851	919	125,550	609	12,091	$1,819	$2,241	0.8	6.6
CZ15	1,851	919	125,550	609	12,091	$1,819	$2,241	0.8	6.6
CZ16	1,851	919	125,550	609	12,091	$1,819	$2,503	0.7	7.3

5 Summary and Conclusions

This report evaluated the feasibility and cost-effectiveness of energy- and water-savings measures in all 16 California climates zones. Local jurisdictions that are considering adopting any of the presented measures, may contact the program for further support through its website, LocalEnergyCodes.com.

Measure 1 – Water Waste Reduction when Delivering Hot Water (New Construction; Single Family)

Option A – Compact Hot Water Distribution Systems: The option to meet requirements for the Compact Hot Water Distribution System Expanded Credit was found to be cost-effective in all climate zones. This analysis builds upon the 2019 CASE Report on Compact Hot Water Distribution System. Calculated savings include natural gas, water, and embedded energy savings.

If a jurisdiction wishes to increase energy and water savings by requiring a threshold for the Compactness Factor (minimum level of compactness) beyond the basic criteria, a cost-effectiveness analysis of the revised threshold would be required. As the compactness of a hot water distribution system increases, so do cost savings for reduced materials and labor associated with installation.

Option B – Demand Recirculation with DWHR: The option to install manually controlled recirculation system with DWHR system was found to be cost-effective in all climate zones. Hot water recirculation systems result in an overall increase in energy consumption. Consequently, the measure requires DWHR system with manual control to offset the energy penalty generated by a recirculation system. Calculated savings include electricity, natural gas, water, and embedded energy savings.

Measure 2 – Graywater-Ready Dwellings (New Construction; Single Family): Building new homes to be graywater-ready was not found to be cost-effective in any climate zone (with an assumption that only laundry-to-landscape component would be used). The alternative of installing and using a laundry-to-landscape system only is cost-effective in all climate zones. Calculated savings include water and embedded energy savings.

Measure 3 – Recycled Water for Common Landscaping (New Construction; Single Family): Using recycled water in single family common landscaping was not found to be cost-effective in any climate zone. While this measure results in significant potable water savings from offsetting consumption with recycled water, from the customer's perspective it is assumed that the amount of water consumption does not change based on whether the water is potable or recycled. The on-bill savings only include the difference in cost between potable and recycled water rates. Calculated savings include the potable water savings offset by recycled water consumption.

Measure 4 – Pool and Spa Covers (New Construction, Additions, Alterations; Single Family): With the lowest cost pool cover, a solar pool cover, requiring reel system pool and spa covers on non-heated pools was found to be cost-effective in all climate zones. Due to limited available data, this analysis does not account for additional savings from reduced chemical usage, nor does the analysis attempts to quantify other possible benefits offered by pool covers, such as reduced cleaning, reduced maintenance costs, and increased safety. Calculated savings include water and embedded energy savings from reduced evaporation.

Measure 5 – Exterior Hose Bib Locks (New Construction; Multifamily and Nonresidential): Installing exterior hose bib locks on publicly accessible faucets on multifamily and nonresidential buildings was not found to be cost-effective in any climate zone, given a lack of defensible methodology for estimating any potential water savings. The annual water savings per building would need to be as low as 1,650 gallons for multifamily buildings and 1,075 gallons for nonresidential buildings to offset the installation and replacement costs. Savings were not calculated.

Measure 6 – Alternate Water Sources (New Construction; Multifamily and Nonresidential): Requiring dual plumbing for multifamily buildings and connection to a recycled water line was found to be cost-effective in climate zones 14 and 15, though only marginally in both climate zones. While this measure results in significant potable water savings from offsetting consumption with recycled water, from the customer's perspective it is assumed that the amount of water consumption does not change based on whether the water is potable or recycled. The on-bill savings include the savings associated with rainfall and foundation drainage offsetting the need to purchase water, as well as the difference in cost associated with using potable and recycled water rates for other alternate water sources. Calculated savings include the potable water savings offset by recycled water consumption. Calculated savings also include embedded energy savings.

Requiring installation of rainwater, graywater, and foundation drainage collection, treatment, and reuse systems in nonresidential buildings was not found to be cost-effective in any climate zone. Refinement of water budgets and project-specific calculations are needed to more accurately reflect potential costs and savings associated with onsite non-potable reuse. Calculated savings include water and embedded energy savings.

Measure 7 – Landscape Irrigation Water Meters and Flow Sensors (New Construction, Additions, Alterations; Residential and Nonresidential): Requiring landscape irrigation meters and flow sensors was not found to be cost-effective for multifamily applications in any climate zone. The measure was found to be cost-effective for nonresidential applications in only climate zone 15. Calculated savings include water and embedded energy.

The authors of the report recommend refining this analysis by considering an alternative scenario where a flow sensor alone (managed by a property owner) would satisfy the requirement for both a landscape irrigation meter and a flow sensor since a flow sensor can serve the same function as an irrigation meter. In this scenario, annual meter costs would not apply, thus further reducing measure costs. Both factors (excluding the cost of water meter and annual meter costs) would increase lifecycle B/C ratio for this measure.

The authors also recommend refining this analysis by considering smaller nonresidential landscapes (smaller than 2,500 ft^2 for rehabilitated projects) since nonresidential landscapes in that size range would not be subject to 2015 DWR MWELO but would be subject to the proposed measure. For reference, the nonresidential landscape was assumed to be 8,826 ft^2. Smaller nonresidential landscapes would produce smaller water savings, thus reducing lifecycle B/C ratio for this measure.

Measure 8 – Irrigation Controllers (New Construction, Additions, Alterations; Residential and Nonresidential): For new construction, requiring Irrigation controllers was found to be cost-effective in all climate zones for both residential and nonresidential applications. Calculated savings include electricity, water, and embedded energy.

The authors of the report recommend refining this analysis by considering a scenario of additions and alterations, in which full costs (not incremental costs) would apply. Further, the authors recommend evaluating a smaller landscape area, between 500 and 2,500 ft^2, for both residential and nonresidential applications since landscapes in that size range would not be subject to 2015 DWR MWELO but would be subject to the proposed measure. Both factors (full costs and smaller landscapes) would reduce lifecycle B/C ratio for this measure.

Measure 9 – Maximum Precipitation Rate for Irrigation Nozzles (New Construction; Residential and Nonresidential): Conservatively, savings were assumed to be zero for this measure.

Measure 10 – Irrigation Audits (New Construction; Residential and Nonresidential): It is assumed that there are no additional savings from the audit itself. This measure, however, is important to ensure that savings from other measures related to irrigation are fully realized.

Measure 11 – Indoor Water Meters (New Construction, Additions; Multifamily and Nonresidential): Requiring a separate indoor water submeter for makeup water for a cooling tower and a water submeter for a boiler in large office buildings was found to be cost-effective in all climate zones. Calculated savings include water and embedded energy.

For local jurisdictions interested in this measure, the authors of the report recommend refining this analysis to account for the additional costs of upgrades performed as a result of monitoring water use (the costs to do upgrades were not included in the measure costs, but the savings from the upgrades were included in the savings calculations). Including upgrade costs into the measure cost would reduce lifecycle B/C ratio for this measure. To further refine this analysis, the authors of this report recommend conducting a separate analysis for a multifamily building.

Measure 12 –Cooling Towers (New Construction; Multifamily and Nonresidential): Capturing cooling tower blowdown water, treating it, and reusing it in cooling towers was not found to be cost-effective in considered climate zones for large office buildings. Calculated savings include electricity, water, and embedded energy savings.

For local jurisdictions interested in this measure, the authors of this report recommend refining the analysis by considering a larger nonresidential building, specifically 498,589-square foot large office prototype used in Measure 11 (for comparison, 117,000-square foot large office prototype was used in this analysis). Also, the authors of this report recommend conducting a separate analysis for a multifamily building.

Measure 13 – Manually Operated Toilets in Commercial Facilities (New Construction; Nonresidential): Installing toilets and urinals with manual flush rather than sensor-based flush was found to be cost-effective in all climate zones. For local jurisdictions interested in this measure, the authors of this report recommend conducting larger scale studies to validate the findings. Calculated savings include water and embedded energy savings.

Measure 14 – Manually Operated Faucets in Commercial Facilities (New Construction; Nonresidential): Installing faucets with manual rather than sensor-based operation was found to be cost-effective in all climate zones. The savings results for this measure are based on findings from one study of two bathrooms. For local jurisdictions interested in this measure, the authors of this report recommend conducting larger scale studies to validate the findings. Calculated savings include electricity, natural gas, water, and embedded energy savings.

Measure 15 – Commercial Kitchen Water Efficiency (New and Replacement Equipment; Nonresidential): Requiring commercial kitchens to meet or exceed 2016 CALGreen voluntary water efficiency requirements for new and replacement commercial dishwashers, food steamers, combination ovens, and food waste pulping systems was found to be cost-effective in all climate zones. Calculated savings include electricity, natural gas, water, and embedded energy savings.

Measure 16 – Selling Compliant Fixtures and Fittings (Residential and Nonresidential): Retailers are already required to sell fixtures and fittings compliant with Title 20. There are no additional savings from this measure.

Measure 17 – Installing Compliant Fixtures and Fittings (Residential and Nonresidential): Contractors are already required to install fixtures and fittings compliant with Title 20. There are no additional savings from this measure.

6 References

Aquacraft. 2009. “Evaluation of California Weather-Based “Smart” Irrigation Controller Programs.” Presented to the California Department of Water Resources by the Metropolitan Water District of Southern California and EBMUD. https://ucanr.edu/sites/UrbanHort/files/99641.pdf

Aquacraft. 2011a. “Embedded Energy in Water Studies Study 3: End-use Water Demand Profiles.” Prepared for the California Public Utilities Commission. April 29, 2011. http://www.energy.ca.gov/appliances/2013rulemaking/documents/responses/Water_Appliances_12-AAER-2C/California_IOU_Response_to_CEC_Invitation_to_Participate-Lavatory_Faucets_and_Faucet_Accessories_REFERENCES/CPUC_2011a_Embedded_Energy_in_Water_Studies-Study_3.PDF

Aquacraft. 2011b. “California Single Family Water Use Efficiency Study.” http://water.cityofdavis.org/Media/PublicWorks/Documents/PDF/PW/Water/Documents/California-Single-Family-Home-Water-Use-Efficiency-Study-20110420.pdf

AWE. 2016. “Drip and Microspray.” http://www.allianceforwaterefficiency.org/Drip_and_Micro-Spray_Irrigation_Introduction.aspx

AWE. 2018. “Metering Introduction.” http://www.allianceforwaterefficiency.org/metering.aspx

Black & Veatch. 2016. “50 Largest Cities Water/Wastewater Rate Survey.” https://pages.bv.com/Whitepaper-ManagementConsulting-50LargestCitiesRateSurvey_01-RegistrationPage.html

CCR (California Code of Regulations). 2019a. “490.1. Applicability.” https://govt.westlaw.com/calregs/Document/I24AC524D6C6B4F3F935C54010CCD4BB2?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)&bhcp=1

CCR. 2019b. “492.6. Landscape Design Plan.” https://govt.westlaw.com/calregs/Document/I8403E54417874B8B94843C8A8341823B?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)

CCR. 2019c. “492.7. Irrigation Design Plan.” https://govt.westlaw.com/calregs/Document/I8ADC2B5DF37C417C9207950C891481ED?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)

CCR. 2019d. “Certificate of Completion.” https://govt.westlaw.com/calregs/Document/I2162D3CD908344AFBF87FF42BC2270BC?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)

CCR. 2019e. “ 492.12. Irrigation Audit, Irrigation Survey, and Irrigation Water Use Analysis.” https://govt.westlaw.com/calregs/Document/IECB839F91BB3442EA7440C832D4A0968?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)

CCR. 2019f. “Appendix A: Reference Evapotranspiration (ETo) Table.” https://govt.westlaw.com/calregs/Document/I0F1A18FBBA574ED797FB19729AC0756A?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)&bhcp=1

CCR. 2019g. “Appendix D: Prescriptive Compliance Option.” https://govt.westlaw.com/calregs/Document/IF088C67ECF9946E09B6A989B1CB24A80?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)

California Department of Conservation. 2007. “Hydrologic Regions.” http://www.conservation.ca.gov/dlrp/watershedportal/InformationResources/Documents/WS_huc10_regions8_26_10.pdf

California Department of Finance. 2018. "E-5 Population and Housing Estimates for Cities, Counties, and the State, January 2011-2018, with 2010 Benchmark." http://www.dof.ca.gov/Forecasting/Demographics/Estimates/E-5/

California Sustainability Alliance. 2013. "Water - Energy Toolkit For Sustainable Development: A Practical Guide To Implementing Water-Energy Conservation Policies And Projects For Local Governments, Developers, Water Agencies And Supporting Parties."

