### Low Flow Showerheads

###### Description

This measure relates to the installation of a low flow showerhead in a single or multi-family household.

This measure may be used for units provided through Efficiency Kit’s however the in service rate for such measures should be derived through evaluation results specifically for this implementation methodology.

This measure was developed to be applicable to the following program types:  TOS, RF, NC, DI, KITS.

If applied to other program types, the measure savings should be verified.

###### Definition of Efficient Equipment

To qualify for this measure the installed equipment must be a low flow showerhead rated at 2.0 gallons per minute (GPM) or less. Savings are calculated on a per showerhead fixture basis.

###### Definition of Baseline Equipment

For Direct-install programs, the baseline condition is assumed to be a standard showerhead rated at 2.5 GPM or greater.

For retrofit and time-of-sale programs, the baseline condition is assumed to be a representative average of existing showerhead flow rates of participating customers including a range of low flow showerheads, standard-flow showerheads, and high-flow showerheads.

###### Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 10 years.[[1]](#footnote-1)

###### Deemed Measure Cost

The incremental cost for this measure is $12[[2]](#footnote-2) or program actual.

For low flow showerheads provided in Efficiency Kits, the actual program delivery costs should be utilized.

###### Loadshape

Loadshape R03 - Residential Electric DHW

###### Coincidence Factor

The coincidence factor for this measure is assumed to be 2.78%.[[3]](#footnote-3)

**Algorithm**

###### Calculation of Savings

###### Electric Energy Savings

Note these savings are per showerhead fixture

ΔkWh = %ElectricDHW \* ((GPM\_base \* L\_base - GPM\_low \* L\_low) \* Household \* SPCD \* 365.25 / SPH) \* EPG\_electric \* ISR

Where:

%ElectricDHW = proportion of water heating supplied by electric resistance heating

|  |  |
| --- | --- |
| **DHW fuel** | **%ElectricDHW** |
| Electric | 100% |
| Natural Gas | 0% |
| Unknown | 16%[[4]](#footnote-4) |

GPM\_base = Flow rate of the baseline showerhead

|  |  |
| --- | --- |
| **Program** | **GPM\_base** |
| Direct-install | 2.67[[5]](#footnote-5) |
| Retrofit, Efficiency Kits, NC or TOS | 2.35[[6]](#footnote-6) |

GPM\_low = As-used flow rate of the low-flow showerhead, which may, as a result of measurements of program evaulations deviate from rated flows, see table below:

| **Rated Flow** |
| --- |
| 2.0 GPM |
| 1.75 GPM |
| 1.5 GPM |
| Custom or Actual[[7]](#footnote-7) |

L\_base = Shower length in minutes with baseline showerhead

= 7.8 min[[8]](#footnote-8)

L\_low = Shower length in minutes with low-flow showerhead

= 7.8 min[[9]](#footnote-9)

Household = Average number of people per household

|  |  |
| --- | --- |
| **Household Unit Type[[10]](#footnote-10)** | **Household** |
| Single-Family - Deemed | 2.56[[11]](#footnote-11) |
| Multi-Family - Deemed | 2.1[[12]](#footnote-12) |
| Custom | Actual Occupancy or Number of Bedrooms[[13]](#footnote-13) |

SPCD = Showers Per Capita Per Day

= 0.6[[14]](#footnote-14)

365.25 = Days per year, on average.

SPH = Showerheads Per Household so that per-showerhead savings fractions can be determined

| **Household Type** | **SPH** |
| --- | --- |
| Single-Family | 1.79[[15]](#footnote-15) |
| Multi-Family | 1.3[[16]](#footnote-16) |
| Custom | Actual |

EPG\_electric = Energy per gallon of hot water supplied by electric

= (8.33 \* 1.0 \* (ShowerTemp - SupplyTemp)) / (RE\_electric \* 3412)

= (8.33 \* 1.0 \* (101 – 54.1)) / (0.98 \* 3412)

= 0.117 kWh/gal

8.33 = Specific weight of water (lbs/gallon)

1.0 = Heat Capacity of water (btu/lb-°)

ShowerTemp = Assumed temperature of water

= 101F [[17]](#footnote-17)

