



**eTRM**  
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**SERVICE & DOMESTIC HOT WATER**  
**TEMPERATURE-INITIATED SHOWER FLOW**  
**RESTRICTION VALVE WITH AND WITHOUT AN**  
**INTEGRATED LOW-FLOW SHOWERHEAD**  
SWWH003-01

**C O N T E N T S**

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## MEASURE NAME

TSV with and without an Integrated Low-Flow Showerhead, Residential

## STATEWIDE MEASURE ID

SWWH003-01

## TECHNOLOGY SUMMARY

This measure is defined as a temperature-initiated shower flow restriction valve, also referred to as a thermostatic shower valve (TSV), with or without the installation of an integrated low-flow showerhead.

**A temperature-initiated flow-restriction valve** is installed at the showerhead. The valve is initially open and allows cold water that has been sitting in the pipes to flow through the showerhead. When the water temperature reaches approximately 95 °F, the valve restricts the water flow to a trickle until the user enters the shower and switches the valve open again to restore full flow.

“Behavioral waste” occurs when the user turns on the hot water but does not enter the shower until a period of time after the water output at the showerhead is the desired temperature. The purpose of a TSV is to reduce the amount of hot water running down the drain during this “pre-shower” warm-up period. By preventing hot water from unnecessarily running down the drain before a shower begins, this device reduces water heater energy consumption.

**A low-flow showerhead** is inexpensive and easy to install. Since about 73% of water used in a typical shower is hot water, reducing hot water usage will save energy because there is less water to be heated. As a result, the water heater will use less energy, creating an opportunity for savings.<sup>1</sup>

## MEASURE CASE DESCRIPTION

The measure case is defined as the installation of a thermostatic shower valve (TSV) without a low-flow showerhead and a TSV installed with a low-flow showerhead. The measure offerings (and therefore energy savings) vary by flow rate (gpm), household type (single family, multifamily, or mobile home), climate zone, and installation type.

### Measure Case Specification

| Measure Offering             | Showerhead Flow Rate (gpm) |
|------------------------------|----------------------------|
| TSV only                     | 2.25                       |
| TSV with Low-flow Showerhead | 1.00                       |
|                              | 1.25                       |
|                              | 1.50                       |
|                              | 1.60                       |
|                              | 1.70                       |

<sup>1</sup> U.S. Department of Energy (DOE). (n.d.) “Reduce Hot Water Use for Energy Savings.”

## BASE CASE DESCRIPTION

The base case is defined as a showerhead with no flow restriction valve installed. The table below specifies the base case scenarios with showerhead flow rates that depend upon the installation type. The 2.25 gpm flow rate is based on a 2009 field study of residential households in Southern California that measured the flow rate of existing showerheads; the base case flow rate is the average of data obtained from this survey. This flow rate is utilized in the California Public Utilities Commission (CPUC) Energy Division “Workpaper Disposition for Water Fixtures” issued in 2013.<sup>2</sup>

### Base Case Specification

| Base Case            | Installation Type                     | Max. Showerhead Flow Rate (gpm) | Source   |
|----------------------|---------------------------------------|---------------------------------|--|
| Showerhead w/ no TSV | Accelerated replacement               | 2.25                            | Sempra Energy Utilities (SEU). 2012. “SEU 2009 ASW Data REDACTED.xlsx”.  |
|                      |                                       | 1.80                            | California Energy Commission (CEC). 2014. <i>2014 Appliance Efficiency Regulations</i> . CEC-400-2014-009-CMF. |
|                      | Normal replacement & New construction | 1.80                            | California Energy Commission (CEC). 2014. <i>2014 Appliance Efficiency Regulations</i> . CEC-400-2014-009-CMF. |
|                      | Add-on equipment                      | 2.25                            | Sempra Energy Utilities (SEU). 2012. “SEU 2009 ASW Data REDACTED.xlsx”.  |

## CODE REQUIREMENTS

There are no existing federal or state code requirements for thermostatic shower valves (TSVs). Applicable state and federal codes and standards for showerheads are specified below. The low-flow showerhead maximum flow rate was originally mandated by the Energy Policy Act of 1992.<sup>3</sup> The California Appliance Efficiency Regulations (Title 20)<sup>4</sup> (originally effective in 1994) met the federal code and have exceeded it in subsequent updates.

### Applicable State and Federal Codes and Standards for Showerheads

| Code  | Applicable Code Reference   | Effective Date  |
|---|---|---|
| CA Appliance Efficiency Regulations – Title 20 (2016) | Section 1605.3, Table H-5: The maximum flow rate of a showerhead shall not be greater than 2.5 gpm at 80 psi. | Units manufactured on or after January 1, 1994 and prior to July 1, 2016. |
|   | Section 1605.3, Table H-5: The maximum flow rate of a showerhead shall not be greater than 2.0 gpm at 80 psi. | Units manufactured on or after July 1, 2016 and prior to July 1, 2018.    |
|   | Section 1605.3, Table H-5: The maximum flow rate of a showerhead shall not be greater than 1.8 gpm at 80 psi. | Units manufactured on or after July 1, 2018.                              |

<sup>2</sup> California Public Utilities Commission (CPUC), Energy Division. 2013. “Workpaper Disposition for Water Fixtures.” February 22.

<sup>3</sup> H.R.776 – 102nd Congress. Energy Policy Act of 1992. Pub. L. 102-486. Stat. 2776.

<sup>4</sup> California Energy Commission (CEC). 2017. *2016 Appliance Efficiency Regulations*. CEC-400-2017-002. Section 1605.3, Table H-5.

| Code  | Applicable Code Reference                  | Effective Date                                 |
|---|--|--|
| Federal Standards (Federal Energy Policy Act of 1992) | Showerheads must use no more than 2.5 gpm. | Units manufactured on or after January 1, 1994 |

The Energy Division of the California Public Utilities Commission (CPUC) issued the “Workpaper Disposition for Water Fixtures” in 2013 that mandated the revision of daily hot water consumption to a baseline of 28.0 gallons per day for single-family homes and 23.3 gallons per day for multifamily dwellings.<sup>5</sup> These baselines are based upon the National Renewable Energy Laboratory (NREL) Building America House Simulation Protocols.<sup>6</sup>

## NORMALIZING UNIT

Thermostatic shower valve (each).

## PROGRAM REQUIREMENTS

### *Measure Implementation Eligibility*

All combinations of measure application type, delivery type, and sector that are established for this measure are specified below. Measure application type is a categorization based on the circumstances and timing of the measure installation; each measure application type is distinguished by its baseline determination, cost basis, eligibility, and documentation requirements. Delivery type is the broad categorization of the delivery channel through which the market intervention strategy (financial incentives or other services) is targeted. This table also designates the broad market sector(s) that are applicable for this measure.

