Savings Calculations for Commercial Showerhead

Baseline Water and Gas Consumption Estimates for Commercial Hot Water Applications

Prepared by, CLEAResult

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# Measure Characteristic Summary

|  |  |
| --- | --- |
| Characteristic | Description |
| Measure | Installation of low-flow showerheads in commercial facilities to reduce water use and save energy associated with water heating |
| Market Sector | Commercial |
| Base Case Description | Flow rate of 2.25 GPM |
| Efficient Case Description | 1.5 GPM |
| Material Cost | $10 |

# Measure Description

This measure consists of installation of low-flow showerheads in commercial facilities to reduce water use and save energy associated with water heating. To qualify for this measure, the flow rate of replacement low-flow showerheads must be rated at 1.5 gallons per minute or less.

## Efficiency Improvement

The savings values are determined for the retrofit of existing operational showerheads with an average flow rate of 2.25 gallons per minute with low-flow showerheads with a flow rate of 1.5 gallons per minute. Facilities that use gas water heaters are eligible for this measure.

# Calculation Methodologies

In our review of studies related to the consumption of water from showers in commercial buildings, we were not able to find direct information concerning hot water consumption. Multiple studies were reviewed to find data that was utilized to determine baseline consumption of water and natural gas in applications using hot water in showers.

## Water Consumption calculations

The water and gas consumption calculations for this measure were developed based on standard engineering methodologies. Data from water conservation programs, published studies, and assumptions provided in statewide technical reference manuals were utilized to calculate the average consumption of water per shower per year. Flow rates were found at existing fixtures up to 3.5 GPM[[1]](#endnote-2).

## Hospitality Calculation 1:

Data were utilized to determine the average water consumption from showers in individual hotel rooms. Water consumption in five hotels was metered over a short-term period at either a whole-building level or sub-metered by room and then disaggregated to determine consumption at multiple end uses. The data was extrapolated to show annual end use consumption. For the purpose of these calculations, one shower is assumed to be located in each room.

Data from the study are summarized for showers below[[2]](#endnote-3).

Table – Hospitality Calculation Data

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Hotel 1** | **Hotel 2** | **Hotel 3** | **Hotel 4** | **Hotel 5** | **Total or Weighted Average** |
| **Total annual metered shower water consumption from five hotels (gallons)** | 1510000 | 4803000 | 1921000 | 1842000 | 1655000 | 11731000 |
| **Occupancy rate during testing** ( | 0.9 | 0.7 | 0.8 | 0.9 | 0.9 | 0.82 |
| **Occupants Per Room** ( | 2 | 1.2 | 1.3 | 2 | 3 | 1.87 |
| **Total number of showers** | 148 | 297 | 140 | 168 | 208 | 961 |

The average water consumption for individual showers was calculated at

Equation

As occupancy rates and occupants per room vary, the data from the study were normalized using the weighted occupancy rate during testing and occupants per room to determine the annual consumption per occupant (UHospOcc).

Equation

Additional data were utilized to account for regional average of occupancy rate and national average of occupants per room to find the annual average consumption per shower. The formula below is used to calculate the normalized annual consumption per shower (UHosp), assuming the number of showers identified in the study equal the number of rooms.

Table – National and Southern California Regional Hospitality Occupancy Data

|  |  |  |
| --- | --- | --- |
|  | **Value** | **Units** |
| **Regional Hospitality Occupancy Rate[[3]](#endnote-4) (OccRate**Regional) | 77% |  |
| **National Hospitality Average Number of Guests per Room[[4]](#endnote-5)** (**OccPerRoom**National) | 1.4 | guests per room |

Equation

## Hospitality Calculation 2:

Additional data were available allowing for an alternate calculation of water consumption utilizing typical lengths of showers and the above occupancy data. Using an average shower time (t) of 16.2 minutes per hotel room per day[[5]](#endnote-6), the following calculation is used to calculate annual water consumption:

Equation

Where,

= Baseline showerhead flow rate

= 2.25 Gallons per minute

Days/year = 365

## Schools Calculation:

Data were utilized to determine the annual average water consumption from showers in schools. Water consumption was logged and bills were reviewed for four schools. Two of those schools had sufficient data to disaggregate annual consumption into multiple end uses. Below is data from those schools related to the number of showers and the total water consumption at showers.