SupplyTemp = Assumed temperature of water entering house

= 54.1F [[18]](#footnote-18)

RE\_electric = Recovery efficiency of electric water heater

= 98% [[19]](#footnote-19)

3412 = Converts Btu to kWh (btu/kWh)

ISR = In service rate of showerhead

= Dependant on program delivery method as listed in table below

|  |  |
| --- | --- |
| **Selection** | **ISR** |
| Direct Install - Single Family | 0.98**[[20]](#footnote-20)** |
| Direct Install – Multi Family | 0.95[[21]](#footnote-21) |
| Efficiency Kits--One showerhead kit | 0.65[[22]](#footnote-22) |
| Efficiency Kits—Two showerhead kit | 0.67[[23]](#footnote-23) |

For example, a direct-installed 1.5 GPM low flow showerhead in a single family home with electric DHW where the number of showers is not known:

ΔkWh = 1.0 \* ((2.67 \* 7.8 – 1.5 \* 7.8) \* 2.56 \* 0.6 \* 365.25 / 1.79) \* 0.117 \* 0.98

= 328 kWh

###### Summer Coincident Peak Demand Savings

ΔkW = ΔkWh/Hours \* CF

Where:

ΔkWh = calculated value above

Hours = Annual electric DHW recovery hours for showerhead use

= ((GPM\_base \* L\_base) \* Household \* SPCD \* 365.25 ) \* 0.712[[24]](#footnote-24) / GPH

= 302 for SF Direct Install; 248 for MF Direct Install

= 266 for SF Retrofit, Efficiency Kits, NC and TOS; 218 for MF Retrofit, Efficiency Kits, NC and TOS

GPH = Gallons per hour recovery of electric water heater calculated for 65.9F temp rise (120-54.1), 98% recovery efficiency, and typical 4.5kW electric resistance storage tank.

= 27.51

CF = Coincidence Factor for electric load reduction

= 0.0278[[25]](#footnote-25)

For example, a direct installed 1.5 GPM low flow showerhead in a single family home with electric DHW where the number of showers is not known:

ΔkW = 328/302 \* 0.0278

= 0.0302 kW

###### Natural Gas Savings

ΔTherms = %FossilDHW \* ((GPM\_base \* L\_base - GPM\_low \* L\_low) \* Household \* SPCD \* 365.25 / SPH) \* EPG\_gas \* ISR

Where:

%FossilDHW = proportion of water heating supplied by Natural Gas heating

|  |  |
| --- | --- |
| **DHW fuel** | **%Fossil\_DHW** |
| Electric | 0% |
| Natural Gas | 100% |
| Unknown | 84%[[26]](#footnote-26) |

EPG\_gas = Energy per gallon of Hot water supplied by gas

= (8.33 \* 1.0 \* (ShowerTemp - SupplyTemp)) / (RE\_gas \* 100,000)

= 0.00501 Therm/gal for SF homes

= 0.00583 Therm/gal for MF homes

RE\_gas = Recovery efficiency of gas water heater

= 78% For SF homes[[27]](#footnote-27)

= 67% For MF homes[[28]](#footnote-28)

100,000 = Converts Btus to Therms (btu/Therm)

Other variables as defined above.

For example, a direct installed 1.5 GPM low flow showerhead in a gas fired DHW single family home where the number of showers is not known:

ΔTherms = 1.0 \* ((2.67 \* 7.8 – 1.5 \* 7.8) \* 2.56 \* 0.6 \* 365.25 / 1.79) \* 0.00501 \* 0.98

= 14.0 therms

###### Water Impact Descriptions and Calculation

Δgallons = ((GPM\_base \* L\_base - GPM\_low \* L\_low) \* Household \* SPCD \* 365.25 / SPH) \* ISR

Variables as defined above

For example, a direct installed 1.5 GPM low flow showerhead in a single family home where the number of showers is not known:

