### ENERGY STAR and ENERGY STAR Most Efficient Clothes Washers

**Description**

This measure relates to the installation of a clothes washer meeting the ENERGY STAR, or ENERGY STAR Most Efficient minimum qualifications. Note if the DHW and dryer fuels of the installations are unknown (for example through a retail program) savings should be based on a weighted blend using RECS data (the resultant values (kWh, therms and gallons of water) are provided). The algorithms can also be used to calculate site specific savings where DHW and dryer fuels are known.

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

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

**Definition of Efficient Equipment**

Clothes washer must meet the ENERGY STAR or ENERGY STAR Most Efficient minimum qualifications, as required by the program.

**Definition of Baseline Equipment**

The baseline condition is a standard sized clothes washer meeting the minimum federal baseline as of March 2015[[1]](#footnote-1).

|  |  |  |
| --- | --- | --- |
| **Efficiency Level** | **Top loading >2.5 Cu ft** | **Front Loading >2.5 Cu ft** |
| Federal Standard | 1.29 IMEF, 8.4 IWF | 1.84 IMEF, 4.7 IWF |
| ENERGY STAR | 2.06 IMEF, 4.3 IWF | 2.38 IMEF, 3.7 IWF |
| ENERGY STAR Most Efficient | 2.76 IMEF, 3.5 IWF | 2.74 IMEF, 3.2IWF |

**Deemed Lifetime of Efficient Equipment**

The expected measure life is assumed to be 14 years[[2]](#footnote-2).

**Deemed Measure Cost**

The incremental cost for an ENERGY STAR unit is assumed to be $65 and for an ENERGY STAR Most Efficient unit it is $210[[3]](#footnote-3).

**Deemed O&M Cost Adjustments**

N/A

**Loadshape**

Loadshape R01 - Residential Clothes Washer

**Coincidence Factor**

The coincidence factor for this measure is 3.8%[[4]](#footnote-4).

**Algorithm**

**Calculation of Savings**

**Electric Energy Savings**

1. Calculate clothes washer savings based on Modified Energy Factor (MEF).

The Modified Energy Factor (MEF) includes unit operation, water heating and drying energy use: *"MEF is the quotient of the capacity of the clothes container, C, divided by the total clothes washer energy consumption per cycle, with such energy consumption expressed as the sum of the machine electrical energy consumption, M, the hot water energy consumption, E, and the energy required for removal of the remaining moisture in the wash load, D"* [[5]](#footnote-5).

The hot water and dryer savings calculated here assumes electric DHW and Dryer (this will be separated in Step 2).

IMEFsavings[[6]](#footnote-6) = Capacity \* (1/IMEFbase - 1/IMEFeff) \* Ncycles

Where

Capacity = Clothes Washer capacity (cubic feet)

= Actual. If capacity is unknown assume 3.45 cubic feet [[7]](#footnote-7)

IMEFbase = Integrated Modified Energy Factor of baseline unit

= 1.66[[8]](#footnote-8)

IMEFeff = Integrated Modified Energy Factor of efficient unit

= Actual. If unknown assume average values provided below.

Ncycles = Number of Cycles per year

= 295[[9]](#footnote-9)

IMEFsavings is provided below based on deemed values[[10]](#footnote-10):

|  |  |  |
| --- | --- | --- |
| **Efficiency Level** | **IMEF** | **IMEFSavings (kWh)** |
| Federal Standard | 1.66 | 0.0 |
| ENERGY STAR | 2.26 | 163 |
| ENERGY STAR Most Efficient | 2.74 | 242 |

1. Break out savings calculated in Step 1 for electric DHW and electric dryer

∆kWh = [Capacity \* 1/IMEFbase \* Ncycles \* (%CWbase + (%DHWbase \* %Electric\_DHW) + (%Dryerbase \* %Electric\_Dryer))] - [Capacity \* 1/IMEFeff \* Ncycles \* (%CWeff + (%DHWeff \* %Electric\_DHW) + (%Dryereff \* %Electric\_Dryer))]

Where:

%CW = Percentage of total energy consumption for Clothes Washer operation (different for baseline and efficient unit – see table below)

%DHW = Percentage of total energy consumption used for water heating (different for baseline and efficient unit – see table below)