California Water Code. 2019. "Multiunit Structures [537-537.5]." Accessed October 2019. https://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=WAT&division=1.&title=&part=&chapter=8.&article=5

Chestnutt, T. 2011. "Volumetric Pricing for Sanitary Sewer Service in the State of California." http://www.allianceforwaterefficiency.org/uploadedFiles/Resource_Center/Library/rates/Thomas-Chesnutt-Volumetric-Pricing-of-Sanitary-Sewer-Service-February-2011(1).pdf

Christian-Smith, Juliet, Matthew Herberger, and Lucy Allen. 2012. "Urban Water Demand in California 2100: Incorporating Climate Change." Pacific Institute. http://pacinst.org/publication/urban-water-demand-to-2100

County of Los Angeles. 2010. "Los Angeles County Watershed Model Configuration and Calibration – Part I: Hydrology." Prepared by Tetra Tech, Inc. http://dpw.lacounty.gov/wmd/wmms/docs/Final_Phase_I_Modeling_Report_Part_I.pdf

CPUC (California Public Utilities Commission). 2013. "Order Instituting Rulemaking into Policies to Promote a Partnership Framework between Energy Investor Owned Utilities and the Water Sector to Promote Water-Energy Nexus Programs." December 19, 2013. Rulemaking 13-12-011.

CPUC. 2015a. "Water/Energy Cost-Effectiveness Analysis: Revised Final Report." Prepared by Navigant Consulting, Inc. http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=5360

CPUC. 2015b. "Water/Energy Cost-Effectiveness Analysis: Errata to the Revised Final Report." Prepared by Navigant Consulting, Inc. http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=5350

Delta Cooling Tower, Inc. 2016. "How to Improve Water Efficiency on Your Cooling Tower." February 16. https://deltacooling.com/resources/news/how-to-improve-water-efficiency-on-your-cooling-tower

DOE (United States Department of Energy). 2010. "Energy Efficiency Program for Consumer Products: Waiver of Federal Preemption of State Regulations Concerning the Water Use or Water Efficiency of Showerheads, Faucets, Water Closets, and Urinals." December 22. http://www.regulations.gov/#!documentDetail;D=EERE-2010-BT-WAV-0045-0001.

EcoAssistant. 2017. "Greywater Planning Guide." https://www.cooldavis.org/wp-content/uploads/2019/08/Greywater-Planning-Guide-2017-p1-2.pdf

Energy Commission (California Energy Commission). 2006. California Energy Commission. "Refining Estimates of Water-related Energy Use in California." Prepared by Navigant Consulting, Inc., Public Interest Energy Research Program. December 2006. Report number: CEC-500-2006-118. http://www.energy.ca.gov/2006publications/CEC-500-2006-118/CEC-500-2006-118.pdf

Energy Commission. 2014. "Staff Analysis of Toilets, Urinals, and Faucets." https://www.energy.ca.gov/2014publications/CEC-400-2014-007/CEC-400-2014-007-SD.pdf

Energy Commission. 2017. California Energy Maps. "California Building Climate Zone Areas." https://www.energy.ca.gov/maps/renewable/building_climate_zones.html

Energy Commission. 2018a. “2019 Building Energy Efficiency Standards for Residential and Nonresidential Buildings. CEC-400-2018-020-CMF.” December 2018. https://ww2.energy.ca.gov/2018publications/CEC-400-2018-020/CEC-400-2018-020-CMF.pdf

Energy Commission. 2018b. “2019 Alternative Calculation Method Approval Manual. CEC-400-2018-023-CMF.” December 2018. https://ww2.energy.ca.gov/2018publications/CEC-400-2018-023/CEC-400-2018-023-CMF.pdf

Energy Commission. 2019a. “Resolution Adopting Regulations, Spray Sprinkler Bodies. TN #229449” August 15, 2019. https://efiling.energy.ca.gov/GetDocument.aspx?tn=229449&DocumentContentId=60843

Energy Commission. 2019b. “Cailfornia Building Climate Zone Areas.” https://ww2.energy.ca.gov/maps/renewable/building_climate_zones.html

Energy & Environment Economics. 2017. “Time Dependent Valuation of Energy for Developing Building Efficiency Standards. 2019 Time Dependent Valuation (TDV) Data Sources and Inputs. Prepared for the California Energy Commission.” February 2017. https://efiling.energy.ca.gov/GetDocument.aspx?tn=216062

Gauley, B. and Koeller, J. 2010. “Sensor-operated Plumbing Fixtures: Do they Save Water?” https://www.map-testing.com/assets/files/hillsborough~study.pdf

Greywater Action. 2018. “How Much Rain Can I Collect from My Roof.” Accessed December 2018. https://greywateraction.org/faq/how-much-rain-can-i-collect-from-my-roof/

The Guardian. 2014. “Will switching to a water meter save money?” https://www.theguardian.com/lifeandstyle/2014/jul/08/will-switching-to-a-water-meter-save-money

HCD (Department of Housing and Community Development). 2019. “Information Bulletin 2019-02.” http://www.hcd.ca.gov/building-standards/buiding-code/docs/IB2019-02.pdf

Horii, B., E. Cutter, N. Kapur, J. Arent, and D. Conotyannis. 2014. “Time Dependent Valuation of Energy for Developing Building Energy Efficiency Standards.” http://www.energy.ca.gov/title24/2016standards/prerulemaking/documents/2014-0709_workshop/2017_TDV_Documents/

Irrigation Association. 2011. “Irrigation, 6th Edition.” Page 54.

Iaqsource.com. 2019. “ASHRAE Climate Zone Map.” https://ww2.energy.ca.gov/maps/renewable/building_climate_zones.html

Laborde H.M., Franca K.B., Neff H., Lima A.M.N. 2001. “Optimization strategy for a small-scale reverse osmosis water desalination system based on solar energy.” Desalination, 133 (1), pp. 1-12.AWE. 2016. https://www.sciencedirect.com/science/article/pii/S0011916401000789

Legislative Analyst’s Office (LAO). 2017. “Residential Water Use Trends and Implications for Conservation Policy.” https://lao.ca.gov/Publications/Report/3611

Millstein, Don. 2018. “Updates on Regulations/Best Practices for Wireless and Cloud-based Submetering.” https://ceregportal.com/wsi/documents/sessions/2018/T-1822.pdf

National Plasterers Council. 2016. “Effectiveness of Pool Covers to Reduce Evaporation from Swimming Pools.” Prepared by California Polytechnic State University, San Luis Obispo. https://rightscapenow.com/images/PDFs/Evaporation-Study-Final-Report_2.pdf

Nall, D. H., P.E. Faia, and R. Sedlak. 2013. “Total Dissolved Solids in Reclaimed Water.” ASHRAE J. (2013), pp. 28-38. http://www.conservationmechsys.com/wp-content/uploads/2016/11/TDS-reclaimed-water.pdf

NAP (National Academies Press). 2016. *Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs, and Benefits*. National Academies of Sciences, Engineering, and Medicine. https://www.nap.edu/read/21866/chapter/9

NBS. 2016. "Recycled Water Pricing Alternatives." Accessed December 2018. https://www.nbsgov.com/blog/2016/09/29/recycled-water-pricing-alternatives/

Ornaghi, Carmine and Mirco Tonin. 2017. "The Effect of Metering on Water Consumption – Policy Note." https://www.waterwise.org.uk/wp-content/uploads/2018/08/The-Effect-of-Metering-on-Water-Consumption_June2017.pdf

Pacific Institute. 2016. "The Cost of Alternative Water Supply and Efficiency Options in California." http://pacinst.org/publication/cost-alternative-water-supply-efficiency-options-california/

https://pacinst.org/wp-content/uploads/2016/10/PI_TheCostofAlternativeWaterSupplyEfficiencyOptionsinCA_AppendixB.pdf

Puretec. 2018. "What is Reverse Osmosis?" Accessed December. https://puretecwater.com/reverse-osmosis/what-is-reverse-osmosis#recovery

Raftelis Financial Consultants, Inc. 2008 "Water and Wastewater Rate Survey." Prepared for American Water Works Association. Values from Western Region.

SFDPH (San Francisco Department of Public Health). 2017. "Director's Rules and Regulations Regarding the Operation of Alternate Water Source Systems." https://www.sfdph.org/dph/files/EHSdocs/ehsWaterdocs/NonPotable/SFHC_12C_Rules.pdf

SFPUC (San Francisco Public Utilities Commission). 2018. "San Francisco's Non-potable Water System Projects." July. https://sfwater.org/Modules/ShowDocument.aspx?documentID=7089

Sher, Chloe. 2016. City of Vancouver "Water Sub-metering to Promote Water Efficiency – A Survey of Existing Literature and Local Case Studies." https://www.crd.bc.ca/docs/default-source/water-conservation-pdf/submetering2016finalreport_gcscholars.pdf?sfvrsn=adc939ca_2

State Water Board (California State Water Resources Control Board). 2019. "Recycled Water Policy." February 21. https://www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/

Statewide CASE Team. 2011. "Cooling Tower Water Savings." Prepared on behalf of the California Statewide Investor-Owned Utilities. http://title24stakeholders.com/wp-content/uploads/2017/10/2013_CASE-Report_Cooling-Tower-Water-Savings.pdf

Statewide CASE Team. 2013a. "Faucets." Prepared on behalf of the California Statewide Investor-Owned Utilities. https://energyarchive.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2C_Water_Appliances/California_IOUs_and_Natural_Resources_defense_Councils_Response_to_the_Invitation_for_Standards_Proposals_for_Faucets_-_Updated_2013-08-05_TN-71810.pdf

Statewide CASE Team. 2013b. "Toilets & Urinals Water Efficiency." Prepared on behalf of the California Statewide Investor-Owned Utilities. https://energyarchive.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2C_Water_Appliances/California_IOUs__and__Natural_Resources_defense_Councils_Responses_to_the_Invitation_for_Standards_Proposals_for_Toilets__and__Urinals_2013-07-29_TN-71765.pdf

Statewide CASE Team. 2015. "Commercial Food Service Equipment Water Efficiency." Prepared on behalf of the California Statewide Investor-Owned Utilities. http://title24stakeholders.com/wp-content/uploads/2015/08/CALGreen-CASE-Report-Commercial-Kitchen-Report_5.29.2015.pdf

Statewide CASE Team. 2017a. "Compact Hot Water Distribution – Final Report." Prepared on behalf of the California Statewide Investor-Owned Utilities. http://title24stakeholders.com/wp-content/uploads/2017/09/2019-T24-CASE-Report_Cmpct-HW-Distbtn_Final_September-2017.pdf

Statewide CASE Team. 2017b. "Drain Water Heat Recovery – Final Report." Prepared on behalf of the California Statewide Investor-Owned Utilities. http://title24stakeholders.com/wp-content/uploads/2017/09/2019-T24-CASE-Report_DWHR_Final_September-2017.pdf

Statewide CASE Team. 2017c. "Landscape Irrigation Controllers." Prepared on behalf of the California Statewide Investor-Owned Utilities. https://efiling.energy.ca.gov/GetDocument.aspx?tn=221225

Statewide CASE Team. 2017d. "Spray Sprinkler Bodies." Prepared on behalf of the California Statewide Investor-Owned Utilities. https://efiling.energy.ca.gov/GetDocument.aspx?tn=221224

Sustainable Silicon Valley. 2016. "Model Water Efficient New Development Ordinance Developed by Santa Clara County Water Efficient New Development Task Force." http://www.wp.sustainablesv.org/wp-content/uploads/2016/12/Draft_Model_Ordinance_for_Water_Efficient_New_Development_v9nov292019.docx

U.S. Census Bureau. 2014. Population Division. "Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2014." https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

U.S. Department of Energy (DOE). 2018. Energy Efficiency & Renewable Energy. "Commercial Prototype Building Models." https://www.energycodes.gov/development/commercial/prototype_models

U.S. Department of Housing and Urban Development (HUD). 2002. "Retrofitting Apartment Buildings to Conserve Water: A Guide for Managers, Engineers, and Contractors." Prepared by Water Resources Engineering, Inc. for the Office of Policy Development and Research. https://www.huduser.gov/Publications/PDF/Book2.pdf

U.S. Department of Labor. 2012. Bureau of Labor Statistics. CPI Inflation Calculator. https://www.bls.gov/data/inflation_calculator.htm

U.S. EIA (Energy Information Administration). 2012. Commercial Buildings Energy Consumption Survey (CBECS). https://www.eia.gov/consumption/commercial/data/2012/

U.S. Environmental Protection Agency. 2017. WaterSense. "Types of Facilities: Office Buildings." https://19january2017snapshot.epa.gov/www3/watersense/commercial/types.html

WRF (The Water Research Foundation). 2016. "Residential End Uses of Water, Version 2." http://www.waterrf.org/PublicReportLibrary/4309A.pdf

WRF. 2018. "Water Use in the Multi-Family Housing Sector." http://www.waterrf.org/PublicReportLibrary/4554.pdf

Western Regional Climate Center. 2018. Evaporation Stations. https://wrcc.dri.edu/Climate/comp_table_show.php?stype=pan_evap_avg

Appendix A – Measure-Specific Assumptions and Methodologies

7.1 Measure 1 – Water Waste Reduction when Delivering Hot Water

Scope: New Construction; Single Family

Option A – Compact Hot Water Distribution Systems

Using compact hot water distribution system saves both water and energy by minimizing the volume of water in distribution system piping, therefore reducing the amount of water discharged from the plumbing system prior to the arrival of hot water. The magnitude of savings is directly related to the level of compactness of the plumbing design.