*Note that some of the implementation combinations below may not be allowed for some measure offerings by all program administrators.*

### Implementation Eligibility

| Measure Application Type | Delivery Type | Sector |
|--------------------------|---------------|--------|
| Accelerated replacement  | DnDeemDI      | Res    |
| Accelerated replacement  | DnDeemed      | Res    |
| Accelerated replacement  | UpDeemed      | Res    |
| Normal replacement       | UpDeemed      | Res    |
| Normal replacement       | DnDeemDI      | Res    |
| Normal replacement       | DnDeemed      | Res    |
| New construction         | DnDeemDI      | Res    |

<sup>5</sup> California Public Utilities Commission (CPUC), Energy Division. 2013. “Workpaper Disposition for Water Fixtures.” February 22.

<sup>6</sup> Henron, H. and C. Engebrecht. 2010. *Building America House Simulation Protocols*. Prepared for the U.S. Department of Energy Building Technologies Program. Golden, CO: National Renewable Energy Laboratory (NREL). NREL Report Number TP-550-49426.

| Measure Application Type | Delivery Type | Sector |
|--------------------------|---------------|--------|
| New construction         | DnDeemed      | Res    |
| New construction         | UpDeemed      | Res    |
| Add-on equipment         | DnDeemed      | Res    |
| Add-on equipment         | UpDeemed      | Res    |
| Add-on equipment         | DnDeemDI      | Res    |

### *Eligible Products*

*Thermostatic shower valve (TSV):* Any TSV certified by applicable standards (e.g., ANSI, ASPE, etc.) is eligible.

*Low-Flow Showerhead:* The low-flow showerhead must meet the measure case requirements provided in the Measure Case Description.

The make and model number must be included with a copy of the customer receipt.

### *Eligible Building Types*

This measure is applicable in all existing California residential households of any vintage, including single-family, multifamily, and mobile homes.

### *Eligible Climate Zones*

This measure is applicable in all California climate zones.

## PROGRAM EXCLUSIONS

This measure is not applicable where recirculation pumps are used or where potential crossover between hot water and cold water may occur.

The measure is not applicable where tankless water heaters are used; instantaneous tankless water heaters may have different effect on savings with temperature-initiated flow-restriction valves.

The measure is not applicable where the showerhead is installed in tub/shower combination systems. (However, note that a gross savings installation adjustment (GSIA) factor has been added to allow for expected leakage. See Gross Savings Installation Adjustment.)

## DATA COLLECTION REQUIREMENTS

Data collection requirements are to be determined.

## USE CATEGORY

Service & Domestic Hot Water

## ELECTRIC SAVINGS (kWh)

This section explains the methodology for calculating the electric (UES) unit energy savings of a thermostatic shower valve (TSV) alone and a TSV with a low-flow showerhead. As per the Workpaper Disposition for Water Fixtures issued by the Energy Division of the California Public Utilities Commission (CPUC) in 2013,<sup>7</sup> the UES of a TSV with a low-flow showerhead is equal to the sum of the UES of each individual device, as presented below.

### Low-Flow Showerhead Electric Savings (kWh)

The electric UES from the installation of a low-flow showerhead is determined by the reduction of hot water usage and the corresponding reduction in energy consumption required to heat water for showers. As shown below, the electric UES is derived from the gas UES, the ratio of the recovery efficiency of a gas water heater to that an electric water heater, and a therm-to-kWh conversion factor.

$$UES_{kWh,showerhead} = UES_{therms,showerhead} \times \frac{EFF_{gas}}{EFF_{elec}} \times \frac{100,000 \text{ BTU}}{\text{therms}} \times \frac{kWh}{3,413 \text{ BTU}}$$

$UES_{kWh} =$  Annual electric unit energy savings of showerhead (kWh/year)  
 $UES_{therms} =$  Annual gas unit energy savings of showerhead (therms/year)  
 $EFF_{gas} =$  Min. water heater efficiency (recovery efficiency), gas  
 $EFF_{elec} =$  Min. water heater efficiency (recovery efficiency), electric

Refer to the Gas Savings section for the derivation of the gas UES. All other inputs used for this calculation are specified in the following table.

#### Electric UES Calculation Constants – Low-flow Showerhead

| Energy Savings Inputs / Constants                           | Units    | Value        | Source   |
|---|----------|--------------|--|
| Gas Unit Energy Savings                                     | Therms   | Varies by CZ | See Gas Savings section.   |
| Gas Water Heater Min. Efficiency (recovery efficiency)      | unitless | 0.77         | Southern California Gas Company (SCG). 2010. "Gas Fired Storage Water Heater Extract from CEC Appliance Data 07.07.2010.xlsx."<br><br>California Public Utilities Commission (CPUC), Energy Division. 2010. <i>Non-DEER Measure Review Template: PGECODHW113 – Low Flow Showerhead and Thermostatic Shower Restriction Valve</i> . April 27. |
| Electric Water Heater Min. Efficiency (recovery efficiency) | unitless | 0.98         | California Energy Commission (CEC). 2014. <i>2014 Appliance Efficiency Regulations</i> . CEC-400-2014-009-CMF. Section 1604.   |

<sup>7</sup> California Public Utilities Commission (CPUC), Energy Division. 2013. "Workpaper Disposition for Water Fixtures." February 22.

**Recovery Efficiency:** To convert the water heating load to electric energy use at the water heater, the recovery efficiency (RE) is used. Recovery efficiency is a measure of how efficiently the heat from the energy source is transferred to the water (the ratio of energy output used to heat the water divided by energy input).

### TSV Electric Savings (kWh)

The electric UES from the installation of a TSV is determined by the reduction of hot water usage and the corresponding reduction in energy consumption required to heat water for showers. As shown below, the electric UES is derived from the gas UES, the ratio of the recovery efficiency of a gas water heater to that an electric water heater, and a therm-to-kWh conversion factor.

$$UES_{kWh,TSV} = UES_{therms,TSV} \times \frac{EFF_{gas}}{EFF_{elec}} \times \frac{100,000 \text{ kWh}}{3,413 \text{ therms}}$$

$UES_{kWh, TSV} =$  Annual electric unit energy savings of TSV (kWh/yr)  
 $UES_{therms} =$  Annual gas unit energy savings of TSV (therms/yr)  
 $EFF_{gas} =$  Min. water heater efficiency (recovery efficiency), gas  
 $EFF_{elec} =$  Min. water heater efficiency (recovery efficiency), electric

Refer to the Gas Savings section for the derivation of the gas UES. All other inputs used for this calculation are presented below.

#### Electric UES Calculation Constants - TSV

| Energy Savings Inputs / Constants                           | Units    | Value        | Source   |
|---|----------|--------------|--|
| Gas Unit Energy Savings                                     | Therms   | Varies by CZ | See Gas Savings section.   |
| Gas Water Heater Min. Efficiency (recovery efficiency)      | unitless | 0.77         | Southern California Gas Company (SCG). 2010. "Gas Fired Storage Water Heater Extract from CEC Appliance Data 07.07.2010.xlsx."<br><br>California Public Utilities Commission (CPUC), Energy Division. 2010. <i>Non-DEER Measure Review Template: PGECODHW113 – Low Flow Showerhead and Thermostatic Shower Restriction Valve</i> . April 27. |
| Electric Water Heater Min. Efficiency (recovery efficiency) | unitless | 0.98         | California Energy Commission (CEC). 2014. <i>2014 Appliance Efficiency Regulations</i> . CEC-400-2014-009-CMF. Section 1604.   |

**Recovery Efficiency:** To convert the water heating load to electric energy use at the water heater, the recovery efficiency (RE) is used. Recovery efficiency is a measure of how efficiently the heat from the energy source is transferred to the water (the ratio of energy output used to heat the water divided by energy input).