%Dryer = Percentage of total energy consumption for dryer operation (different for baseline and efficient unit – see table below)

|  | **Percentage of Total Energy Consumption[[11]](#footnote-11)** | | |
| --- | --- | --- | --- |
|  | **%CW** | **%DHW** | **%Dryer** |
| Baseline | 7.6% | 31.2% | 61.2% |
| ENERGY STAR | 8.1% | 23.4% | 68.5% |
| ENERGY STAR Most Efficient | 13.6% | 10% | 76.3% |

%Electric\_DHW = Percentage of DHW savings assumed to be electric

| **DHW fuel** | **%Electric\_DHW** |
| --- | --- |
| Electric | 100% |
| Natural Gas | 0% |
| Unknown | 16%[[12]](#footnote-12) |

%Electric\_Dryer = Percentage of dryer savings assumed to be electric

|  |  |
| --- | --- |
| **Dryer fuel** | **%Electric\_DHW** |
| Electric | 100% |
| Natural Gas | 0% |
| Unknown | 27%[[13]](#footnote-13) |

Using the default assumptions provided above, the prescriptive savings for each configuration are presented below:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **ΔkWH** | | | | | | | | |
|  | **Electric DHW Electric Dryer** | **Gas DHW**  **Electric Dryer** | **Electric DHW**  **Gas Dryer** | **Gas DHW**  **Gas Dryer** | **Electric DHW Unknown Dryer** | **Gas DHW Unknown Dryer** | **Unknown DHW Electric Dryer** | **Unknown DHW**  **Gas Dryer** | **Unknown DHW Unknown Dryer** |
| ENERGY STAR | 162.7 | 77.0 | 96.0 | 10.2 | 114.0 | 28.2 | 90.7 | 24.0 | 42.0 |
| ENERGY STAR Most Efficient | 242.1 | 88.2 | 149.9 | -4.0 | 174.8 | 20.9 | 112.8 | 20.6 | 45.5 |



**Summer Coincident Peak Demand Savings**

ΔkW = ΔkWh/Hours \* CF

Where:

ΔkWh = Energy Savings as calculated above

Hours = Assumed Run hours of Clothes Washer

= 295 hours[[14]](#footnote-14)

CF = Summer Peak Coincidence Factor for measure.

= 0.038[[15]](#footnote-15)

Using the default assumptions provided above, the prescriptive savings for each configuration are presented below:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **ΔkW** | | | | | | | | |
|  | **Electric DHW**  **Electric Dryer** | **Gas DHW**  **Electric Dryer** | **Electric DHW**  **Gas Dryer** | **Gas DHW**  **Gas Dryer** | **Electric DHW Unknown Dryer** | **Gas DHW Unknown Dryer** | **Unknown DHW Electric Dryer** | **Unknown DHW**  **Gas Dryer** | **Unknown DHW Unknown Dryer** |
| ENERGY STAR | 0.0210 | 0.0099 | 0.0124 | 0.0013 | 0.0147 | 0.0036 | 0.0117 | 0.0031 | 0.0054 |
| ENERGY STAR Most Efficient | 0.0312 | 0.0114 | 0.0193 | -0.0005 | 0.0225 | 0.0027 | 0.0145 | 0.0027 | 0.0059 |



**Natural Gas Savings**

Break out savings calculated in Step 1 of electric energy savings (MEF savings) and extract Natural Gas DHW and Natural Gas dryer savings from total savings:

∆Therm = [Capacity \* 1/IMEFbase \* Ncycles \* ((%DHWbase \* %Natural Gas\_DHW \* R\_eff) + (%Dryerbase \* %Gas \_Dryer))] - [Capacity \* 1/IMEFeff \* Ncycles \* ((%DHWeff \* %Natural Gas\_DHW \* R\_eff) + (%Dryereff \* %Gas\_Dryer))] \* Therm\_convert

Where:

Therm\_convert = Convertion factor from kWh to Therm

= 0.03413

R\_eff = Recovery efficiency factor

= 1.26[[16]](#footnote-16)

%Natural Gas\_DHW = Percentage of DHW savings assumed to be Natural Gas

|  |  |
| --- | --- |
| **DHW fuel** | **%Natural Gas\_DHW** |
| Electric | 0% |
| Natural Gas | 100% |
| Unknown | 84%[[17]](#footnote-17) |