Δgallons = ((2.67 \* 7.8 – 1.5 \* 7.8) \* 2.56 \* 0.6 \* 365.25 / 1.79) \* 0.98

= 2803 gallons

###### Deemed O&M Cost Adjustment Calculation

N/A

**Sources**

|  |  |
| --- | --- |
| **Source ID** | **Reference** |
| 1 | 2011, DeOreo, William. California Single Family Water Use Efficiency Study. April 20, 2011. |
| 2 | 2000, Mayer, Peter, William DeOreo, and David Lewis. Seattle Home Water Conservation Study. December 2000. |
| 3 | 1999, Mayer, Peter, William DeOreo. Residential End Uses of Water. Published by AWWA Research Foundation and American Water Works Association. 1999. |
| 4 | 2003, Mayer, Peter, William DeOreo. Residential Indoor Water Conservation Study. Aquacraft, Inc. Water Engineering and Management. Prepared for East Bay Municipal Utility District and the US EPA. July 2003. |
| 5 | 2011, DeOreo, William. Analysis of Water Use in New Single Family Homes. By Aquacraft. For Salt Lake City Corporation and US EPA. July 20, 2011. |
| 6 | 2011, Aquacraft. Albuquerque Single Family Water Use Efficiency and Retrofit Study. For Albuquerque Bernalillo County Water Utility Authority. December 1, 2011. |
| 7 | 2008, Schultdt, Marc, and Debra Tachibana. Energy related Water Fixture Measurements: Securing the Baseline for Northwest Single Family Homes. 2008 ACEEE Summer Study on Energy Efficiency in Buildings. |