This measure uses the savings estimates from the 2019 CASE Report on Compact Hot Water Distribution Systems (CHWDS) (Statewide CASE Team 2017a).[6] The analysis assumes that the pipe insulation credit available under the 2016 Title 24, Part 6 Standards was in place as the base system design and assumes a minimum efficiency gas instantaneous water heater (primary prescriptive path). The CASE Report analysis uses the 2016 baseline and calculates savings for the CHWDS Basic Credit. Since the expanded credit would yield higher savings resulting from higher compactness and reduction of larger diameter pipe lengths, the results presented in this report are conservative estimates for HERS verified CHWDS.

The assumed measure life is 30 years.

Option B – Demand Recirculation with DWHR

Both demand control manual (manual control) with HERS verification and demand control occupancy (sensor control) with HERS verification recirculation systems were modeled and compared to the consumption of the standard design with no recirculation system. Only recirculation system with manual control when combined with DWHR resulted in compliance for all climate zones. Therefore, the proposed measure excludes sensor-controlled recirculation system and requires recirculation system with manual control in combination with DWHR. Option 1B was simulated using the CBECC-Res 2019 compliance software (version 2019.1.0). The CBECC-Res software installation comes with two single-family prototype energy models (2100 ft^2 and 2700 ft^2) developed for each climate zone, which are approved by the Energy Commission to evaluate energy efficiency measures. Both single-family prototype models were used to simulate the proposed measure package in each climate zone. The results are presented for a 2,430 ft^2 blended single family prototype by taking a weighted average of results for two single family prototypes (45 percent weighting of 2,100 ft^2 prototype and 55 percent weighting of 2,700 ft^2 protype consistent with analysis in 2019 CASE Reports for residential measures). Key assumptions include:

- An instantaneous gas-fired water heater (prescriptive baseline).
- Pipe insulation is assumed to be included in the demand recirculation calculations. While 2019 ACM does not specify whether the water distribution system multipliers in Table B-1 assume pipe insulation, CBECC-RES does not allow selection of both the type of recirculation system and pipe insulation, and according to Title 24, Part 6 Section 150.0(j)2.A.iii, all piping associated with a domestic hot water recirculation loop must be insulated regardless of pipe diameter.

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[6] The full methodology can be found in Sections 4.1 and 4.2 of the Final 2019 CHWDS CASE Report (Statewide CASE Team 2017a).

- Distribution system multipliers reflect the energy impact of reduced hot water consumption associated with manual control recirculation systems, as stated in Table B-1 of 2019 ACM.

To determine water savings associated with the demand recirculation system, the duty cycle per end use (shower, bathroom, and kitchen) were used from the CASE Report on Faucets (Statewide CASE Team 2013a). Based on the Energy Commission Staff Report for faucets, the analysis assumes 45 feet pipe length to each fixture (Energy Commission 2014). The base case water entrapment volume was calculated according to the formula $A = \pi*(\text{Inside Diameter})^2/4$ using this 45-foot pipe length for ¾" PEX pipe and assuming an average inside diameter of 0.681 inches. The resulting base case and measure case entrapment volumes (0.85 gallons and 0.125 gallons, respectively) were multiplied by each duty cycle to yield total base case and measure case water consumption. The water savings is the difference between these two values. The assumed measure life is 30 years.

7.2 Measure 2 – Graywater-Ready Dwellings

Scope: New Construction; Single Family

Conservatively, the analysis in this report assumes water savings only from laundry washing machines. The analysis assumes no savings from graywater from other sources (showers, baths, and lavatory sinks) since graywater from those sources is more burdensome to use (given the likely need for a surge tank and water treatment).

To calculate water savings, annual indoor household water usage was assumed to be 50,370 gallons based on 2016 Water Research Foundation study on residential end uses of water (WRF 2016). WRF study and a 2011 Aquacraft study on water end use profiles (WRF 2016, Aquacraft 2011a) were used to determine percent of water by end use. The average values from the two studies for allowable end uses for graywater resulted in 20 percent used in showers, three percent used in baths, ten percent used in lavatory faucets, and 17 percent used in laundry. Applying 17 percent to the indoor household water usage results in 8,563 gallons of potential water savings from using graywater from laundry washing machines.

Since the amount of graywater provided by a laundry-to-landscape system does not entirely offset the landscape irrigation needs in any climate zone, water savings are the same in each climate zone. The assumed measure life is 30 years.

7.3 Measure 3 – Recycled Water for Common Landscaping

Scope: New Construction; Single Family

This analysis included the cost of connecting to the recycled water source, assuming the maximum distance of 200 feet from the property line to the recycled water source. It was assumed that potable water consumption is offset by recycled water for the total irrigation water use in each climate zone. The landscape area for residential landscapes was assumed to be 2,648 ft^2, which was the median from an Aquacraft study on end use water profiles (Aquacraft 2011a). The assumed measure life is 30 years.

Irrigation Water Demand by Climate Zone

The methodology from the Pacific Institute study was adopted to estimate irrigation water demand by climate zone (Pacific Institute 2016). The Pacific Institute study on alternative water supply and efficiency calculates irrigation demand in gallons per year based on the monthly reference evapotranspiration, monthly effective rainfall, plant factor of the irrigated area, distribution uniformity of irrigation, irrigation management efficiency, irrigated landscape area, and a conversion factor to convert inches of water to gallons (Pacific Institute 2016). For each climate zone's representative city (Energy Commission 2017), reference evapotranspiration values were used from 2015 DWR MWELO

(CCR 2019f) and monthly rainfall from usclimatedata.com. The rainfall was adjusted by a factor of 0.25 to account for evaporation, runoff, and deep percolation, all of which affects the effective rainfall (Pacific Institute 2016). This analysis uses an average plant factor of 0.55 based on 0.3 for low water plants and 0.8 for turf grass (Pacific Institute 2016). Additionally, calculations for irrigation water demand by climate zone align with the Pacific Institute assumption for the product of distribution uniformity and irrigation management efficiency of 0.62 (Pacific Institute 2016).

7.4 Measure 4 – Pool and Spa Covers

Scope: New Construction, Additions, Alterations; Single Family

While evaporation rates depend on many factors including pool size, climate, and wind, this analysis applies average pan evaporation rates by building climate zone based on measured evaporation rates from the Western Regional Climate Center and Los Angeles County Watershed Model Configuration and Calibration report, as shown in

Table 25 (Western Regional Climate Center 2018, County of Los Angeles 2010). As these reports present pan evaporation in inches per year, the rates were converted to gallons per year using standard conversions and assuming an average pool size of 392 ft^2. Total evaporation per year was multiplied by an average efficiency of 81 percent based on a National Plasters Council report addressing pool cover effectiveness of reducing evaporation (National Plasterers Council 2016). The assumed measure life is four years.

Table 25: Average Annual Evaporation by Climate Zone

Climate Zone	Average Annual Evaporation (inches/year)
CZ1	31.6
CZ2	55.9
CZ3	62.3
CZ4	85.9
CZ5	70.2
CZ6	37.0
CZ7	63.8
CZ8	42.4
CZ9	44.3
CZ10	72.0
CZ11	63.8
CZ12	69.9
CZ13	96.9
CZ14	102.7
CZ15	85.3
CZ16	61.4

Sources: Western Regional Climate Center 2018, County of Los Angeles 2010.

7.5 Measure 5 – Exterior Hose Bib Locks

Scope: New Construction; Multifamily and Nonresidential

Due to lack of available data, there is no strong defensible way to estimate per-building savings. As such, this analysis took the conservative approach of assuming the average building would not achieve energy or water savings as a result of lock installation. The assumed measure life is 10 years.

7.6 Measure 6 – Alternate Water Sources

Scope: New Construction; Multifamily and Nonresidential

To calculate daily irrigation demand per climate zone for both multifamily and nonresidential applications, the methodology described previously for Measure 3 was used.

To calculate demand for toilet flushing and graywater supply for multifamily buildings, building assumptions were based on the two-story, 6,960-square foot multifamily prototype building with four one-bedroom, 780-square foot units and four two-bedroom, 960-square foot units. With an assumption of 1.5 toilets per unit and toilet water usage of 3,450 gallons per year (Statewide CASE Team 2013b), it was calculated that a multifamily building uses 41,400 gallons of water for toilet flushing each year. Daily water consumption of 85 gallons per capita per day and an average of 2.46 people per unit (LAO 2017, WRF 2018) were used to calculate total annual water consumption; it was assumed that 84 percent of this water was used indoors (HUD 2002), resulting in a total of 512,881 gallons of annual indoor water per building. Using the 512,881 gallons of indoor water usage, it was assumed that 19.5 percent is used in showers, 2.5 percent is used in baths, and 9.5 percent is used in bathroom faucets (WRF 2016; Aquacraft 2011b), resulting in a total of 161,557 gallons of graywater produced each year.

To calculate demand for toilet/urinal flushing and graywater supply for nonresidential buildings, building assumptions were based on the three-story, 53,628-square foot medium sized office building prototype. While the prototype does not give any sense of how many bathrooms or fixtures are located in the building, it was estimated that the building contains five toilets and one urinal per story with an annual water usage of 1,974 gallons per year per toilet and 585 gallons per year per urinal for a total of 31,365 gallons per year of toilet and urinal water use (Statewide CASE Team 2013b). The calculations also include 696,970 gallons per year (rounding 696,969.7 value) of total building water usage where 37 percent goes to bathrooms and 28 percent (rounding 28.09 value) of that bathroom usage goes to faucets, resulting in 72,438 gallons of graywater per year from sinks (Statewide CASE Team 2017c; U.S. EPA 2017). The calculations do not include graywater production from showers as this was assumed to be low or nonexistent in a typical medium-sized office building.

To estimate available rainwater supply for a multifamily and nonresidential buildings, the average rainfall per month was calculated in each climate zone, multiplied by the assumed footprint of the building (3,480 ft^2 for multifamily and 17,876 ft^2 for nonresidential), converted to gallons received per month, adjusted by 90 percent to account for the rainwater that cannot be collected (Greywater Action 2018), and evenly distributed across the respective days in each month.

To estimate foundation drainage supply for a multifamily and nonresidential buildings, the area of the building footprint was used (3,480 ft^2 for multifamily, 17,876 ft^2 for nonresidential) to calculate the building perimeter. Assuming a square building for each application, the perimeter was calculated to be 236 feet for the multifamily building and 535 feet for the nonresidential building. To calculate the foundation drainage water collected, this perimeter was multiplied by an assumed four-foot width, the estimated rainfall for each climate zone, and a 90 percent adjustment factor to account for rainwater that cannot be collected.

For both multifamily and nonresidential applications, it was assumed that the storage tank is empty starting January 1st. Then, the values for water demand – irrigation and toilet/urinal flushing – were compared with the daily supply of rainwater, graywater, and foundation drainage to determine the net capacity of the tank. This way, the analysis accounted for water potentially lost due to the tank being full when the demand (irrigation, toilet/urinal flushing) did not exceed supply (rainwater, graywater from acceptable sources, and foundation drainage). This approach also allowed to track how much additional water is needed from the municipal water supply. Potential demand for alternative source water for a cooling tower was not considered in this analysis.

An annual maintenance cost was not included for multifamily buildings due to lack of public data, but an annual maintenance cost of 2.36 percent of the installation cost was included in the cost calculations, using the average of available case study data (SFPUC 2018). The assumed measure life for multifamily and nonresidential applications is 30 years.

7.7 Measure 7 – Landscape Irrigation Water Meters and Flow Sensors

Scope: New Construction, Additions, Alterations; Residential and Nonresidential

The base case for this measure assumes neither landscape irrigation meter nor flow sensor is installed. The measure case conservatively assumes installation of both a landscape irrigation meter and a flow sensor. The analysis also includes an annual $200 water meter fee; this assumes that the irrigation water meter is managed by a water provider for billing purposes, while the flow sensor is used by the owner to monitor for leaks and over and under irrigation issues. The analysis did not take into account existing 2015 DWR MWELO requirements related to irrigation water meters and flow sensors due to low compliance with MWELO.

The landscape area for a residential landscape was assumed to be 2,648 ft^2, which was the median from an Aquacraft study on end use water profiles (Aquacraft 2011a). The landscape area for nonresidential landscape was assumed to be 8,826 ft^2. The area for a nonresidential landscape was calculated by scaling the residential landscape area of 2,648 ft^2 based on the comparison between 69,000 gallons per year used outdoors for single family homes (Aquacraft 2011b) and 230,000 gallons per year used outdoors for nonresidential buildings (Statewide CASE Team 2017c).

It was assumed that the use of a landscape irrigation meter and flow sensor would reduce landscape irrigation water by 15 percent (AWE 2018). Estimated savings were applied to the irrigation water demand in each climate zone. For more information regarding estimating irrigation water demand, see methodology description for Irrigation Water Demand by Climate Zone under Measure 3.

The assumed life of irrigation water meter is 18 years. Flow sensors are not assumed to be replaced during the 30-year analysis period due to a lifetime of 30 years.

7.8 Measure 8 – Irrigation Controllers

Scope: New Construction, Additions, Alterations; Residential and Nonresidential

The analysis only considered new construction scenario by including incremental costs to purchase weather-based or soil moisture-based controller over a basic irrigation controller. For addition and alteration scenario, the results of this analysis may not apply since additions and alterations would likely involve replacing an existing irrigation controller, in other words, full costs (not incremental costs) for a weather-based or soil moisture-based controller would need to be used.