## PEAK ELECTRIC DEMAND REDUCTION (kW)

Peak demand reduction is calculated as a function of the electric UES, a peak period usage factor, and the operating hours per year. The peak period usage factor (PPUF) – similar in concept to a coincident demand factor (CDF) – reflects the percent of hot water usage during the designated peak demand period.

$$kW_{reduction} = \frac{UES_{kWh} \times PPUF}{(DAYS \times PEAKHRS)}$$

$UES_{kWh}$  = Annual electric unit energy savings (kWh/yr)

$PPUF$  = Peak period usage factor

$DAYS$  = Operating days per year (days)

$PEAKHRS$  = Peak hours per day

### Peak Demand Reduction Parameters

| Parameter                       | Value | Source   |
|---------------------------------|-------|--|
| Peak Period Usage Factor (PPUF) | 0.37  | Southern California Edison (SCE). 2019. "Water Heater - Electric Peak Usage Factor adjustment to new TOU.xlsx" |
| Operating days per year         | 365   | Professional judgement   |
| Peak hours per day              | 5     | California Public Utilities Commission (CPUC). 2018. <i>Resolution E-4952</i> . October 11. Op 1.              |

## GAS SAVINGS (Therms)

This section explains the methodology for calculating the gas unit energy savings (UES) of a TSV alone and a TSV with a low-flow showerhead. As per the Workpaper Disposition for Water Fixtures issued by the Energy Division of the California Public Utilities Commission (CPUC) in 2013,<sup>8</sup> the energy savings of a TSV with a low-flow showerhead is equal to the sum of the savings of each individual device, each of which is provided below.

### Low-Flow Showerhead Gas Energy Savings (Therms)

The gas UES of this measure is based upon the estimated decrease in hot water usage as a result of the installation of a low-flow showerhead. The calculation of water savings and gas energy savings are explained below.

#### *Calculation of Water Usage and Water Savings of Low-Flow Showerhead*

The calculation of water savings due to the installation of a low-flow showerhead is shown below. Annual water savings is calculated as the difference between the estimated base case and measure case annual water usage.

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<sup>8</sup> California Public Utilities Commission (CPUC), Energy Division. 2013. "Workpaper Disposition for Water Fixtures." February 22.

Annual water usage is a function of the showerhead flow rate (gpm), the average duration of each shower, the average number of showers taken per day per household, and the average number of showerheads per household. This calculation also includes a throttling factor which is a constant that represents the assumed actual water pressure as a portion of full pressure (80 psi). The annual water use calculation also includes a baseline water usage normalization factor, which adjusts the estimated water consumption to account for a change in the baseline hot water consumption as per the Water Fixture Disposition issued by the Energy Division of the California Public Utilities Commission (CPUC) in 2013.<sup>9</sup>

$$WS_{\text{showerhead}} = WU_{\text{base}} - WU_{\text{measure}}$$

$$WU = \frac{\text{FlowRate} \times F \times \text{Min} \times \text{Days} \times Q\text{Shwr}}{N} \times G$$

- WS<sub>showerhead</sub>* = Annual water savings (gal/yr) for low-flow showerhead
- WU* = Annual water use (gal/yr), for base or measure case
- FlowRate* = Showerhead water flow rate (gpm) for base or measure case fixtures
- F* = Throttling factor (%)
- Min* = Average shower time (min/day)
- QShwr* = Number of showers per household per day
- Days* = Shower days of operation (days/yr)
- N* = Number of showerheads per household, SF or MF
- G* = Baseline water usage normalization factor

The inputs to calculate base case and measure case water usage are provided in the following tables. Note that this measure is applicable for single family, multifamily, and mobile home installations. Due to lack of data on mobile home water usage, particularly at the fixture type level (showerhead, faucet), the mobile home water usage and savings calculations adopt the more conservative multifamily values.

**Base Case Water Usage Inputs**

| Parameter                              | Single Family | Multifamily / Mobile Home | Source  |
|--|---------------|---------------------------|---|
| Base Case Flow Rate – NR (gpm)         | 1.80          | 1.80                      | California Energy Commission (CEC). 2014. <i>2014 Appliance Efficiency Regulations</i> . CEC-400-2014-009-CMF.  |
| Base Case Flow Rate – AR and AOE (gpm) | 2.25          | 2.25                      | Sempra Energy Utilities (SEU). 2012. "SEU 2009 ASW Data REDACTED.xlsx".   |
| Average Shower Time (min/shower)       | 7.4           | 7.4                       | DeOreo, W., P. Mayer, and D. Lewis. 2000. <i>Seattle Home Water Conservation Study: The Impacts Of High Efficiency Plumbing Fixture Retrofits In Single-Family Homes</i> . Prepared for the Seattle Public Utilities and the U.S. Environmental Protection Agency. Boulder, CO: Aquacraft, Inc. Water Engineering and Management. |

<sup>9</sup> California Public Utilities Commission (CPUC), Energy Division. 2013. "Workpaper Disposition for Water Fixtures." February 22.

| Parameter  | Single Family | Multifamily / Mobile Home | Source  |
|--|---------------|---------------------------|---|
| Avg. # of Showers Taken per Day Per Household (showers/day/hh) | 2.79          | 2.22                      | Single Family:<br>Sempra Energy Utilities (SEU). 2012. "SEU 2009 ASW Data REDACTED.xlsx".<br><br>Multifamily:<br>KEMA-XENERGY, Itron, and RoperASW. 2004. <i>California Statewide Residential Appliance Saturation Study</i> . Prepared for the California Energy Commission. Contract No. 400-04-009. PG&E Banner Subset, Pages 100 and 102. |
| Avg. # of Showerheads per Household (showerheads/hh)           | 2.01          | 1.50                      | Single Family:<br>Sempra Energy Utilities (SEU). 2012. "SEU 2009 ASW Data REDACTED.xlsx".<br><br>Multifamily:<br>U.S. Census Bureau. (n.d.). "U.S. 2000 Census Bathrooms in NC MF Units.xls."   |
| Throttling Factor (%)  | 90%           | 90%                       | Biermayer, P. 2006. <i>Potential Water and Energy Savings from Showerheads</i> . Ernest Orlando Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division. Contract No. DE-AC02-05CH11231. P. 6.  |
| Operating Days (days/year)                                     | 365           | 365                       | Constant, professional judgement.   |
| Baseline Usage Normalization Factor                            | 0.670         | 0.702                     | See below.  |