###### Measure Code: RS-HWE-LFSH-V04-160601

1. Table C-6, Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007. Evaluations indicate that consumer dissatisfaction may lead to reductions in persistence, particularly in Multi-Family , "http://neep.org/uploads/EMV%20Forum/EMV%20Studies/measure\_life\_GDS%5B1%5D.pdf" [↑](#footnote-ref-1)
2. Direct-install price per showerhead assumes cost of showerhead (Market research average of $7 and assess and install time of $5 (20min @ $15/hr) [↑](#footnote-ref-2)
3. Calculated as follows: Assume 11% showers take place during peak hours (based on: <http://www.aquacraft.com/sites/default/files/pub/DeOreo-%282001%29-Disaggregated-Hot-Water-Use-in-Single-Family-Homes-Using-Flow-Trace-Analysis.pdf>). There are 65 days in the summer peak period, so the percentage of total annual aerator use in peak period is 0.11\*65/365 = 1.96%. The number of hours of recovery during peak periods is therefore assumed to be 1.96% \* 369 = 7.23 hours of recovery during peak period, where 369 equals the average annual electric DHW recovery hours for showerhead use including SF and MF homes with Direct Install and Retrofit/TOS measures. There are 260 hours in the peak period so the probability you will see savings during the peak period is 7.23/260 = 0.0278 [↑](#footnote-ref-3)
4. Default assumption for unknown fuel is based on EIA Residential Energy Consumption Survey (RECS) 2009 for Midwest Region, data for the state of IL. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area then that should be used [↑](#footnote-ref-4)
5. Based on measured data from Ameren IL EM&V of Direct-Install program. Program targets showers that are rated 2.5 GPM or above. [↑](#footnote-ref-5)
6. Representative value from sources 1, 2, 4, 5, 6 and 7 (See Source Table at end of measure section) adjusted slightly upward to account for program participation which is expected to target customers with existing higher flow devices rather than those with existing low flow devices. [↑](#footnote-ref-6)
7. Note that actual values may be either a) program-specific minimum flow rate, or b) program-specific evaluation-based value of actual effective flow-rate due to increased duration or temperatures. The latter increases in likelihood as the rated flow drops and may become significant at or below rated flows of 1.5 GPM. The impact can be viewed as the inverse of the throttling described in the footnote for baseline flowrate. [↑](#footnote-ref-7)
8. Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum dated June 2013, directed to Michigan Evaluation Working Group. This study of 135 single and multi-family homes in Michigan metered energy parameters for efficient showerhead and faucet aerators. [↑](#footnote-ref-8)
9. Ibid. [↑](#footnote-ref-9)
10. If household type is unknown, as may be the case for time of sale measures, then single family deemed value shall be used. [↑](#footnote-ref-10)
11. ComEd Energy Efficiency/ Demand Response Plan: Plan Year 2 (6/1/2009-5/31/2010) Evaluation Report: All Electric Single Family Home Energy Performance Tune-Up Program citing 2006-2008 American Community Survey data from the US Census Bureau for Illinois cited on p. 17 of the PY2 Evaluation report. 2.75 \* 93% evaluation adjustment [↑](#footnote-ref-11)
12. ComEd PY3 Multi-Family Evaluation Report REVISED DRAFT v5 2011-12-08.docx [↑](#footnote-ref-12)
13. Bedrooms are suitable proxies for household occupancy, and may be preferable to actual occupancy due to turnover rates in residency and non-adult population impacts. [↑](#footnote-ref-13)
14. Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum dated June 2013, directed to Michigan Evaluation Working Group. [↑](#footnote-ref-14)
15. Based on findings from a 2009 ComEd residential survey of 140 sites, provided by Cadmus. [↑](#footnote-ref-15)
16. Ibid. [↑](#footnote-ref-16)
17. Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum dated June 2013, directed to Michigan Evaluation Working Group. [↑](#footnote-ref-17)
18. US DOE Building America Program. Building America Analysis Spreadsheet. For Chicago, IL <http://www1.eere.energy.gov/buildings/building_america/analysis_spreadsheets.html>. [↑](#footnote-ref-18)
19. Electric water heaters have recovery efficiency of 98%: <http://www.ahridirectory.org/ahridirectory/pages/home.aspx> [↑](#footnote-ref-19)
20. Deemed values are from ComEd Energy Efficiency/ Demand Response Plan: Plan Year 2 (6/1/2009-5/31/2010) Evaluation Report: All Electric Single Family Home Energy Performance Tune-Up Program Table 3-8. Alternative ISRs may be developed for program delivery methods based on evaluation results. [↑](#footnote-ref-20)
21. Navigant, ComEd-Nicor Gas EPY4/GPY1 Multi-Family Home Energy Savings Program Evaluation Report FINAL 2013-06-05 [↑](#footnote-ref-21)
22. From Navigant memo, “Nicor Gas energySMART Energy Saving Kits Program In Service Rate and Process  
    Analysis”, August 28, 2015. [↑](#footnote-ref-22)
23. Ibid [↑](#footnote-ref-23)
24. 71.2% is the proportion of hot 120F water mixed with 54.1F supply water to give 101F shower water. [↑](#footnote-ref-24)
25. Calculated as follows: Assume 11% showers take place during peak hours (based on: <http://www.aquacraft.com/sites/default/files/pub/DeOreo-%282001%29-Disaggregated-Hot-Water-Use-in-Single-Family-Homes-Using-Flow-Trace-Analysis.pdf>). There are 65 days in the summer peak period, so the percentage of total annual aerator use in peak period is 0.11\*65/365 = 1.96%. The number of hours of recovery during peak periods is therefore assumed to be 1.96% \* 369 = 7.23 hours of recovery during peak period where 369 equals the average annual electric DHW recovery hours for showerhead use including SF and MF homes with Direct Install and Retrofit/TOS measures. There are 260 hours in the peak period so the probability you will see savings during the peak period is 7.23/260 = 0.0278 [↑](#footnote-ref-25)
26. Default assumption for unknown fuel is based on EIA Residential Energy Consumption Survey (RECS) 2009 for Midwest Region, data for the state of IL. If utilities have specific evaluation results providing a more appropriate assumption for homes in a particular market or geographical area then that should be used [↑](#footnote-ref-26)
27. DOE Final Rule discusses Recovery Efficiency with an average around 0.76 for Gas Fired Storage Water heaters and 0.78 for standard efficiency gas fired tankless water heaters up to 0.95 for the highest efficiency gas fired condensing tankless water heaters. These numbers represent the range of new units however, not the range of existing units in stock. Review of AHRI Directory suggests range of recovery efficiency ratings for new Gas DHW units of 70-87%. Average of existing units is estimated at 78%. [↑](#footnote-ref-27)
28. Water heating in multi-family buildings is often provided by a larger central boiler. This suggests that the average recovery efficiency is somewhere between a typical central boiler efficiency of 0.59 and the 0.75 for single family homes. An average efficiency of 0.67 is used for this analysis as a default for multi-family buildings. [↑](#footnote-ref-28)