This analysis assumes a basic irrigation controller for a base case and a weather-based (with a rain sensor) or soil moisture-based controller for the measure case. Existing 2015 DWR MWELO requirements related to irrigation controllers were not taken into account in this analysis due to low compliance rate with MWELO. It was assumed that 18 percent of weather-based controllers did not have rain sensors (Aquacraft 2009); this was accounted for in the overall cost of the weather-based controllers.

The landscape area for a residential landscape was assumed to be 2,648 ft^2, which was the median from an Aquacraft study on end use water profiles (Aquacraft 2011a). The landscape area for nonresidential landscape was assumed to be 8,826 ft^2. The area for a nonresidential landscape was calculated by scaling the residential landscape area of 2,648 ft^2 based on the comparison between 69,000 gallons per year used outdoors for single family homes (Aquacraft 2011b) and 230,000 gallons per year used outdoors for nonresidential buildings (Statewide CASE Team 2017c).

Based on the CASE Report on Landscape Irrigation Controllers, the analysis assumes that weather-based controllers save 15 percent of irrigation water use and soil moisture-based controllers save 38 percent of irrigation water use (Statewide CASE Team 2017c). A 50/50 split was assumed for the adoption rate of weather and soil moisture-based controllers. Estimated savings were applied to the irrigation water demand in each climate zone. For more information regarding estimating irrigation water demand, see methodology description for Irrigation Water Demand by Climate Zone under Measure 3.

The assumed measure life is 11 years.

7.9 Measure 9 – Maximum Precipitation Rate for Irrigation Nozzles

Scope: New Construction; Residential and Nonresidential

Conservatively, savings for this measure were assumed to be zero given that the cap for the precipitation rate of nozzles is fairly high compared to the range of infiltration rates by soil type. Infiltration rate of soils vary from one inch per hour (upper threshold) for coarse sands to 0.1 inch per hour (lower threshold) for clay loam soils (Irrigation Association 2011). Studies of potential savings from just upgrading irrigation nozzles were not readily available.

7.10 Measure 10 – Irrigation Audits

Scope: New Construction; Residential and Nonresidential

Based on personal communications with representatives from the California Landscape Contractors Association, the analysis team estimated total hours for conducting the audit, developing the report, and follow-up appointment for both residential and nonresidential irrigation audits. It was assumed that audits do not result in direct savings.

Total hours will vary depending on landscape size, complexity of the irrigation system, whether applicant or auditor develops audit report, and what the jurisdiction will require as part of the audit. For instance, what is required for an irrigation audit may differ depending on whether a jurisdiction requires following the Irrigation Association's Certified Landscape Irrigation Auditor requirements or EPA WaterSense labeled auditing program. Some water providers may offer irrigation audits for free.

7.11 Measure 11 – Indoor Water Meters

Scope: New Construction, Additions; Multifamily and Nonresidential

The intended scope of the measure is multifamily and nonresidential applications. However, the analysis in this report only considered a nonresidential building (498,589-square foot large office).

Most of the scope of the measure for nonresidential application is already covered by 2016 CALGreen (Section 5.303.1). The additional savings come from metering cooling towers, evaporative coolers, and boilers for nonresidential buildings (where separate submeters for individual building tenants are feasible). For the base case, the analysis assumed submetering of individual tenants is in place, submetering of makeup water for a cooling tower is not in place, and submetering of a boiler is not in place. For the measure case, the analysis assumed installation of two additional submeters for a cooling tower and a boiler.

Building model simulations based on ASHRAE 90.1-2016 were used to determine how much water is used in cooling towers and boilers for each ASHRAE climate zone (U.S. DOE 2018). The building model simulations for the Large Office building (498,589 ft^2) were used since cooling towers and large boilers (with energy input greater than 500,000 Btu/h per measure requirement) are often used in larger buildings.

The savings from submetering a boiler were assumed to be zero due to lack of readily available data on potential savings. To estimate savings from submetering makeup water for a cooling tower, the ASHRAE climate zones were matched to the Energy Commission climate zones for California. If an Energy Commission climate zone covered multiple ASHRAE climate zones, the cooling tower water usage was averaged between all ASHRAE climate zones in the Energy Commission climate zone (iaqsource.com 2019; Energy Commission 2019b). It was assumed that by submetering the makeup water for a cooling tower, the building owner would take additional steps to improve the efficiency of the cooling tower. Changing the pipes can improve the efficiency by up to two percent; increasing the cooling cycles can reduce makeup water by up to 20 percent (Delta Cooling Tower, Inc. 2016). The average of savings from these different upgrade methods was used to estimate the savings from submetering a cooling tower. However, the costs to do upgrades were not included in the measure costs. The increase of cooling cycles will likely require a water treatment system to remove dissolved salts, so the cost of this upgrade may be significant and needs to be included in the measure cost in the next iteration of this analysis. The assumed measure life is 15 years.

7.12 Measure 12 –Cooling Towers

Scope: New Construction; Multifamily and Nonresidential

The intended scope of the measure is multifamily and nonresidential applications. However, the analysis in this report only considered a nonresidential building (117,000-square foot large office prototype).

Due to high capital costs of Zero Liquid Discharge (ZLD) treatment systems, and the need for specially-designed cooling towers to enable the use of high total dissolved solids water operation, the analysis assumes a packaged reverse osmosis treatment system for treating cooling tower blowdown water. These systems have an installed cost of $5-10 per gallon of daily capacity, so the analysis assumes an average of $7.50 per gallon of daily capacity (Nall, Faia, and Sedlak 2013). It was assumed the system would be dedicated to cooling tower blowdown water reuse. Given that most of the cooling tower water use is makeup for evaporative losses (the primary heat rejection mechanism), blowdown water reuse will not sufficiently provide all makeup water needs. If other on-site treated graywater or rainwater exists in sufficient quantities, recycled water from that treatment system can serve as cooling tower makeup water as well. It was assumed that the blowdown water treatment loop, as shown in Figure 1, would be mounted on the roof with the cooling tower; piping length costs and pumping energy were calculated accordingly.

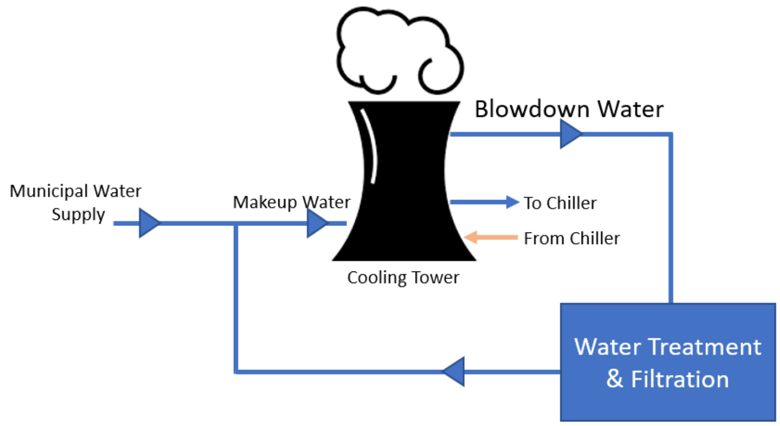

Figure 1: Assumed cooling tower blowdown treatment and reuse setup.
Source: Energy Solutions.

Cost-effectiveness was calculated for climate zones 3, 4, 6, 7, 8, 9, 10, 12, and 13 as these climate zones account for approximately 90 percent of large office buildings in the nonresidential construction forecast (Statewide CASE Team 2011). The system was assumed to be installed on the 117,000-square foot large office prototype, the same prototype used in the 2013 CASE Report on Cooling Tower Water Savings. The analysis uses chiller sizing, cooling tower sizing, condenser water flow, annual cooling tower water use, and annual blowdown water use results for each climate zone from the cooling tower water use model used in the 2013 CASE Report.

As part of the analysis for the CASE Report, the authors ran energy simulations in EnergyPro to produce an annual hourly output of chiller load in each climate zone. This output was used to calculate the full load equivalent hours for the chiller on the cooling design day in each climate zone. One percent of the cooling tower flow rate was used for the flow rate of blowdown water and to calculate the design day gallons per day (gpd) of effluent through the treatment system. This value was used to size the treatment system and corresponding capital cost in each climate zone. To calculate operational energy use of the reverse osmosis treatment system, the analysis assumed an average value of 0.00114 kWh/gal of treated water (Nall, Faia, and Sedlak 2013; Laborde et al 2001) and multiplied this value by the annual blowdown water in each climate zone. The reverse osmosis membrane needs to be replaced every three years, which was accounted for in operational costs. To calculate annual water savings, the analysis assumes a reverse osmosis treatment system recovery rate of 70 percent (Puretec 2018). The assumed measure life is 20 years.

7.13 Measure 13 – Manually Operated Toilets in Commercial Facilities

Scope: New Construction; Nonresidential

Based on a 2010 study conducted by Veritec Consulting and Koeller & Company (Gauley and Koeller 2010), the analysis assumes a 5.7 percent increase in consumption from manual flush urinals and a 54 percent decrease in consumption from manual flush toilets relative to sensor-operated toilets and urinals. The study was conducted from February 2007 to January 2009 using two bathrooms on one of the floors of an eight-story, 223,000-square foot office building located in Tampa, Florida. The study included two urinals and eight toilets. The authors of the study state that given the small scale of the study, the results may not be indicative of other projects.

Per unit annual water consumption for toilets and urinals were used from the 2013 Case Report on Toilets and Urinals and multiplied by the average number of toilets and urinals per medium-sized office building (Statewide CASE Team 2013b). While the Energy Commission prototypes do not specify number of bathrooms or plumbing fixtures, it was estimated that there are 23 toilets and nine urinals in each 53,628-square foot three-story medium-size office building prototype. The assumed measure life is 12 years.

7.14 Measure 14 – Manually Operated Faucets in Commercial Facilities

Scope: New Construction; Nonresidential

Based on a 2010 study conducted by Veritec Consulting and Koeller & Company, the analysis assumes a 30.1% decrease in consumption from manual faucets (Gauley and Koeller 2010). The study was conducted from February 2007 to January 2009 using two bathrooms on one of the floors of an eight-story, 223,000-square foot office building located in Tampa, Florida. The number of monitored faucets was not specified in the report. The authors of the study state that given the small scale of the study, the results may not be indicative of other projects.

Per unit electricity, gas, and water consumption for lavatory faucets were used from the 2013 CASE Report on Faucets and multiplied by the average number of lavatory faucets per medium-sized office building (Statewide CASE Team 2013a). The assumed measure life is ten years (Statewide CASE Team 2013a).

7.15 Measure 15 – Commercial Kitchen Water Efficiency

Scope: New and Replacement Equipment; Nonresidential

All savings values for dishwashers, food steamers, combination ovens, and pulpers were taken from the CASE Report on Commercial Food Service Equipment, as shown in Table 26 (Statewide CASE Team 2015). Electricity and natural gas savings are calculated using the assumption that 90 percent of commercial kitchens are using natural gas for water heating and 10 percent are using electricity for water heating. The assumed measure life is 11 years based on the average life measure for considered equipment types.

The analysis does not consider costs and savings from pre-rinse spray valves and commercial ice makers as these appliances are federally preempted. It was assumed that the average commercial kitchen contains one of each of the following equipment types: dishwasher, food steamer, and combination oven. Pulpers were not assumed to be present in the average commercial kitchen due to low statewide shipments at approximately 35 units per year; therefore, the savings achieved with high-efficiency pulpers were not included in the total savings presented in Section 4.15.

Table 26: Per-Unit Savings for Commercial Kitchen Appliances

Appliance	Number of Units Per Commercial Kitchen	Water Savings (Gal/Unit/Year)	On-Site Electricity Savings (kWh/Unit/Year)[b]	Natural Gas Savings (Therms/Unit/Year)[b]	Lifetime (Years)
Dishwashers	1	19,315	2,848	157	10
Food Steamers	1	95,659	14,105	778	12
Combination Ovens	1	10,576	1,559	86	12
Pulpers[a]	0	777,600	0	0	8

Source: Statewide CASE Team 2015.

[a] Savings from pulpers are not included in this measure's results due to the assumption that this appliance is not installed in a typical commercial kitchen. Savings are presented to assist with understanding potential additional savings for kitchens that do install pulpers.

[b] While per-unit on-site electricity and natural gas savings are presented, a commercial kitchen will only realize the savings associated with the kitchen's actual water heating type.

7.16 Measure 16 – Selling Compliant Fixtures and Fittings

Scope: Residential and Nonresidential

This measure is reiterating Title 20 requirements. Therefore, it is assumed that there are no associated savings.

7.17 Measure 17 – Installing Compliant Fixtures and Fittings

Scope: Residential and Nonresidential

This measure is reiterating Title 20 requirements. Therefore, it is assumed that there are no associated savings.

Appendix B – Additional Resources

The following lists address rebate programs and additional resources directly relevant to the measures addressed in this report. This does not constitute a comprehensive list of available rebate programs and resources.