#### Measure Case Water Usage Parameters – Single Family

| Parameter  | Single Family |       |       |       |       | Source                  |
|--|---------------|-------|-------|-------|-------|-------------------------|
| Measure Case Flow Rate (gpm)                                   | 1.00          | 1.25  | 1.50  | 1.60  | 1.70  | -                       |
| Average Shower Time (min/shower)                               | 7.4           | 7.4   | 7.4   | 7.4   | 7.4   | See below.              |
| Avg. # of Showers Taken per Day Per Household (showers/day/hh) | 2.79          | 2.79  | 2.79  | 2.79  | 2.79  | See below.              |
| Avg. # of Showerheads per Household (showerheads/hh)           | 2.01          | 2.01  | 2.01  | 2.01  | 2.01  | See below.              |
| Throttling Factor (%)  | 90%           | 90%   | 90%   | 90%   | 90%   | See below.              |
| Operating Days (days/year)                                     | 365           | 365   | 365   | 365   | 365   | Professional judgement. |
| Baseline Usage Normalization Factor                            | 0.670         | 0.670 | 0.670 | 0.670 | 0.670 | See below.              |

#### Measure Case Water Usage Parameters – Multifamily / Mobile Home

| Parameter  | Multifamily / Mobile Home |       |       |       |       | Source                  |
|--|---------------------------|-------|-------|-------|-------|-------------------------|
| Measure Case Flow Rate (gpm)                                   | 1.00                      | 1.25  | 1.50  | 1.60  | 1.70  | -                       |
| Average Shower Time (min/shower)                               | 7.4                       | 7.4   | 7.4   | 7.4   | 7.4   | See below.              |
| Avg. # of Showers Taken per Day Per Household (showers/day/hh) | 2.22                      | 2.22  | 2.22  | 2.22  | 2.22  | See below.              |
| Avg. # of Showerheads per Household (showerheads/hh)           | 1.50                      | 1.50  | 1.50  | 1.50  | 1.50  | See below.              |
| Throttling Factor (%)  | 90%                       | 90%   | 90%   | 90%   | 90%   | See below.              |
| Operating Days (days/year)                                     | 365                       | 365   | 365   | 365   | 365   | Professional judgement. |
| Baseline Usage Normalization Factor                            | 0.702                     | 0.702 | 0.702 | 0.702 | 0.702 | See below.              |

**Base Case Showerhead Flow Rate:** The baseline for normal replacement (NR) showerhead installations have a single baseline flow rate that complies with the Title 20 code effective on July 1, 2016. For accelerated replacement and add-on equipment installations, the first baseline flow rate was derived as the average of measured existing showerhead flow rates from a residential field survey in Southern California. The second baseline for accelerated replacement and add-on equipment installations complies with the Title 20 flow regulations effective on July 1, 2018.

**Measure Case Showerhead Flow Rate:** The mixed water flow rate for each of the measure case showerheads used in the water saving calculation.

**Average Shower Time per Day:** The average shower duration was derived from water trace data from ten single family homes in Seattle in 1999. A study of residential end use of water conducted for the AWWA Research Foundation found a similar result (a median of 7.2 minutes and a mean of 8.2 minutes).<sup>10</sup> Note that the average shower time in minutes per day is fixed and varies only by housing type. The assumption that the minutes per day a showerhead is used does not change between the base case and measure case scenarios means that a reduction in the showerhead flow rate will reduce water usage.

**Average Number of Showers per Day:** The average number of showers per day per single-family household was derived from the 2009 residential water fixture field study conducted in Southern California. The average number of showers per day per multifamily household was derived from the 2004 California Residential Appliance Saturation Study survey data.

**Number of Showerheads per Household.** The average number of showerheads per single-family household was derived from the 2009 residential water fixture field study conducted in Southern California. The average number of showerheads per multifamily household was calculated from U.S. Census 2000 data as the weighted average of the number of bathrooms in new construction homes the West Region from 1978 to 2006. This calculation assumes that each bathroom contains a shower or bath with one showerhead.

**Throttling Factor:** This factor adjusts the showerhead flow rate to account for pressures less than 80 psig, for limiting flow by throttling back (closing) the control valve to the shower, and to account for partial clogging due to debris in the pipe or from calcium deposits in areas with hard water contributes to this factor.

**Operating Days per Year.** This analysis assumes showerhead fixtures are in operation 365 days per year.

**Baseline Usage Normalization Factor:** The 2013 “Water Fixture Disposition” adopted the assumptions for baseline daily hot water (DHW) usage in the Database for Energy Efficient Resources (DEER). As per the 2013 Water Fixture Disposition, the “DEER values for daily hot water use by end use are developed by NREL for the Building America House Simulation Protocols” (p.3). The NREL baselines standardize the daily shower hot water usage for NR and AR measure installations to 28.01 and 23.3 gallons per day for single and multifamily, respectively.

The purpose of the normalization factor is to account for this change in assumed daily hot water baseline water usage from the daily usage derived from the residential field study to the usage adopted for DEER

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<sup>10</sup> Mayer, P. and W. DeOreo. 1999. *Residential End Uses of Water 1999, Subject Area: Water Resources*. Denver, CO: American Water Works Association (AWWA) Research Foundation. Page 99.

from the NREL study. The normalization factor is calculated as the ratio of daily hot water consumption derived from the NREL study to the daily hot water consumption calculated from the 2009 field study. The inputs for this calculation are explained below.

$$G = \frac{WU_{day\ DEER/NREL}}{WU_{day\ field\ study}}$$

**Baseline Usage Normalization Factor Parameters**

| Parameter   | Units      | Single Family | Multifamily / Mobile Home | Source   |
|---|------------|---------------|---------------------------|--|
| Shower<br>gpd/household<br>(DEER assumption/<br>NREL) | gal/day/hh | 28.01         | 23.34                     | Henron, H. and C. Engebrecht. 2010. <i>Building America House Simulation Protocols</i> . Prepared for the U.S. Department of Energy Building Technologies Program. Golden, CO: National Renewable Energy Laboratory (NREL). NREL Report Number TP-550-49426.<br><br>California Public Utilities Commission (CPUC), Energy Division. 2013. "Workpaper Disposition for Water Fixtures." February 22. |
| Shower<br>gpd/household                               | gal/day/hh | 48.81         | 33.27                     | Sempra Energy Utilities (SEU). 2012. "SEU 2009 ASW Data REDACTED.xlsx".  |

*Calculation of Gas Unit Energy Savings from Low-Flow Showerhead*

The gas unit energy savings (UES) of this measure is based upon the estimated decrease in hot water usage as a result of the installation of a low-flow aerator. The calculation of gas UES is represented below.

$$UES_{therms} = \left[ \frac{WS_{showerhead} \times Cp \times WaterWeight \times \left( \frac{1\ therm}{100,000\ Btu} \right) (T_{mixed} - T_{ground})}{EFF_{gas}} \right]$$

- UES<sub>therms</sub>* = Annual gas unit energy savings (therms/yr)
- Cp* = Specific heat capacity of water (Btu/lb/°F), fixed constant
- WaterWeight* = Weight of water (lb/gal), fixed constant
- T<sub>mixed</sub>* = Mixed water temperature, at faucet (°F)
- T<sub>ground</sub>* = Make-up groundwater temperature, varies by climate zone (°F)
- EFF<sub>gas</sub>* = Water heater efficiency, gas

The inputs and assumptions used in these equations are specified below. Refer to Electric Savings for explanation of the fuel-neutral inputs. Additional explanation for the inputs that are specific only to natural gas follows the table.