Table – Schools Calculation 1 Data 2

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Combined** | **School 1** | **School 2** |
| **Total annual water consumption at showers (gallons)** | 258000 | 115000 | 143000 |
| **Total number of showers** | 59 | 25 | 34 |

The average water consumption for individual showers was calculated as

Equation

## Water Savings Calculations

The consumption of replacing a 2.25 GPM showerhead (FB) with a 1.5 GPM showerhead (FP) is calculated as:

Equation

Where,

UP = Annual post-installation consumption in gallons

UB = Annual baseline consumption in gallons

Water Savings (US) is calculated as:

Equation

Table – Calculated Water Savings

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Baseline Water Consumption, UB (Gallons/Year)** | **Post-Installation Water Consumption, UP (Gallons/Year)** | **Water Savings (Gallons/Year)** |
| **Hospitality 1** | 8581 | 5721 | 2860 |
| **Hospitality 2** | 10273 | 6849 | 3424 |
| **Schools** | 4373 | 2915 | 1458 |

## Energy Consumption calculations

Annual gas consumption is calculated as:

Equation

Table – Energy Calculation Constants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Value** | | **Units** | |
| **Base Flow Rate (F**B) | | 2.25 | | Gallons per Minute | |
| **Post Flow Rate (F**P) | | 1.5 | | Gallons per Minute | |
| **Mixed Water Temperature (T**H)[[6]](#endnote-7) | | 104 | | oF | |
| **Hospitality Supply Water Temperature (T**supply)[[7]](#endnote-8) | | 63.3 | | oF | |
| **School Supply Water Temperature (T**supply) | | 63.9 | | oF | |
| **Restaurant Supply Water Temperature (T**supply) | | 63.5 | | oF | |
| **Water Density (**) | | 8.33 | | lb/gallon | |
| **Specific Heat of Water (C**p) | | 1 | | BTU/lboF | |
| **Recovery Efficiency (E**T) | | 0.78 | |  | |

Table – Calculated Energy Savings

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Baseline Natural Gas Consumption (Therms/Year)** | **Post-Installation Natural Gas Consumption (Therms/Year)** | **Natural Gas Savings (Therms/Year)** |
| **Hospitality 1** | 37.34 | 24.89 | 12.45 |
| **Hospitality 2** | 44.70 | 29.80 | 14.90 |
| **Schools** | 18.73 | 12.49 | 6.24 |

## Measure cost

The cost for installing this measure includes material and labor costs. Material cost per showerhead is found at $10 from internet retailers. Three showerhead installs per hour are assumed in the labor cost calculations. A value of $58.80 per hour is found in READI v2.3.0 under Domestic Hot Water – Storage Water Heater. The tables below provide location-specific and weighted labor costs based on DEER material and labor multipliers.

Table – Material and Labor Costs by Building Location

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Building Location | Material Multiplier | Labor Multiplier | Showerhead Material Cost | Showerhead Labor Cost |
| CZ05 | 0.96 | 1.067 | $ 9.60 | $ 20.91 |
| CZ06 | 1.002 | 1.076 | $ 10.02 | $ 21.09 |
| CZ08 | 0.959 | 1.067 | $ 9.59 | $ 20.91 |
| CZ09 | 1.001 | 1.075 | $ 10.01 | $ 21.07 |
| CZ10 | 1.001 | 1.076 | $ 10.01 | $ 21.09 |
| CZ13 | 1.003 | 1.158 | $ 10.03 | $ 22.70 |
| CZ14 | 0.96 | 1.04 | $ 9.60 | $ 20.38 |
| CZ15 | 0.959 | 1.067 | $ 9.59 | $ 20.91 |
| CZ16 | 0.96 | 1.083 | $ 9.60 | $ 21.23 |

Table – Location-Weighted Costs

|  |  |  |
| --- | --- | --- |
|  | Hospitality | School |
| Material | $ 9.86 | $ 9.86 |
| Labor | $ 21.06 | $ 21.03 |
| Total | $ 30.91 | $ 30.89 |

1. Seattle Public Utilities. (2002), *Hotel Water Conservation A Seattle Demonstration* [↑](#endnote-ref-2)
2. Dziegielewski, B., Kiefer, J., Opitz, E., Porter, G., Lantz, G. (2000) *Commercial and Institutional End Uses of Water* [↑](#endnote-ref-3)
3. Southern California Lodging Forecast, PKF Consulting USA https://www.cpp.edu/~collins/partners/outlook.../PKFConsulting.pdf [↑](#endnote-ref-4)
4. 2013 Lodging Industry Profile. American Hotel and Lodging Association [↑](#endnote-ref-5)
5. Table D-7 Page 5; Gleick, P., Haasz, D., Henges-Jeck, C., Srinivasan, V., Wolff, G., Cushing, K. K., et al. (2003). Waste Not, Want Not: The Potential for Urban Water Conservation in California. Pacific Institute. [↑](#endnote-ref-6)
6. California Public Utilities Commission, Energy Division, WORKPAPER DISPOSITION FOR Water Fixtures (2013) [↑](#endnote-ref-7)
7. Southern California Gas Company, Workpaper SCGWP100303A, Revision 3 (2013) [↑](#endnote-ref-8)