Rebate Programs

Indoor Water Efficiency

- **EPA WaterSense Rebate Finder.** Tool to help identify rebate programs for WaterSense labeled products.
- **SoCal Water$mart Commercial Food Equipment.** Rebates for connectionless food steamers and air-cooled ice machines. http://socalwatersmart.com/commercial/?page_id=3050
- **Solano County Water Agency Hot Water Recirculating System Components Rebate.** http://www.scwa2.com/water-conservation/rebates/residential-rebates

Landscape Irrigation Efficiency

- **Alameda County Water District (ACWD) Weather-Based "Smart" Irrigation Controller Rebate Program.** Rebates available to commercial, industrial, institutional, or multifamily/HOA customers within ACWD territory for replacing conventional irrigation controller(s) with smart controller(s). https://www.acwd.org/DocumentCenter/View/389
- **California Water Service Rebates and Programs.** Various rebate programs available to residential and commercial customers, including rebates for smart irrigation controllers and high efficiency nozzles. Commercial customers may also pursue rebates for large rotary nozzles and spray sprinkler bodies with integrated pressure regulation and check valves. https://www.calwater.com/conservation/rebates-and-programs/residential/av/
- **City of Sacramento Irrigation Upgrade Rebates; Smart Controller Rebates.** Includes rebates for conversion to high efficiency sprinkler nozzles and smart irrigation controllers. https://www.cityofsacramento.org/Utilities/Conservation/Residents/Residential-Rebates
- **East Bay Municipal Utility District Efficient Irrigation Equipment.** Includes rebates for high efficiency nozzles, smart irrigation controllers, and irrigation submeters. https://www.ebmud.com/water/conservation-and-rebates/residential/rebates/lawn-conversion-irrigation-upgrade-rebates/
- **EPA WaterSense Rebate Finder.** Tool to help identify rebate programs for WaterSense labeled products.
- **North Marin Water District Water Rebates and Programs.** Includes various rebates such as rebates for qualifying high efficiency irrigation equipment including check valves, rotating sprinkler nozzles, and rain shut-off devices and rebates for weather-based irrigation controllers. Also, offers free outdoor water efficiency checks and landscape irrigation system efficiency test, large landscape water audit program, and large landscape budget program. https://www.nmwd.com/conservation_exterior.php
- **Santa Clara Valley Water District (SCVWD) Landscape Rebate Program.** Rebate program for irrigation equipment upgrades. Includes high-efficiency nozzles, rotor sprinklers or spray bodies with pressure regulation and/or check valves, rain sensors, dedicated landscape meters/flow

sensors/hydrometers, and weather-based irrigation controllers. https://scvwd.dropletportal.com/irrigation-equipment-details

- **SCVWD Large Landscape Survey Program.** Free landscape surveys for minimum ½ acre irrigated landscape and/or 1,000 centum cubic feet (CCF) of water consumption for irrigation in multifamily, commercial, industrial, and institutional sites. https://www.valleywater.org/saving-water/commercial/large-landscape-surveys
- **SCVWD Water Wise Survey Program.** Free irrigation survey for single family and small multifamily sites (under ½ acre irrigated landscape). https://www.valleywater.org/saving-water/residential/water-wise-surveys
- **SoCal Water$mart Irrigation Controllers.** Residential rebates for weather-based irrigation controllers. http://www.socalwatersmart.com/?page_id=2979
- **SoCal Water$mart Commercial Landscaping Equipment.** Rebates for smart irrigation controllers, high efficiency nozzles, flow regulators, and soil moisture sensors. http://socalwatersmart.com/commercial/?page_id=3050
- **Solano County Water Agency Rain Sensors Rebate.** Rebate for rain sensors that shut-off irrigation systems when 1/8 inch or greater precipitation is detected. http://www.scwa2.com/water-conservation/rebates/residential-rebates
- **Zone 7 Water Agency Weather-Based Irrigation Controller Rebates.** Rebates for replacing irrigation controllers with smart controllers. Available to single family residences, multifamily residences, and nonresidential properties. Zone 7 Water Agency covers City of Livermore, California Water Service Company-Livermore, City of Pleasanton, and Dublin San Ramon Services District. http://zone7water.com/conservation-rebates/rebate-programs/weather-based-irrigation-controllers

Alternate Water Sources and Onsite Non-Potable Water Systems

- **Bay Area Water Supply and Conservation Agency (BAWSCA) Rain Barrel Rebates.** BAWSCA and participating member agencies offer rebates for purchase and installation of qualifying rain barrels. http://bawsca.org/conserve/rebates/barrels
- **City of Sacramento Rain Barrel Rebates; Laundry-to-Landscape Rebates.** https://www.cityofsacramento.org/Utilities/Conservation/Residents/Residential-Rebates
- **North Marin Water District Rainwater / Graywater Rebate.** Pilot program to incentivize capture and distribution of rainwater or graywater for landscape irrigation. https://www.nmwd.com/conservation_exterior.php
- **SCVWD Laundry-to-Landscape Rebate Program.** Rebate for connecting a clothes washer to a simple graywater irrigation system. https://www.valleywater.org/graywater-rebate-program
- **San Francisco Public Utilities Commission (SFPUC) Non-potable Grant Program.** Encourages alternate water source collection, treatment, and distribution https://www.sfwater.org/index.aspx?page=686
- **SFPUC Rainwater Harvesting Program**: Participating customers receive up to two 50-gallon rain barrels (must pay tax), plus large discounts on 250- to 750-gallon cisterns. https://www.sfwater.org/index.aspx?page=178

- **SoCal Water$mart Rain Barrels & Cisterns.** Rebates for rain barrels or cisterns. http://www.socalwatersmart.com/?page_id=2973
- **Solano County Water Agency Laundry-to-Landscape System Components Rebate and Rain Barrel Rebate.** Rebate for eligible components to distribute graywater from clothes washers to landscape irrigation. Rebate for rain barrels. http://www.scwa2.com/water-conservation/rebates/residential-rebates

Submetering

- **SCVWD Submeter Rebate Program.** Rebate per installed submeter for mobile home parks and condominium complexes. https://www.valleywater.org/saving-water/commercial/submeter-rebate-program

Swimming Pools & Spa Covers

- **North Marin Water District Pool Cover Rebate.** Rebates to residential customers for installing a new solar or safety pool cover. https://www.nmwd.com/conservation_exterior.php
- **Solano County Water Agency Pool Cover Rebate.** Rebates for new pool covers. http://www.scwa2.com/water-conservation/rebates/residential-rebates

Water Efficient Technology (WET) Rebates

- **SCVWD WET Rebates for Businesses and Facilities.** Rebates available to commercial, industrial, and institutional water customers for water conservation projects directly reducing water consumption by at least 75,800 gallons per year. https://www.valleywater.org/saving-water/commercial/commercial-facility-rebates

Other Resources

MWELO

- **California Department of Water Resources (DWR)**: The 2015 Updated Model Water Efficient Landscape Ordinance Guidance for California Local Agencies**.** https://water.ca.gov/LegacyFiles/wateruseefficiency/landscapeordinance/docs/2015%20MWELO%20Guidance%20for%20Local%20Agencies.pdf

Onsite Non-Potable Water Systems

- **National Blue Ribbon Commission (NBRC) for Onsite Non-Potable Water Systems**: A Guidebook for Developing and Implementing Regulations for Onsite Non-Potable Water Systems. http://uswateralliance.org/sites/uswateralliance.org/files/NBRC%20GUIDEBOOK%20FOR%20DEVELOPING%20ONWS%20REGULATIONS.pdf
- **Water Research Foundation**: Risk-Based Framework for the Development of Public Health Guidance for Decentralized Non-Potable Water Systems. https://www.waterrf.org/research/projects/risk-based-framework-development-public-health-guidance-decentralized-non-potable

Water-Energy Nexus

- **Energy Code Ace Title 20 Essentials:** The Water Energy Nexus. Free online self-study to learn about the water-energy nexus and the importance to California, Title 20 and CALGreen (Title 24, Part 11) water efficiency requirements, and compliance with Title 20 water efficiency requirements. https://energycodeace.com/training

Appendix C – Energy Utility Rate Schedules

Below are hyperlinks to the energy rates used for each utility. Detailed rate schedules are provided in subsequent sections.

Residential

- Southern California Edison
  Electric: Schedule D. https://www.sce.com/NR/sc3/tm2/pdf/ce12-12.pdf
- Southern California Gas
  Gas: Schedule GR. https://www.socalgas.com/regulatory/tariffs/tm2/pdf/GR.pdf
- Pacific Gas and Electric
  Electric: Schedule E1. https://www.pge.com/tariffs/assets/pdf/tariffbook/ELEC_SCHEDS_E-1.pdf
  Gas: Schedule G-1. https://www.pge.com/tariffs/assets/pdf/tariffbook/GAS_SCHEDS_G-1.pdf
- San Diego Gas and Electric
  Electric: Schedule DR. https://www.sdge.com/sites/default/files/regulatory/11-1-18%20Schedule%20DR%20Total%20Rates%20Table.pdf
  Gas: Schedule GR. http://regarchive.sdge.com/tm2/pdf/GAS_GAS-SCHEDS_GR.pdf

Commercial

- Southern California Edison
  Electric: Schedule GS-2-A. https://www.sce.com/NR/sc3/tm2/pdf/ce30-12.pdf
- Southern California Gas
  Gas: Schedule G-10. https://www.socalgas.com/regulatory/tariffs/tm2/pdf/G10.pdf
- Pacific Gas and Electric
  Electric: Schedule A-10. https://www.pge.com/tariffs/electric.shtml#COMMA10
  Gas: Schedule G-NR1. https://www.pge.com/tariffs/tm2/pdf/GAS_SCHEDS_G-NR1.pdf
- San Diego Gas and Electric
  Electric: Schedule A Secondary. https://www.sdge.com/sites/default/files/A_3.pdf
  Gas: Schedule GN-3. http://regarchive.sdge.com/tm2/pdf/GAS_GAS-SCHEDS_GN-3.pdf

Residential Electric Rates

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL Company

Southern California Edison — Revised — Cal. PUC Sheet No. 64914-E
Rosemead, California (U 338-E) — Cancelling Revised — Cal. PUC Sheet No. 64474-E

Schedule D
DOMESTIC SERVICE

Sheet 2

(Continued)

RATES

	Delivery Service Total[1]	Generation[2] UG***	Generation[2] DWREC[3]
Energy Charge- $/kWh/Meter/Day			
Baseline Service			
Summer	0.08942 (R)	0.08470 (I)	0.00000
Winter	0.08942 (R)	0.08470 (I)	0.00000
Nonbaseline Service*			
101% - 400% of Baseline - Summer	0.16102 (I)	0.08470 (I)	0.00000
Winter	0.16102 (I)	0.08470 (I)	0.00000
High Usage Charge			
(Over 400% of Baseline) - Summer	0.26092 (I)	0.08470 (I)	0.00000
- Winter	0.26092 (I)	0.08470 (I)	0.00000
Basic Charge - $/Meter/Day			
Single-Family Accommodation	0.031		
Multi-Family Accommodation	0.024		
Minimum Charge** - $/Meter/Day			
Single-Family Accommodation	0.338		
Multi-Family Accommodation	0.338		
Minimum Charge (Medical Baseline)** - $/Meter/Day			
Single-Family Accommodation	0.169		
Multi-Family Accommodation	0.169		
California Climate Credit[4]	(36.00)		

* Nonbaseline Service includes all kWh in excess of applicable Baseline allocations as described in Preliminary Statement, Part H, Baseline Service.

** The Minimum Charge is applicable when the Delivery Service Energy Charge, minus the DWRBC, plus the applicable Basic Charge is less than the Minimum Charge. The difference between these two amounts is the Balance of Minimum Charge and is included on a customer's bill. (P)

*** The ongoing Competition Transition Charge (CTC) of $0.00075 per kWh is recovered in the UG component of Generation. (P)

1 Total = Total Delivery Service rates are applicable to Bundled Service, Direct Access (DA) and Community Choice Aggregation Service (CCA Service) Customers, except DA and CCA Service Customers are not subject to the DWRBC rate component of this Schedule but instead pay the DWRBC as provided by Schedule DA-CRS or Schedule CCA-CRS.

2 Generation = The Generation rates are applicable only to Bundled Service Customers.

3 DWREC = Department of Water Resources (DWR) Energy Credit - For more information on the DWR Energy Credit, see the Billing Calculation Special Condition of this Schedule.

4 Applied on an equal basis, per household, semi-annually. See the Special Conditions of this Schedule for more information.

(Continued)

(To be inserted by utility)	Issued by	(To be inserted by Cal. PUC)
Advice 3868-E	Caroline Choi	Date Submitted Sep 25, 2018
Decision 18-07-037	Senior Vice President	Effective Oct 1, 2018
2C11		Resolution

Pacific Gas and Electric Company
U 39 San Francisco, California

	Revised	Cal. P.U.C. Sheet No.	42707-E
Cancelling	Revised	Cal. P.U.C. Sheet No.	41845-E

ELECTRIC SCHEDULE E-1
RESIDENTIAL SERVICES

Sheet 1

APPLICABILITY: This schedule is applicable to single-phase and polyphase residential service in single-family dwellings and in flats and apartments separately metered by PG&E; to single-phase and polyphase service in common areas in a multifamily complex (see Special Condition 8); and to all single-phase and polyphase farm service on the premises operated by the person whose residence is supplied through the same meter.

The provisions of Schedule S—Standby Service Special Conditions 1 through 6 shall also apply to customers whose premises are regularly supplied in part (but not in whole) by electric energy from a nonutility source of supply. These customers will pay monthly reservation charges as specified under Section 1 of Schedule S, in addition to all applicable Schedule E-1 charges. See Special Conditions 11 and 12 of this rate schedule for exemptions to standby charges.