**Gas Energy Use Parameters**

| Parameter  | Value                   | Source   |
|--|-------------------------|--|
| Specific Heat Capacity of Water (Btu/lb/°F)            | 1                       | Fixed constant   |
| Water Weight (lb/gal)                                  | 8.34                    | Fixed constant   |
| Average Make-up (Groundwater) Water Temperature (°F)   | Varies by climate zone. | See below.   |
| Mixed Water Temperature @ Faucet (°F)                  | 106 °F                  | Sempra Energy Utilities (SEU). 2012. "SEU 2009 ASW Data REDACTED.xlsx".  |
| Gas Water Heater Min. Efficiency (recovery efficiency) | 0.77                    | Southern California Gas Company (SCG). 2010. "Gas Fired Storage Water Heater Extract from CEC Appliance Data 07.07.2010.xlsx."<br><br>California Public Utilities Commission (CPUC), Energy Division. 2010. <i>Non-DEER Measure Review Template: PGECODHW113 – Low Flow Showerhead and Thermostatic Shower Restriction Valve</i> . April 27. |

**Groundwater Temperature.** The ground water temperature is a key factor in determining the amount of hot water that is needed to achieve a mixed water temperature of 106 °F, which is a typical mixed-water temperature exiting the showerhead. To reflect differences across climate zones, this analysis includes the average groundwater temperature for each California climate zone, developed from California climate zone weather data. Specifically, the groundwater temperatures used for this analysis are based upon the weather files adopted for the 2013 update of the California Building Efficiency Standards. The average ground water temperatures by climate zone utilized in this analysis are specified below.

**Make-up (Groundwater) Water Temperatures by Climate Zone**

| Climate Zone | Make-up (Groundwater) Temperature (°F) | Source  |
|--------------|--|---|
| CZ 1         | 51.4                                   | Reeves, P. (Consultant to California Public Utilities Commission, Energy Division). 2013. "Comparison-of-Ground-Temperatures-v2_byPaulReeves.xlsx." |
| CZ 2         | 57.3                                   |   |
| CZ 3         | 57.1                                   |   |
| CZ 4         | 59.5                                   |   |
| CZ 5         | 55.8                                   |   |
| CZ 6         | 61.8                                   |   |
| CZ 7         | 62.6                                   |   |
| CZ 8         | 63.7                                   |   |
| CZ 9         | 63.8                                   |   |
| CZ 10        | 64.2                                   |   |
| CZ 11        | 63.2                                   |   |
| CZ 12        | 60.9                                   |   |
| CZ 13        | 64.1                                   |   |
| CZ 14        | 62.7                                   |   |
| CZ 15        | 75.5                                   |   |
| CZ 16        | 51.8                                   |   |

**Mixed Water Temperature at Showerhead Outlet.** For low-flow showerheads, the outlet water heater temperature was derived from the Sempra Energy Utilities (San Diego Gas and Electric and the Southern California Gas Company) 2009 field survey data. The mixed water temperature reflects that hot water

does not comprise the entire shower flow and the tempering of the hot water with cold water to establish full shower flow.

**Recovery Efficiency:** To convert the water heating load to gas energy use at the water heater, the recovery efficiency (RE) is used. Recovery efficiency is a measure of how efficiently the heat from the energy source is transferred to the water (the ratio of energy output used to heat the water divided by energy input). A weighted RE value was derived from the natural-gas fired, storage-type water heaters extracted from the California Energy Commission database of certified equipment (without limit to the listed equipment energy factor, EF).

### TSV Gas Energy Savings (Therms)

The gas UES of a TSV is based upon the estimated decrease in hot water usage as a result of the reduction of time before the user enters the shower to wait for the mixed water to reach the optimum temperature. The calculation of water usage and water savings, and the corresponding energy savings due to hot water usage reduction are explained below.

#### *Calculation Water Usage and Water Savings with TSV*

The calculation of water savings due to the installation of a TSV without a low-flow showerhead follows the same methodology as the water savings of a low-flow showerhead, represented in the previous section. The UES calculation for the TSV assumes base case showerhead flow rate for the base case and measure case water usage. Instead of the total shower time (used in the showerhead water usage calculation), the water usage calculation for the TSV uses “adjusted time” parameter that disaggregates the total time into the “behavioral time” and the “shower time.” The behavioral time represents the average time a person waits to enter the shower *after* the water temperature has already reached the optimum temperature.

The calculation of water savings and water usage for the TSV installation is shown below. Annual water savings is calculated as the difference between the estimated base case and measure case annual water usage.

$$WS_{TSV} = WU_{base} - WU_{measure}$$

$$WU = \frac{FlowRate \times F \times AdjMin \times Days \times QShwr}{N} \times G$$

|              |   |
|--------------|---|
| $WS_{TSV} =$ | <i>Annual water savings (gal/yr) for TSV</i>                              |
| $WU =$       | <i>Annual water use (gal/yr), for base or measure case</i>                |
| $FlowRate =$ | <i>Showerhead water flow rate (gpm) for base or measure case fixtures</i> |
| $F =$        | <i>Throttling factor (%)</i>  |
| $AdjMin =$   | <i>Adjusted average shower time (min/day)</i>                             |
| $QShwr =$    | <i>Number of showers per household per day</i>                            |
| $Days =$     | <i>Shower days of operation (days/yr)</i>                                 |
| $N =$        | <i>Number of showerheads per household, SF or MF</i>                      |
| $G =$        | <i>Baseline water usage normalization factor</i>                          |