TERRITORY: This rate schedule applies everywhere PG&E provides electric service.

RATES: Total bundled service charges are calculated using the total rates below. Customers on this schedule are subject to the delivery minimum bill amount shown below applied to the delivery portion of the bill (i.e. to all rate components other than the generation rate). In addition, total bundled charges will include applicable generation charges per kWh for all kWh usage.

Customers receiving a medical baseline allowance shall pay for all usage in excess of 200 percent of baseline at a rate $0.04000 per kWh less than the applicable rate for usage in excess of 200 percent of baseline. No portion of the rates paid by customers that receive a Medical Baseline allowance shall be used to pay the DWR Bond charge. For these customers, the Conservation Incentive Adjustment is calculated residually based on the total rate less the sum of: Transmission, Transmission Rate Adjustments, Reliability Services, Distribution, Generation, Public Purpose Programs, Nuclear Decommissioning, Competition Transition Charges (CTC), New System Generation Charges, and Energy Cost Recovery Amount. Customers receiving a medical baseline allowance shall also receive a 50 percent discount on the delivery minimum bill amount shown below.

Direct Access (DA) and Community Choice Aggregation (CCA) charges shall be calculated in accordance with the paragraph in this rate schedule titled Billing.

TOTAL RATES

Total Energy Rates ($ per kWh)	
Baseline Usage	$0.21536 (I)
101% - 400% of Baseline	$0.28478 (I)
High Usage Over 400% of Baseline	$0.44095 (I)
Delivery Minimum Bill Amount ($ per meter per day)	$0.32854
California Climate Credit (per household, per semi-annual payment occurring in the April and October bill cycles)	($39.42)

(Continued)

Advice	5339-E	Issued by	Date Filed	July 27, 2018
Decision	18-06-011	**Robert S. Kenney**	Effective	September 1, 2018
		Vice President, Regulatory Affairs	Resolution	

Schedule DR - RESIDENTIAL SERVICE Effective 11/1/2018

This is SDG&E's standard UDC schedule for domestic residential electric service. If you're a typical household, you're most likely on this rate.

SCHEDULE DR												Schedule DWR-BC Rate	Schedule EECC + DWR Credit Rate	Total Electric Rate
Energy Charges ($/kWh)		Transm	Distr	PPP	ND	CTC	LGC	RS	TRAC	UDC Total				
Summer														
Up to 130% of Baseline Energy	Tier 1	0.03622	0.09854	0.01517	(0.00005)	0.00165	0.01031	0.00004	(0.06699)	0.09489		0.00549	0.16837	0.26875
131% to 400% of Baseline	Tier 2	0.03622	0.09854	0.01517	(0.00005)	0.00165	0.01031	0.00004	0.13540	0.29728		0.00549	0.16837	0.47114
Above 400% of Baseline	HUC	0.03622	0.09854	0.01517	(0.00005)	0.00165	0.01031	0.00004	0.21320	0.37508		0.00549	0.16837	0.54894
Winter														
Up to 130% of Baseline Energy	Tier 1	0.03622	0.09854	0.01517	(0.00005)	0.00165	0.01031	0.00004	(0.00844)	0.15344		0.00549	0.06908	0.22801
131% to 400% of Baseline	Tier 2	0.03622	0.09854	0.01517	(0.00005)	0.00165	0.01031	0.00004	0.16326	0.32514		0.00549	0.06908	0.39971
Above 400% of Baseline	HUC	0.03622	0.09854	0.01517	(0.00005)	0.00165	0.01031	0.00004	0.22926	0.39114		0.00549	0.06908	0.46571
Other Charges/Discounts														
Minimum Bill		0.000	0.329	0.000	0.000	0.000	0.000	0.000	0.000	0.329				0.329

The total rates presented reflect the UDC rates associated with service under Schedule DR and the generation rates associated with Schedules EECC and DWR-BC. The UDC rate-by-rate components presented are associated with service under Schedule DR as presented in the utility's tariff book.

Residential Gas Rates

Pacific Gas and Electric Company
U 39 San Francisco, California

	Revised	Cal. P.U.C. Sheet No.	34592-G
Cancelling	Revised	Cal. P.U.C. Sheet No.	34549-G

GAS SCHEDULE G-1
RESIDENTIAL SERVICE

Sheet 1

APPLICABILITY: This rate schedule[1] applies to natural gas service to Core End-Use Customers on PG&E's Transmission and/or Distribution Systems. To qualify, service must be to individually-metered single family premises for residential use, including those in a multifamily complex, and to separately-metered common areas in a multifamily complex where Schedules GM, GS, or GT are not applicable. Common area accounts that are separately metered by PG&E have an option of switching to a core commercial rate schedule. Common area accounts are those accounts that provide gas service to common use areas as defined in Rule 1.

Per D.15-10-032 and D.18-03-017, transportation rates include GHG Compliance Cost for non-covered entities. Customers who are directly billed by the Air Resources Board (ARB), i.e., covered entities, are exempt from paying AB 32 GHG Compliance Costs through PG&E's rates.[2] A "Cap-and-Trade Cost Exemption" credit for these costs will be shown as a line item on exempt customers' bills.[3, 4]

TERRITORY: Schedule G-1 applies everywhere within PG&E's natural gas Service Territory.

RATES: Customers on this schedule pay a Procurement Charge and a Transportation Charge, per meter, as shown below. The Transportation Charge will be no less than the Minimum Transportation Charge, as follows:

	Per Day	
Minimum Transportation Charge:[5]	$0.09863	

	Per Therm Baseline		Per Therm Excess	
Procurement:	$0.35368	(I)	$0.35368	(I)
Transportation Charge:	$0.93438		$1.49502	
Total:	$1.28806	(I)	$1.84870	(I)
California Natural Gas Climate Credit (per Household, annual payment occurring in October 2018 bill cycle, and thereafter in the April bill cycle)	($29.85)			

Public Purpose Program Surcharge:
Customers served under this schedule are subject to a gas Public Purpose Program (PPP) Surcharge under Schedule G-PPPS.

See Preliminary Statement, Part B for the Default Tariff Rate Components.

The Procurement Charge on this schedule is equivalent to the rate shown on informational Schedule G-CP—Gas Procurement Service to Core End-Use Customers.

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1 PG&E's gas tariffs are available online at www.pge.com.
2 Covered entities are not exempt from paying costs associated with LUAF Gas and Gas used by Company Facilities.
3 The exemption credit will be equal to the effective non-exempt AB 32 GHG Compliance Cost Rate ($ per therm) included in Preliminary Statement – Part B, multiplied by the customer's billed volumes (therms) for each billing period.
4 PG&E will update its billing system annually to reflect newly exempt or newly excluded customers to conform with lists of Directly Billed Customers provided annually by the ARB.
5 The Minimum Transportation charge does not apply to submetered tenants of master-metered customers served under gas rate Schedules GS and GT.

(Continued)

Advice	4034-G	Issued by	Submitted	October 25, 2018
Decision	97-10-065 and D.98-07-025	**Robert S. Kenney** Vice President, Regulatory Affairs	Effective	November 1, 2018
			Resolution	

SOUTHERN CALIFORNIA GAS COMPANY Revised CAL. P.U.C. SHEET NO. 55635-G
LOS ANGELES, CALIFORNIA CANCELING Revised CAL. P.U.C. SHEET NO. 55601-G

Schedule No. GR
RESIDENTIAL SERVICE
(Includes GR, GR-C and GT-R Rates)

Sheet 1

APPLICABILITY

The GR rate is applicable to natural gas procurement service to individually metered residential customers.

The GR-C, cross-over rate, is a core procurement option for individually metered residential core transportation customers with annual consumption over 50,000 therms, as set forth in Special Condition 10.

The GT-R rate is applicable to Core Aggregation Transportation (CAT) service to individually metered residential customers, as set forth in Special Condition 11.

The California Alternate Rates for Energy (CARE) discount of 20%, reflected as a separate line item on the bill, is applicable to income-qualified households that meet the requirements for the CARE program as set forth in Schedule No. G-CARE.

TERRITORY

Applicable throughout the service territory.

RATES	GR	GR-C	GT-R	
Customer Charge, per meter per day:	16.438¢	16.438¢	16.438¢	
For "Space Heating Only" customers, a daily Customer Charge applies during the winter period from November 1 through April 30[1]:	33.149¢	33.149¢	33.149¢	
Baseline Rate, per therm (baseline usage defined in Special Conditions 3 and 4):				
Procurement Charge: [2]	35.980¢	35.980¢	N/A	I
Transmission Charge: [3]	54.841¢	54.841¢	54.991¢	
Total Baseline Charge:	90.821¢	90.821¢	54.991¢	I
Non-Baseline Rate, per therm (usage in excess of baseline usage):				
Procurement Charge: [2]	35.980¢	35.980¢	N/A	I
Transmission Charge: [3]	87.852¢	87.852¢	88.002¢	
Total Non-Baseline Charge:	123.832¢	123.832¢	88.002¢	I

[1] For the summer period beginning May 1 through October 31, with some exceptions, usage will be accumulated to at least 20 Ccf (100 cubic feet) before billing.

(Footnotes continue next page.)

(Continued)

(TO BE INSERTED BY UTILITY)	ISSUED BY	(TO BE INSERTED BY CAL. PUC)
ADVICE LETTER NO. 5379	**Dan Skopec**	SUBMITTED Nov 8, 2018
DECISION NO.	Vice President	EFFECTIVE Nov 10, 2018
1C5	Regulatory Affairs	RESOLUTION NO. G-3351

SDGE
San Diego Gas & Electric Company
San Diego, California

	Revised	Cal. P.U.C. Sheet No.	23514-G
Canceling	Revised	Cal. P.U.C. Sheet No.	23501-G

Sheet 1

SCHEDULE GR

RESIDENTIAL NATURAL GAS SERVICE
(Includes Rates for GR, GR-C, GTC/GTCA)

APPLICABILITY

The GR rate is applicable to natural gas procurement service for individually metered residential customers.

The GR-C, cross-over rate, is a core procurement option for individually metered residential core transportation customers with annual consumption over 50,000 therms, as set forth in Special Condition 10.

The GTC/GTCA rate is applicable to intrastate gas transportation-only services to individually metered residential customers, as set forth in Special Condition 11.

Customers taking service under this schedule may be eligible for a 20% California Alternate Rate for Energy (CARE) program discount, reflected as a separate line item on the bill, if they qualify to receive service under the terms and conditions of Schedule G-CARE.

TERRITORY

Within the entire territory served natural gas by the utility.

RATES

	GR	GR-C		GTC/GTCA[1/]
Baseline Rate, per therm (baseline usage defined in Special Conditions 3 and 4):				
Procurement Charge:[2/]	$0.36001	$0.36001	I	N/A
Transmission Charge:	$0.87416	$0.87416		$0.87416
Total Baseline Charge:	$1.23417	$1.23417	I	$0.87416
Non-Baseline Rate, per therm (usage in excess of baseline usage):				
Procurement Charge:[2/]	$0.36001	$0.36001	I	N/A
Transmission Charge:	$1.05166	$1.05166		$1.05166
Total Non-Baseline Charge:	$1.41167	$1.41167	I	$1.05166
Minimum Bill, per day:[3/]				
Non-CARE customers:	$0.09863	$0.09863		$0.09863
CARE customers:	$0.07890	$0.07890		$0.07890

[1/] The rates for core transportation-only customers, with the exception of customers taking service under Schedule GT-NGV, include any FERC Settlement Proceeds Memorandum Account (FSPMA) credit adjustments.
[2/] This charge is applicable to Utility Procurement Customers and includes the GPC and GPC-A Procurement Charges shown in Schedule GPC which are subject to change monthly as set forth in Special Condition 7.
[3/] Effective starting May 1, 2017, the minimum bill is calculated as the minimum bill charge of $0.09863 per day times the number of days in the billing cycle (approximately $3 per month) with a 20% discount applied for CARE customer resulting in a minimum bill charge of $0.07890 per day (approximately $2.40 per month).

(Continued)

1C5		Issued by	Submitted	Nov 8, 2018
Advice Ltr. No.	2719-G	Dan Skopec	Effective	Nov 10, 2018
Decision No.		Vice President Regulatory Affairs	Resolution No.	

Commercial Electric Rates

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL Company

Southern California Edison — Revised Cal. PUC Sheet No. 64951-E
Rosemead, California (U 338-E) — Cancelling Revised Cal. PUC Sheet No. 64511-E

Schedule GS-2
GENERAL SERVICE - DEMAND

Sheet 2

(Continued)

RATES

	Delivery Service								Generation[9]	
	Trans[1]	Distrbtn[2]	NSGC[3]	NDC[4]	PPPC[5]	DWRBC[6]	PUCRF[7]	Total[8]	UG**	DWREC[10]
Non TOU										
Energy Charge - $/kWh/Meter/Month										
Summer	(0.00172)	0.00254	0.00513	0.00005	0.01072 (I)	0.00549	0.00046	0.02267 (I)	0.05945 (I)	0.00000
Winter	(0.00172)	0.00254	0.00513	0.00005	0.01072 (I)	0.00549	0.00046	0.02267 (I)	0.05042 (I)	0.00000
Customer Charge - $/Meter/Month		231.17						231.17		
Facilities Related Demand Charge - $/kW	4.20	11.58						15.78		
Summer Time Related Demand Charge - $/kW		0.00						0.00	20.73 (I)	
Single Phase Service - $/Month		(14.88)						(14.88)		
Voltage Discount, Demand - $/kW										
Facilities Related										
From 2 kV to 50 kV	0.00	(0.21)						(0.21)		
Above 50 kV but below 220 kV	0.00	(6.44)						(6.44)		
At 220 kV	0.00	(11.16)						(11.16)		
Time Related										
From 2 kV to 50 kV		0.00						0.00	(0.55) (R)	
Above 50 kV but below 220 kV		0.00						0.00	(1.52) (R)	
At 220 kV		0.00						0.00	(1.54) (R)	
Voltage Discount, Energy - $/kWh										
From 2 kV to 50 kV	0.00000	0.00000						0.00000	(0.00099) (R)	
Above 50 kV but below 220 kV	0.00000	0.00000						0.00000	(0.00227) (R)	
At 220 kV	0.00000	0.00000						0.00000	(0.00229) (R)	
California Alternate Rates for Energy Discount - %		100.00*						100.00*		
California Climate Credit - $/kWh		(0.00484)						(0.00484)		

* Represents 100% of the discount percentage as shown in the applicable Special Condition of this Schedule.

** The ongoing Competition Transition Charge (CTC) of $0.00063 per kWh is recovered in the UG component of Generation. (P)

1 Trans = Transmission and the Transmission Owners Tariff Charge Adjustments (TOTCA) which are FERC approved. The TOTCA represents the Transmission Revenue Balancing Account Adjustment (TRBAA) of $(0.00144) per kWh, Reliability Services Balancing Account Adjustment (RSBAA) of $0.00005 per kWh, and Transmission Access Charge Balancing Account Adjustment (TACBAA) of $(0.00033) per kWh.

2 Distrbtn = Distribution

3 NSGC = New System Generation Charge

4 NDC = Nuclear Decommissioning Charge

5 PPPC = Public Purpose Programs Charge (includes California Alternate Rates for Energy Surcharge where applicable.)

6 DWRBC = Department of Water Resources (DWR) Bond Charge. The DWR Bond Charge is not applicable to exempt Bundled Service and Direct Access Customers, as defined in and pursuant to D.02-10-063, D.02-02-051, and D.02-12-082.

7 PUCRF = The PUC Reimbursement Fee is described in Schedule RF-E.

8 Total = Total Delivery Service rates are applicable to Bundled Service, Direct Access (DA) and Community Choice Aggregation Service (CCA Service) Customers, except DA and CCA Service Customers are not subject to the DWRBC rate component of this Schedule but instead pay the DWRBC as provided by Schedule DA-CRS or Schedule CCA-CRS.

9 Generation = The Generation rates are applicable only to Bundled Service Customers.

10 DWREC = Department of Water Resources (DWR) Energy Credit – For more information on the DWR Energy Credit, see the Billing Calculation Special Condition of this Schedule.

(Continued)

(To be inserted by utility)		Issued by	(To be inserted by Cal. PUC)	
Advice	3868-E	Caroline Choi	Date Submitted	Sep 25, 2018
Decision	18-07-037	Senior Vice President	Effective	Oct 1, 2018
2C10			Resolution	

Pacific Gas and Electric Company
U 39 San Francisco, California

	Revised	Cal. P.U.C. Sheet No.	42686-E
Cancelling	Revised	Cal. P.U.C. Sheet No.	41812-E

ELECTRIC SCHEDULE A-10 Sheet 3
MEDIUM GENERAL DEMAND-METERED SERVICE

RATES: Standard Non-Time-of-Use Rate

Table A

TOTAL RATES	Secondary Voltage	Primary Voltage	Transmission Voltage
Total Customer/Meter Charge Rates			
Customer Charge ($ per meter per day)	$4.59959	$4.59959	$4.59959
Optional Meter Data Access Charge ($ per meter per day)	$0.98563	$0.98563	$0.98563
Total Demand Rates ($ per kW)			
Summer	$19.85 (I)	$18.85 (I)	$13.00 (I)
Winter	$11.96 (I)	$12.26 (I)	$9.31 (I)
Total Energy Rates ($ per kWh)			
Summer	$0.17113 (I)	$0.15972 (I)	$0.12518 (I)
Winter	$0.13174 (I)	$0.12691 (I)	$0.10488 (I)

Total bundled service charges shown on customers' bills are unbundled according to the component rates shown below.

(Continued)

Advice	5339-E	*Issued by*	*Date Filed*	July 27, 2018
Decision	18-06-011	***Robert S. Kenney***	*Effective*	September 1, 2018
		Vice President, Regulatory Affairs	*Resolution*	

Customer Rate Information
Schedule A Secondary

SDGE
A Sempra Energy utility

Applicability:

Applicable to general service including lighting, appliances, heating, and power, or any combination thereof, including common use. This schedule is not applicable to residential customers, except for those three-phase residential customers taking service on this schedule as of April 12, 2007 who may remain on this schedule while service continues in their name at the same service address. Those three-phase
residential customers remaining on this schedule who choose to switch to a residential rate schedule may not return to this schedule. This schedule is not applicable to any customer whose Maximum Monthly Demand equals, exceeds, or is expected to equal or exceed 20 kW for 12 consecutive months. When demand metering is not available, the monthly consumption cannot equal or exceed 12,000 kWh per month for 12 consecutive months. This schedule is the utility's standard tariff for commercial customers with a demand less than 20 kW.

Rates Effective 01/01/2016:

Secondary customers who receive metered electric service after the voltage has been reduced from SDG&E's distribution level.

Basic Service Fee ($/Mth):

	Transm	Distr	PPP	ND	CTC	LGC	RS	TRAC	GHG	UDC Total
0-5 kW	0.00	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**7.00**
5-20 kW	0.00	12.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**12.00**
20-50 kW	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**20.00**
>50 kW	0.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**50.00**

Energy Charge ($/kWh):

	Transm	Distr	PPP	ND	CTC	LGC	RS	TRAC	GHG	UDC Total
Summer:	0.03077	0.07307	0.01609	0.00052	0.00186	0.00040	0.00014	0.00000	0.00000	**0.12285**
Winter:	0.03077	0.07307	0.01609	0.00052	0.00186	0.00040	0.00014	0.00000	0.00000	**0.12285**

Notes: Transmission Energy charges include the Transmission Revenue Balancing Account Adjustment (TRBAA) of $(0.00060) per kWh and the Transmission Access Charge Balancing Account Adjustment (TACBAA) of $(0.01359) per kWh. PPP rate is composed of: Low Income PPP rate (LI-PPP) $0.00709 /kWh, Non-low Income PPP rate (Non-LI-PPP) $0.00061 /kWh (pursuant to PU Code Section 399.8, the Non-LI-PPP rate may not exceed January 1, 2000 levels), and Procurement Energy Efficiency Surcharge Rate of $0.00811/kWh.

Commodity Rates - EECC ($/kWh): (Eff. 01/01/2016)

Summer:	0.11707	**Winter:**	0.06051

The Electric Energy Commodity Cost known as the EECC price that is passed through to customers who purchase their commodity from SDG&E is not included in the above UDC rates.

DWR Credit - $/kWh:	(0.00021)

Dept. of Water Resources Bond Charge (DWR-BC): (Eff. 01/01/2016)

Energy Rate - $/kWh:	0.00539

This schedule is applicable to all electric commodity customers, excluding customers receiving discounts under the California Alternate Rates for Energy (CARE) Program and customers receiving a medical baseline allowance.

Commercial questions? Please contact our Business Contact Center at 1-800-336-7343

Commercial Gas Rates

SOUTHERN CALIFORNIA GAS COMPANY Revised CAL. P.U.C. SHEET NO. 46445-G
LOS ANGELES, CALIFORNIA CANCELING Revised CAL. P.U.C. SHEET NO. 46215-G
43002-G

Schedule No. G-10 Sheet 1

CORE COMMERCIAL AND INDUSTRIAL SERVICE
(Includes GN-10, GN-10C and GT-10 Rates)

APPLICABILITY

Applicable to core non-residential natural gas service, including both procurement service (GN rates) and transportation-only service (GT rates) including Core Aggregation Transportation (CAT). This schedule is also available to residential customers with separately metered service to common facilities (swimming pools, recreation rooms, saunas, spas, etc.) only and otherwise eligible for service under rates designated for GM-C, GM-CC, GM-BC, GM-BCC, GT-MC or GT-MBC, as appropriate, if so elected by the customer. Also applicable to service not provided under any other rate schedule. Pursuant to D.02-08-065, this schedule is not available to those electric generation, refinery, and enhanced oil recovery customers that are defined as ineligible for core service in Rule No. 23.B.

The California Alternate Rates for Energy (CARE) discount of 20%, reflected as a separate line item on the bill, is applicable to Nonprofit Group Living Facilities and Qualified Agricultural Employee Housing Facilities (migrant farmworker housing centers, privately owned employee housing, and agricultural employee housing operated by nonprofit entities) that meet the requirements for the CARE as set forth in Schedule No. G-CARE.

TERRITORY

Applicable throughout the service territory.

RATES

Customer Charge

Per meter, per day:

All customers except "Space Heating Only"	49.315¢
"Space Heating Only" customers:	
Beginning Dec. 1 through Mar. 31	$1.48760
Beginning Apr. 1 through Nov. 30	None

(Continued)

(TO BE INSERTED BY UTILITY)	ISSUED BY	(TO BE INSERTED BY CAL. PUC)
ADVICE LETTER NO. 4152	**Lee Schavrien**	DATE FILED Sep 30, 2010
DECISION NO. 98-07-068	Senior Vice President	EFFECTIVE Oct 1, 2010
1C11	Regulatory Affairs	RESOLUTION NO.

SOUTHERN CALIFORNIA GAS COMPANY Revised CAL. P.U.C. SHEET NO. 55640-G
LOS ANGELES, CALIFORNIA CANCELING Revised CAL. P.U.C. SHEET NO. 55608-G

Schedule No. G-10 Sheet 2
CORE COMMERCIAL AND INDUSTRIAL SERVICE
(Includes GN-10, GN-10C and GT-10 Rates)
(Continued)

RATES (Continued)

All Procurement, Transmission, and Commodity Charges are billed per therm.

			Tier I[1]	Tier II[1]	Tier III[1]	
GN-10:[6]	Applicable to natural gas procurement service to non-residential core customers, including service not provided under any other rate schedule.					
	Procurement Charge:[2]	G-CPNR	35.980¢	35.980¢	35.980¢	
	Transmission Charge:	GPT-10	55.413¢	30.219¢	13.327¢	
	Commodity Charge:	GN-10	91.393¢	66.199¢	49.307¢	
GN-10C[6]:	Core procurement service for previous non-residential transportation-only customers returning to core procurement service, including CAT customers with annual consumption over 50,000 therms, as further defined in Schedule No. G-CP.					
	Procurement Charge:[2]	G-CPNRC	35.980¢	35.980¢	35.980¢	I,I,I
	Transmission Charge:	GPT-10	55.413¢	30.219¢	13.327¢	
	Commodity Charge:	GN-10C	91.393¢	66.199¢	49.307¢	I,I,I
GT-10[4/6]:	Applicable to non-residential transportation-only service including CAT service, as set forth in Special Condition 13.					
	Transmission Charge:	GT-10	55.563¢[3]	30.369¢[3]	13.477¢[3]	

[1] Tier I rates are applicable for the first 250 therms used per month. Tier II rates are applicable for usage above Tier I quantities and up through 4,167 therms per month. Tier III rates are applicable for all usage above 4,167 therms per month. Under this schedule, the winter season shall be defined as December 1 through March 31 and the summer season as April 1 through November 30.

[2] This charge is applicable for service to Utility Procurement Customers as shown in Schedule No. G-CP, in the manner approved by D.96-08-037, and subject to change monthly, as set forth in Special Condition 5.

[3] These charges are equal to the core commodity rate less the following two components as approved in D.97-04-082: (1) the weighted average cost of gas; and (2) the core brokerage fee.

[4] CAT Transmission Charges include a 0.150 cents per therm debit to amortize an undercollection in the FERC Settlement Proceeds Memorandum Account during 2018 as authorized in Advice No. 5202 approved on December 18, 2017.

(Footnotes continue next page.)