#### Base Case Water Usage Parameters for TSV-only Installation

| Parameter  | Single Family | Multifamily /<br>Mobile Home | Source  |
|--|---------------|------------------------------|---|
| Base Case Flow Rate – NR and NC (gpm)  | 1.80          | 1.80                         | California Energy Commission (CEC). 2014. <i>2014 Appliance Efficiency Regulations</i> . CEC-400-2014-009-CMF.  |
| Base Case Flow Rate – AR and AOE (gpm)   | 2.25          | 2.25                         | Sempra Energy Utilities (SEU). 2012. "SEU 2009 ASW Data REDACTED.xlsx".   |
| Average Shower Time (min/shower)   | 7.40          | 7.40                         | DeOreo, W., P. Mayer, and D. Lewis. 2000. <i>Seattle Home Water Conservation Study: The Impacts Of High Efficiency Plumbing Fixture Retrofits In Single-Family Homes</i> . Prepared for the Seattle Public Utilities and the U.S. Environmental Protection Agency. Boulder, CO: Aquacraft, Inc. Water Engineering and Management.             |
| Behavior Time (min/shower)<br>* Time hot water flows before user enters shower | 0.56          | 0.56                         | Sherman, T. 2014. <i>Disaggregating Residential Shower Warm-Up Waste: An Understanding and Quantification of Behavioral Waste Based On Data From Lawrence Berkeley National Labs</i> . Scottsdale: AZ. Evolve Technologies, LLC.  |
| Avg. # of Showers Taken per Day Per Household (showers/day/hh)                 | 2.79          | 2.22                         | Single Family:<br>Sempra Energy Utilities (SEU). 2012. "SEU 2009 ASW Data REDACTED.xlsx".<br><br>Multifamily:<br>KEMA-XENERGY, Itron, and RoperASW. 2004. <i>California Statewide Residential Appliance Saturation Study</i> . Prepared for the California Energy Commission. Contract No. 400-04-009. PG&E Banner Subset, Pages 100 and 102. |
| Avg. # of Showerheads per Household (showerheads/hh)                           | 2.01          | 1.50                         | Single Family:<br>Sempra Energy Utilities (SEU). 2012. "SEU 2009 ASW Data REDACTED.xlsx".<br><br>Multifamily:<br>U.S. Census Bureau. (n.d.). "U.S. 2000 Census Bathrooms in NC MF Units.xls."   |
| Throttling Factor (%)  | 90%           | 90%                          | Biermayer, P. 2006. <i>Potential Water and Energy Savings from Showerheads</i> . Ernest Orlando Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division. Contract No. DE-AC02-05CH11231. P. 6.  |
| Operating Days (days/year)   | 365           | 365                          | Constant, professional judgement.   |

#### Measure Case Water Usage Parameters for TSV-only Installation

| Parameter                              | Single Family | Multifamily | Source  |
|--|---------------|-------------|---|
| Base Case Flow Rate – NR (gpm)         | 1.80          | 1.80        | California Energy Commission (CEC). 2014. <i>2014 Appliance Efficiency Regulations</i> . CEC-400-2014-009-CMF.  |
| Base Case Flow Rate – AR and AOE (gpm) | 2.25          | 2.25        | Sempra Energy Utilities (SEU). 2012. "SEU 2009 ASW Data REDACTED.xlsx".   |
| Average Shower Time (min/shower)       | 7.40          | 7.40        | DeOreo, W., P. Mayer, and D. Lewis. 2000. <i>Seattle Home Water Conservation Study: The Impacts Of High Efficiency Plumbing Fixture Retrofits In Single-Family Homes</i> . Prepared for the Seattle Public Utilities and the U.S. Environmental Protection Agency. Boulder, CO: Aquacraft, Inc. Water Engineering and Management. |

| Parameter   | Single Family | Multifamily | Source  |
|---|---------------|-------------|---|
| Behavior Waste Shower Time (min/shower)<br>* Time hot water flows before user enters shower | 0.0           | 0.0         | TSV installation eliminates time hot water is wasted due to user delay in entering shower.  |
| Avg. # of Showers Taken per Day Per Household (showers/day/hh)                              | 2.79          | 2.22        | Single Family:<br>Sempra Energy Utilities (SEU). 2012. "SEU 2009 ASW Data REDACTED.xlsx".<br><br>Multifamily:<br>KEMA-XENERGY, Itron, and RoperASW. 2004. <i>California Statewide Residential Appliance Saturation Study</i> . Prepared for the California Energy Commission. Contract No. 400-04-009. PG&E Banner Subset, Pages 100 and 102. |
| Avg. # of Showerheads per Household (showerheads/hh)  | 2.01          | 1.50        | Single Family:<br>Sempra Energy Utilities (SEU). 2012. "SEU 2009 ASW Data REDACTED.xlsx".<br><br>Multifamily:<br>U.S. Census Bureau. (n.d.). "U.S. 2000 Census Bathrooms in NC MF Units.xls."   |
| Throttling Factor (%)   | 90%           | 90%         | Biermayer, P. 2006. <i>Potential Water and Energy Savings from Showerheads</i> . Ernest Orlando Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division. Contract No. DE-AC02-05CH11231. P. 6.  |
| Operating Days (days/year)  | 365           | 365         | Professional judgement.   |

**Adjusted Shower Time per Day:** For the estimation of water usage before and after the installation of a TSV, this parameter represents the average time before user enters shower *after* the water has already reached the optimum temperature.

The adjusted time for the base case was based upon results of a 2014 study of shower water waste in single-family residences. The study estimated "behavioral waste time" due to user activity through a survey of 1,057 homes and water use monitoring of 19 homes in California. The results of this study were adopted for multifamily residences.

The adjusted time for the measure case assumes the behavior time has been eliminated.

*Calculation of Gas Unit Energy Savings with TSV*

The gas UES of this measure is based upon the estimated decrease in hot water usage as a result of the installation of a TSV. This methodology is identical to the calculation of gas UES of a low-flow showerhead but includes the estimated water savings from the TSV instead of the water savings from the low-flow showerhead. See "Calculation of Gas Unit Energy Savings from Low-Flow Showerhead" for input parameters and definitions.

$$UES_{therms} = \left[ \frac{WS_{TSV} \times Cp \times WaterWeight \times \left( \frac{1 \text{ therm}}{100,000 \text{ Btu}} \right) (T_{mixed} - T_{ground})}{EFF_{gas}} \right]$$



|                  |   |
|------------------|---|
| $UES_{therms} =$ | <i>Annual gas unit energy savings (therms/year)</i>                 |
| $C_p =$          | <i>Specific heat capacity of water (Btu/lb/°F), fixed constant</i>  |
| $WaterWeight =$  | <i>Weight of water (lb/gal), fixed constant</i>                     |
| $T_{mixed} =$    | <i>Mixed water temperature, at faucet (°F)</i>                      |
| $T_{ground} =$   | <i>Make-up groundwater temperature, varies by climate zone (°F)</i> |
| $EFF_{gas} =$    | <i>Water heater efficiency, gas</i>                                 |

The inputs and assumptions used in these equations are specified below. Refer to the Electric Savings section for explanation of the fuel-neutral inputs. Additional explanation of the inputs that are specific only to natural gas follows.

### Gas UES Inputs

| Parameter  | Value                   | Source   |
|--|-------------------------|--|
| Specific Heat Capacity of Water (Btu/lb/°F)            | 1                       | Fixed constant   |
| Water Weight (lb/gal)                                  | 8.34                    | Fixed constant   |
| Mixed Water Temperature @ Faucet (°F)                  | 106 °F                  | Sempra Energy Utilities (SEU). 2012. "SEU 2009 ASW Data REDACTED.xlsx".<br>California Public Utilities Commission (CPUC), Energy Division. 2013. "2013-2014_DHWFixtureMeasures_Disposition-1March2013.xls." February 22. See "Annexe_Low_FlowShowerHeads_gas" tab.   |
| Average Make-up (Groundwater) Water Temperature (°F)   | Varies by climate zone. | See below.   |
| Gas Water Heater Min. Efficiency (recovery efficiency) | 0.77                    | Southern California Gas Company (SCG). 2010. "Gas Fired Storage Water Heater Extract from CEC Appliance Data 07.07.2010.xlsx."<br>California Public Utilities Commission (CPUC), Energy Division. 2010. <i>Non-DEER Measure Review Template: PGECODHW113 – Low Flow Showerhead and Thermostatic Shower Restriction Valve</i> . April 27. |

**Groundwater Temperature.** The ground water temperature is a key factor in determining the amount of hot water that is needed to achieve a mixed water temperature of 106 °F, which is a typical mixed-water temperature exiting the showerhead. To reflect differences across climate zones, this analysis includes the average groundwater temperature for each California climate zone, developed from California climate zone weather data. Specifically, the groundwater temperatures used for this analysis are based upon the weather files adopted for the 2013 update of the California Building Efficiency Standards. The average ground water temperatures utilized in this analysis are provided below.