(Continued)

(TO BE INSERTED BY UTILITY)	ISSUED BY	(TO BE INSERTED BY CAL. PUC)
ADVICE LETTER NO. 5379	**Dan Skopec**	SUBMITTED Nov 8, 2018
DECISION NO.	Vice President	EFFECTIVE Nov 10, 2018
2C5	Regulatory Affairs	RESOLUTION NO. G-3351

Pacific Gas and Electric Company
U 39 San Francisco, California

	Revised	Cal. P.U.C. Sheet No.	34596-G
Cancelling	Revised	Cal. P.U.C. Sheet No.	34553-G

GAS SCHEDULE G-NR1 Sheet 2
GAS SERVICE TO SMALL COMMERCIAL CUSTOMERS

RATES (CON'T):

	ADU (Therms)				
	0 – 5.0	5.1 to 16.0	16.1 to 41.0	41.1 to 123.0	123.1 & Up
Customer Charge: (per day)	$0.27048	$0.52106	$0.95482	$1.66489	$2.14936

Per Therm

	Summer				Winter			
	First 4,000 Therms		Excess		First 4,000 Therms		Excess	
Procurement Charge:	$0.33687	(I)	$0.33687	(I)	$0.33687	(I)	$0.33687	(I)
Transportation Charge:	$0.65673		$0.40291		$0.77013		$0.47248	
Total:	$0.99360	(I)	$0.73978	(I)	$1.10700	(I)	$0.80935	(I)

Cap-and-Trade Cost Exemption (per therm): $0.02600

The Cap-and-Trade Cost Exemption is applicable to customers who are identified by the California Air Resources Board (CARB) as being Covered Entities for their Greenhouse Gas (GHG) emissions as part of the Cap-and-Trade program. Applicable Cap-and-Trade Cost Exemptions may be provided from the date CARB identifies a customer as as being a Covered Entity, or provided based upon documentation satisfactory to the Utility for the time period for which the customer was a Covered Entity, whichever is earlier.

Public Purpose Program Charge: Customers served under this schedule are subject to a gas Public Purpose Program (PPP) Surcharge under Schedule G-PPPS.

See Preliminary Statement, Part B for the Default Tariff Rate Components.

The Procurement Charge on this schedule is equivalent to the rate shown on informational Schedule GCP—
Gas Procurement Service to Core End-Use Customers.

SEASONS: The Summer Season begins April 1 and ends on October 31. The Winter Season begins November 1 and ends on March 31.

CARE DISCOUNT FOR QUALIFIED FACILITIES: Facilities which meet the eligibility criteria in Rules 19.2 or 19.3 are eligible for a California Alternate Rates for Energy (CARE) Discount under Schedule G-CARE.

(Continued)

Advice	4034-G	*Issued by*	*Submitted*	October 25, 2018
Decision	97-10-065 and D.98-07-025	***Robert S. Kenney***	*Effective*	November 1, 2018
		Vice President, Regulatory Affairs	*Resolution*	

San Diego Gas & Electric Company
San Diego, California

	Revised	Cal. P.U.C. Sheet No.	18445-G
Canceling	Revised	Cal. P.U.C. Sheet No.	18058-G

SCHEDULE GN-3

Sheet 1

NATURAL GAS SERVICE FOR CORE NON-RESIDENTIAL CUSTOMERS
(Includes Rates for GN-3, GN-3C, GN-3/GTC and GN-3/GTCA)

APPLICABILITY

Applicable to core nonresidential natural gas service, including both procurement service and transportation-only service including Core Aggregation Transportation (CAT). Also applicable to service not provided under any other rate schedule. This schedule is not available to electric generation customers who generator's rated capacity exceeds one megawatt, refinery customers, and enhanced oil recovery customers, whose gas consumption exceeds 250,000 therms per year.

The GN-3 rate is applicable to natural gas procurement and transportation service to nonresidential core customers and to separately metered, common area use service to residential detached homes. This schedule is optionally available to customers with separately metered, common area use service to residential, multi-family accommodations, as defined in Rule 1.

The GN-3C cross-over rate is a core procurement service for previous transportation-only customers returning to core procurement service customers with annual consumption over 50,000 therms, as set forth in Special Condition 8. T

The GN-3/GTC (GTC) and GN-3/GTCA (GTCA) rates are applicable to intrastate gas transportation-only N
services as set forth in Special Conditions 9-14. T

Non-profit group living facilities taking service under this schedule may be eligible for a 20% low-income rate discount on their bill, if such facilities qualify to receive service under the terms and conditions of Schedule G-CARE.

Agricultural Employee Housing Facilities, as defined in Schedule G-CARE, may qualify for a 20% CARE discount on the bill if all eligibility criteria set forth in Form 142-4032 or Form 142-4035 is met.

TERRITORY

Within the entire territory served natural gas by the Utility.

RATES	GN-3	GN-3-C	GTC/GTCA
Customer charges, $ per meter per month:	$10.00	$10.00	$10.00

D

(Continued)

1C11	Issued by	Date Filed	Oct 15, 2010
Advice Ltr. No. 1980-G	**Lee Schavrien**	Effective	Nov 14, 2010
Decision No.	Senior Vice President Regulatory Affairs	Resolution No.	

SDGE
San Diego Gas & Electric Company
San Diego, California

	Revised	Cal. P.U.C. Sheet No.	23517-G
Canceling	Revised	Cal. P.U.C. Sheet No.	23504-G

SCHEDULE GN-3

Sheet 2

NATURAL GAS SERVICE FOR CORE NON-RESIDENTIAL CUSTOMERS
(Includes Rates for GN-3, GN-3C, GN-3/GTC and GN-3/GTCA)

RATES (continued)

Volumetric charges, $ per therm:

	GN-3	GN-3C		GTC/GTCA[2]
Procurement Charge (0 to 1,000)	$0.36001	$0.36001	I	N/A
Transportation Charge	$0.33296	$0.33296		$0.33296
Total Charge	$0.69297	$0.69297	I	$0.33296
Procurement Charge (1,001 to 21,000	$0.36001	$0.36001	I	N/A
Transportation Charge	$0.20095	$0.20095		$0.20095
Total Charge	$0.56096	$0.56096	I	$0.20095
Procurement Charge (Over 21,000	$0.36001	$0.36001	I	N/A
Transportation Charge	$0.16366	$0.16366		$0.16366
Total Charge	$0.52367	$0.52367	I	$0.16366

[2] The rates for core transportation-only customers, with the exception of customers taking service under Schedule GT-NGV, include any FERC Settlement Proceeds Memorandum Account (FSPMA) credit adjustments.

Standby Service Fee for GTC/GTCA Customers
Per decatherm $10

This fee shall be assessed to customers only during curtailments of transportation services to firm noncore customers. This fee will apply only to the difference between the customer's nominations and their confirmed deliveries.

The customer's storage volumes, if available, may be used to offset the standby service fee. Revenues collected from this fee shall be credited to the Utility's Non-Margin Fixed Cost Account (NMFCA). Curtailments of standby services provided to core customers are described in Rule 14.

GTC/GTCA customers who receive service under this schedule shall also be eligible for standby services ahead of such services offered to noncore customers, including core subscription customers.

Billing adjustments may be necessary to reflect changes in volumes used in developing prior periods' transportation charges.

(Continued)

2C5

Advice Ltr. No. 2719-G	Issued by	Submitted	Nov 8, 2018
	Dan Skopec	Effective	Nov 10, 2018
Decision No.	Vice President Regulatory Affairs	Resolution No.	

Appendix D – Water and Wastewater Rates

Water rates vary significantly across the state of California and even within individual building climate zones. The 2018 potable water rates used in the analysis are based on residential water rate data from a Black & Veatch study that includes the eight largest cities in California (Black & Veatch 2016). This data was weighted by the number of single family homes in each city based on data from the California Department of Finance (2018). About 30 percent of Californians live in one of the eight cities, and the consultants authoring this report assumed that rates for these cities are representative of rates throughout the state. It was assumed that a typical customer with irrigation uses 11,000 gallons per month as a baseline (Aquacraft 2011b) and the 7,500–15,000 gallons per month rate tier would apply to water saved by this measure. The estimate only considers the variable portion of the residential potable water bill and does not include fixed charges that occur regardless of the amount of water consumption. Costs in 2016 were escalated to 2018 rates using Black & Veatch annual increases. The commercial rates are based on data from the 2008 American Water Works Association Water and Wastewater Survey using values from the western region, converted to $2018 (Raftelis 2008).

To determine the statewide average wastewater rates, average volumetric residential wastewater rates of $6.44 per 1,000 gallons were calculated based on the data for the four California cities that were listed with volumetric (volume-related) wastewater (Black & Veatch 2016). Thirty percent of California residents pay a volumetric wastewater rate, which is typically linked to the potable water meter (Chesnutt 2011). The average wastewater rate in cities were multiplied with volumetric rates (assuming the same baseline water usage noted above) by 0.30 resulting in an average statewide residential volumetric wastewater cost of $1.54 per 1,000 gallons for 2018.[7] The 2009 commercial wastewater rates were derived from cost data that assumes customers use 100,000 gallons per month and converted to $2018. The 2009 rates were used because they were readily available to the authors of this report.

Recycled water rates are assumed to be 90 percent of potable rates based on common non-tiered pricing structure for both northern and southern California water agencies (NBS 2016).

Table 27 lists the estimated water costs to consumers in each city and the number of single family houses in each city in 2016 dollars from Black & Veatch. No potable water or wastewater rate escalation past 2018 is assumed (conservative assumption).

Table 27: Residential Water and Wastewater Costs (in $2016)

	Fresno	Long Beach	Los Angeles	Oakland	Sacramento	San Diego	San Francisco	San Jose
Number of single family detached homes	105,031	74,394	557,495	73,991	113,494	237,084	65,783	175,614
Incremental residential water cost ($/1000gal)	$1.81	$4.84	$7.48	$6.92	$0.00	$9.01	$11.76	$2.24
Incremental residential wastewater cost ($/1000gal)	$0.00	$0.53	$5.05	$0.00	$0.53	$5.08	$14.80	$0.00

[7] Wasted irrigation water, about 50 percent of flow rate for spray sprinkler bodies (AWE 2016), may be lost to runoff to sanitary sewers, storm sewers, surface water, or deep percolation. The cost avoided from reduced runoff to sanitary sewers and stormwater collection systems or surface waters were not quantified in this analysis because the Energy Commission determines cost-effectiveness from a consumer cost perspective.

Appendix E – Embedded Electricity Usage Methodology

The following embedded electricity in water values were used in this analysis: 4,848 kilowatts (kWh)/million gallons of water (MG) for indoor water use and 3,565 kWh/MG for outdoor water use. Embedded electricity use for indoor water use includes electricity used for water extraction, conveyance, treatment to potable quality, water distribution, wastewater collection, and wastewater treatment. Embedded electricity for outdoor water use includes all energy uses upstream of the customer; it does not include wastewater collection or wastewater treatment. The embedded electricity values do not include on-site energy uses for water such as on-site pumping. On-site energy impacts are accounted for in the energy savings estimates presented in this report.

These embedded electricity values were derived from research conducted for CPUC Rulemaking 13-12-011 (CPUC 2013). The CPUC study aimed to quantify the embedded electricity savings associated with IOU incentive programs that result in water savings, and the findings represent the most up-to-date research by CPUC on embedded energy in water throughout California (CPUC 2015a, 2015b). The CPUC analysis was limited to evaluating the embedded electricity in water and does not include embedded natural gas in water. Since accurate estimates of the embedded natural gas in water were not available at the time of writing, this report does not include estimates of embedded natural gas savings associated with water reductions.

The CPUC embedded electricity values used in the report are shown in Table 28 in units of kWh per acre-foot (AF). These values represent the average energy intensity by hydrologic region, which are based on the historical supply mix for each region regardless of who supplied the electricity (IOU supplied and non-IOU supplied). The CPUC calculated the energy intensity of marginal supply but recommended using the average IOU and non-IOU energy intensity to estimate total statewide average embedded electricity of water use in California.

Table 28: Embedded Electricity in Water by DWR Hydrologic Region

Hydrologic Region	Extraction, Conveyance, and Treatment (kWh/AF)	Distribution (kWh/AF)	Wastewater Collection and Treatment (kWh/AF)	Outdoor (Upstream of Customer) (kWh/AF)	Indoor (All Components) (kWh/AF)
North Coast	235	163	418	398	816
San Francisco Bay	375	318	418	693	1,111
Central Coast	513	163	418	677	1,095
South Coast	1,774	163	418	1,937	2,355
Sacramento River	238	18	418	255	674
San Joaquin River	279	18	418	297	715
Tulare Lake	381	18	418	399	817
North Lahontan	285	18	418	303	721
South Lahontan	837	163	418	1,000	1,418
Colorado River	278	18	418	296	714

Source: CPUC 2015b.

CPUC indoor and outdoor embedded electricity estimates by hydrologic region and population data from the U.S. Census Bureau (separated by hydrologic region) were used to calculate the statewide population-weighted average indoor and outdoor embedded electricity values that were used in this report (see Table 29). The energy intensity values presented in Table 29 were converted from kWh per

AF to kWh per MG to harmonize with the units used in this report. There are 3.07 acre-feet per million gallons.

Table 29: Statewide Population-Weighted Average Embedded Electricity in Water

Hydrologic Region	Outdoor Water Use (kWh/MG)[a]	Indoor Water Use (kWh/MG)[b]	Percent of California Population[c]
North Coast	1,221	2,504	2.1%
San Francisco Bay	2,127	3,410	18.2%
Central Coast	2,078	3,360	3.8%
South Coast	5,944	7,227	44.8%
Sacramento River	783	2,068	8.1%
San Joaquin River	911	2,194	4.7%
Tulare Lake	1,224	2,507	6.3%
North Lahontan	930	2,213	0.1%
South Lahontan	3,069	4,352	5.5%
Colorado River	908	2,191	6.5%
Statewide Population-weighted Average	**3,565**	**4,848**	

[a,b] Source: CPUC 2015b.

[c] Source: U.S. Census Bureau 2014 and California Department of Conservation 2007.