**Make-up (Groundwater) Water Temperatures by Climate Zone**

| Climate Zone | Make-up (Groundwater) Temperature (°F) | Source  |
|--------------|--|---|
| CZ 1         | 51.4                                   | Reeves, P. (Consultant to California Public Utilities Commission, Energy Division). 2013. "Comparison-of-Ground-Temperatures-v2_byPaulReeves.xlsx." |
| CZ 2         | 57.3                                   |   |
| CZ 3         | 57.1                                   |   |
| CZ 4         | 59.5                                   |   |
| CZ 5         | 55.8                                   |   |
| CZ 6         | 61.8                                   |   |
| CZ 7         | 62.6                                   |   |
| CZ 8         | 63.7                                   |   |
| CZ 9         | 63.8                                   |   |
| CZ 10        | 64.2                                   |   |
| CZ 11        | 63.2                                   |   |
| CZ 12        | 60.9                                   |   |
| CZ 13        | 64.1                                   |   |
| CZ 14        | 62.7                                   |   |
| CZ 15        | 75.5                                   |   |
| CZ 16        | 51.8                                   |   |

**Mixed Water Temperature at Showerhead Outlet.** The outlet water heater temperature was derived from the Sempra Energy Utilities (San Diego Gas and Electric and the Southern California Gas Company) 2009 field survey data. The mixed water temperature reflects that hot water does not comprise the entire shower flow and the tempering of the hot water with cold water to establish full shower flow. This temperature was subsequently specified in the analysis supporting the “Workpaper Disposition for Water Fixtures” issued in 2013.

**Recovery Efficiency:** To convert the water heating load to gas energy use at the water heater, the recovery efficiency (RE) is used. Recovery efficiency is a measure of how efficiently the heat from the energy source is transferred to the water (the ratio of energy output used to heat the water divided by energy input). A weighted RE value was derived from the natural-gas fired, storage-type water heaters extracted from the California Energy Commission (CEC) database of certified equipment (without limit to the listed equipment energy factor, EF). RE was subsequently stipulated by the Energy Division of the CPUC.<sup>11</sup>

## LIFE CYCLE

Effective Useful Life (EUL) is an estimate of the median number of years that a measure installed through a program is still in place and operable. EUL is often, but not always, derived from measure persistence or retention studies. Remaining Useful Life (RUL) is an estimate of the median number of years that a technology or piece of equipment replaced or altered by an energy efficiency program would have

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<sup>11</sup> California Public Utilities Commission (CPUC), Energy Division. 2013. “Workpaper Disposition for Water Fixtures.” February 22.

remained in service and operational had the program intervention not caused the replacement or alteration.

The RUL is only applicable to the first baseline period for a retrofit measure with an applicable code baseline. The methodology to calculate the RUL conforms with Version 5 of the Energy Efficiency Policy Manual, which recommends “one-third of the effective useful life in DEER as the remaining useful life until further study results are available to establish more accurate values.”<sup>12</sup> This approach provides a reasonable RUL estimate without the requiring of any prior knowledge about the age of the equipment being replaced.<sup>13</sup>

The EUL and RUL are specified below. For *normal replacement installations*, only the EUL is applicable. For the *accelerated replacement installations*, the first period savings utilizes the RUL period of one-third of the useful life. The second period savings utilizes the EUL minus the RUL value.

The showerhead EUL is adopted for the TSV, because of lack of data for TSVs. The only known product of this type of device, manufactured by ShowerStart™, passed a required IAPMO<sup>14</sup> life-cycle test of a minimum of 10,000 cycles.<sup>15</sup> Assuming that one cycle corresponds with one shower event, and number of showerheads per household adopted for this measure analysis, 10,000 cycles translates to a minimum of 19 years. However, the life-cycle testing does not account for prolonged exposure to hot water. The TSV and the low-flow showerhead are subject to the same environmental conditions, with the main difference between the TSV and the showerhead being the thermostatic capability of the valve. Thus, the EUL of the TSV is estimated to be equal to the EUL of the showerhead.

#### Effective Useful Life and Remaining Useful Life

| Type  | TSV Only<br>(gas & elec) | TSV w/ Low-flow<br>Showerhead<br>(gas & elec) | Source  |
|---|--------------------------|---|---|
| <b>Single baseline for normal replacement/new construction</b>          |                          |   | California Public Utilities Commission (CPUC). 2014. “DEER2014-EUL-table-update_2014-02-05.xlsx.”                                 |
| EUL   | 10.00                    | 10.00   |   |
| RUL   | n/a                      | n/a   |   |
| <b>Dual baseline for accelerated replacements/<br/>add-on equipment</b> |                          |   | California Public Utilities Commission (CPUC), Energy Division. 2013. <i>Energy Efficiency Policy Manual Version 5</i> . Page 32. |
| RUL =1/3 EUL  | n/a                      | 3.33  |   |
| EUL minus RUL   | n/a                      | 6.67  |   |

<sup>12</sup> California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 32.

<sup>13</sup> KEMA, Inc. 2008. "Summary of EUL-RUL Analysis for the April 2008 Update to DEER." Memorandum submitted to Itron, Inc.

<sup>14</sup> The IAPMO, or the International Association of Plumbing and Mechanical Officials, is a plumbing and mechanical product certification agency.

<sup>15</sup> IAPMO R&T Lab. 2007. “Test Report for ShowerStart, LLC. Project No. 14375” October. Report Number 1052-07001. October 2007.

### BASE CASE MATERIAL COST (\$/UNIT)

Base case material costs of *add-on equipment* and *accelerated replacement installations* are equal to \$0.

Base case material costs for *normal replacement and new construction installations* were developed from the 2008 revised measure cost summary for the Database of Energy Efficient Resources (DEER).<sup>16</sup>

### MEASURE CASE MATERIAL COST (\$/UNIT)

The measure case equipment costs for a thermostatic shower valve (TSV) and a TSV with a low-flow showerhead combination was obtained from the manufacturer website in 2016. The costs represent a TSV with and without a single-function low-flow showerhead, and the cost of the TSV with a low-flow showerhead is the same regardless of showerhead flow rate.

### BASE CASE LABOR COST (\$/UNIT)

Base case labor costs of *add-on equipment* and *accelerated replacement installations* are equal to \$0.

Base case material costs for *normal replacement and new construction installations* were developed from the 2008 revised measure cost summary for the Database of Energy Efficient Resources (DEER).<sup>17</sup>

### MEASURE CASE LABOR COST (\$/UNIT)

The measure case labor costs for the installation of a thermostatic shower valve (TSV) only and the installation of a TSV with a low-flow showerhead is assumed to equal to the labor installation cost for a low-flow showerhead *only*, which was drawn from the 2010-2012 Ex Ante Measure Cost Study conducted by Itron, Inc.<sup>18</sup> The resultant cost was derived from labor costs obtained from contractors that provided direct installation services to the California IOUs during the 2010-2012 and 2013-2014 program cycles. The study validated the direct installation program prices against data obtained from RSMeans, Grainger, and Home Depot.

### NET-TO-GROSS (NTG)

The net-to-gross (NTG) ratio represents the portion of gross impacts that are determined to be directly attributed to a specific program intervention. The NTG value is based upon the average of all NTG ratios for all evaluated 2006 – 2008 residential programs, as documented in the 2011 DEER Update Study conducted by Itron, Inc. This sector average NTG (“default NTGs”) is applicable to all energy

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<sup>16</sup> California Public Utilities Commission (CPUC), Energy Division. 2008. “Revised DEER Measure Cost Summary (05\_30\_2008) Revised (06\_02\_2008).xlsx.” See Res - Shwrhd & Aerators tab.

<sup>17</sup> California Public Utilities Commission (CPUC), Energy Division. 2008. “Revised DEER Measure Cost Summary (05\_30\_2008) Revised (06\_02\_2008).xlsx.” See Res - Shwrhd & Aerators tab.

<sup>18</sup> Itron, Inc. 2014. *2010-2012 WO017 Ex Ante Measure Cost Study Final Report*. Prepared for the California Public Utilities Commission. Table 4-15.

efficiency measures that have been offered through residential programs for more than two years and for which impact evaluation results are not available.

#### Net-to-Gross Ratios

| Parameter                  | Electric | Gas  | Source  |
|----------------------------|----------|------|---|
| NTG – Residential, default | 0.55     | 0.55 | Itron, Inc. 2011. <i>DEER Database 2011 Update Documentation</i> . Prepared for the California Public Utilities Commission. Page 15-4 Table 15-3. |

#### GROSS SAVINGS INSTALLATION ADJUSTMENT (GSIA)

The gross savings installation adjustment (GSIA) rate represents the ratio of the number of verified installations of the measure to the number of claimed installations reported by the utility. This factor varies by end use, sector, technology, application, and delivery method. This GSIA value was derived from a the residential low-flow showerhead GSIA (value of 0.737, GSIA ID: Res-LowF-SH-All) that was specified in the Workpaper Disposition for Water Fixtures disposition issued by the Energy Division of the California Public Utilities Commission (CPUC) in 2013<sup>19</sup> and was derived as the gross savings weighted installation rate reported in the 2006-2008 Residential Retrofit impact evaluation report.<sup>20</sup>

In conformance with the Workpaper Disposition for Water Fixtures, an additional adjustment factor of 0.80 was applied to the showerhead GSIA to account for installations without a tub/shower combination system. This adjustment factor reflects the assumption that a portion of TSV installations are in tub-shower combinations. Specifically, it is assumed that, in a bathtub where both a showerhead and a tub spout are present, the use of TSV attached on the showerhead may not be effective because the water may be dispensed through the tub spout instead of the showerhead while waiting for the water temperature to reach a desired level. Thus a “tub/shower” adjustment factor was applied to reduce the unit energy savings (UES).

The resultant GSIA stipulated for this measure is specified below.

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<sup>19</sup> California Public Utilities Commission (CPUC), Energy Division. 2013. “2013-2014\_DHWFixtureMeasures\_Disposition-1March2013.xls.” February 22. See ED\_IR tab.

<sup>20</sup> The Cadmus Group, Inc. 2010. *Residential Retrofit High Impact Measure Evaluation Report*. Prepared for the California Public Utilities Commission Energy Division.

**Gross Savings Installation Adjustment Rates**

| Parameter | Value | Source  |
|-----------|-------|---|
| GSIA      | 0.59  | <p>California Public Utilities Commission (CPUC), Energy Division. 2013. "Workpaper Disposition for Water Fixtures." February 22. Page 2.</p> <p>California Public Utilities Commission (CPUC), Energy Division. 2013. "2013-2014_DHWFixtureMeasures_Disposition-1March2013.xls." February 22.</p> <p>California Public Utilities Commission (CPUC). 2014. <i>Third Decision Addressing Petition for Modification of Decision 09-09-047. Decision 11-07-030. Applications 08-07-021, 08-07-022, 08-07-023 and 08-07-031. Issued on Month July 14. Attachments A-B, Page A3.</i></p> |

**NON-ENERGY IMPACTS**

Non-energy impacts for this measure have not been quantified.

**DEER DIFFERENCES ANALYSIS**

This section provides a summary of DEER-based inputs and methods, and the rationale for inputs and methods that are not DEER-based.

**DEER Difference Summary**

| DEER Item                      | Comment / Used for Workpaper  |
|--------------------------------|---|
| Modified DEER methodology      | No  |
| Scaled DEER measure            | No  |
| DEER Base Case                 | No  |
| DEER Measure Case              | No  |
| DEER Building Types            | Yes   |
| DEER Operating Hours           | No  |
| DEER eQUEST Prototypes         | No  |
| DEER Version                   | DEER 2016   |
| Reason for Deviation from DEER | DEER does not contain this type of measure  |
| DEER Measure IDs Used          | n/a   |
| NTG                            | NTG of 0.55 is associated with NTG ID <i>Res-Default&gt;2</i>                       |
| GSIA                           | GSIA of 0.59 is associated with GSIA ID: <i>Res-LowF-wRest-SH-All</i> .             |
| EUL/RUL                        | Source: DEER. The value of 10 years is associated with EUL ID <i>Wtr-WH-Shrhd</i> . |

## REVISION HISTORY

### Measure Characterization Revision History

| Revision Number | Revision Complete Date | Primary Author, Title, Organization | Revision Summary and Rationale for Revision Effective Date and Approved By   |
|-----------------|------------------------|-------------------------------------|--|
| 01              | 03/31/2018             | Jennifer Holmes<br>Cal TF Staff     | Draft of consolidated text for this statewide measure is based upon:<br>SCGWP100303B Revision 7 (December 22, 2016)<br>WPSDGEEREWH1012, Revision 1 (January 30, 2014)<br>Consensus reached among Cal TF members.   |
|                 | 01/31/2019             | Jennifer Holmes<br>Cal TF Staff     | Revisions for submittal of version 01.   |
|                 | 10/31/2019             | Cal TF Staff                        | Updated data to remove an 80% factor that was being double-counted. The new GSIA ID of <i>Res-LowF-wRest-SH-All</i> account for the 80% reduction ( $0.59 = 0.73 * 0.8$ ) to account for installations in non-showers.<br>Update calculation to match the methodology. |
|                 | 03/21/2021             | Soe K Hla<br>PG&E                   | Adopted all remaining measures for PG&E<br>Fixed incorrect GSIA ID and ElecImpactProfile ID in EAD   |