%Gas\_Dryer = Percentage of dryer savings assumed to be Natural Gas

| **Dryer fuel** | **%Gas\_Dryer** |
| --- | --- |
| Electric | 100% |
| Natural Gas | 0% |
| Unknown | 44%[[18]](#footnote-18) |

Other factors as defined above

Using the default assumptions provided above, the prescriptive savings for each configuration are presented below:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **ΔTherms** | | | | | | | | |
|  | **Electric DHW**  **Electric Dryer** | **Gas DHW**  **Electric Dryer** | **Electric DHW**  **Gas Dryer** | **Gas DHW**  **Gas Dryer** | **Electric DHW Unknown Dryer** | **Gas DHW Unknown Dryer** | **Unknown DHW Electric Dryer** | **Unknown DHW**  **Gas Dryer** | **Unknown DHW Unknown Dryer** |
| ENERGY STAR | 0.00 | 3.7 | 2.3 | 6.0 | 1.0 | 4.7 | 3.1 | 5.4 | 4.1 |
| ENERGY STAR Most Efficient | 0.00 | 6.6 | 3.1 | 9.8 | 8.0 | 8.0 | 5.6 | 8.7 | 6.9 |



**Water Impact Descriptions and Calculation**

∆Water (gallons) = Capacity \* (IWFbase - IWFeff) \* Ncycles

Where

IWFbase = Integrated Water Factor of baseline clothes washer

= 5.92[[19]](#footnote-19)

IWFeff = Water Factor of efficient clothes washer

= Actual. If unknown assume average values provided below.

Using the default assumptions provided above, the prescriptive water savings for each efficiency level are presented below:

| **Efficiency Level** | **IWF[[20]](#footnote-20)** | **∆Water**  **(gallons per year)** |
| --- | --- | --- |
| Federal Standard | 5.92 | 0.0 |
| ENERGY STAR | 3.93 | 2024 |
| ENERGY STAR Most Efficient | 3.21 | 2760 |

**Deemed O&M Cost Adjustment Calculation**

N/A

**Measure Code: RS-APL-ESCL-V04-160601**

1. See http://www1.eere.energy.gov/buildings/appliance\_standards/product.aspx/productid/39. [↑](#footnote-ref-1)
2. Based on DOE Life-Cycle Cost and Payback Period Excel-based analytical tool, available online at:

   [http://www1.eere.energy.gov/buildings/appliance\_standards/residential/clothes\_washers\_support\_stakeholder\_negotiations.html](http://www.ahrinet.org/ARI/util/showdoc.aspx) [↑](#footnote-ref-2)
3. Cost estimates are based on Navigant analysis for the Department of Energy (see CW Analysis\_09092014.xls). This analysis looked at incremental cost and shipment data from manufacturers and the Association of Home Appliance Manufacturers and attempts to find the costs associated only with the efficiency improvements. The ENERGY STAR level in this analysis was made the baseline (as it is now equivalent), the CEE Tier 3 level was made ENERGY STAR and ENERGY STAR Most efficient was extrapolated based on equal rates. Note these assumptions should be reviewed as qualifying product becomes available. [↑](#footnote-ref-3)
4. Calculated from Itron eShapes, 8760 hourly data by end use for Missouri, as provided by Ameren. [↑](#footnote-ref-4)
5. Definition provided on the Energy star website. [↑](#footnote-ref-5)
6. Tsavings represents total kWh only when water heating and drying are 100% electric. [↑](#footnote-ref-6)
7. Based on the average clothes washer volume of all units that pass the new Federal Standard on the California Energy Commission (CEC) database of Clothes Washer products accessed on 08/28/2014. 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-7)
8. Weighted average IMEF of Federal Standard rating for Front Loading and Top Loading units. Weighting is based upon the relative top v front loading percentage of available non-ENERGY STAR product in the CEC database. [↑](#footnote-ref-8)
9. Weighted average of 295 clothes washer cycles per year (based on 2009 Residential Energy Consumption Survey (RECS) national sample survey of housing appliances section, state of IL: [http://www.eia.gov/consumption/residential/data/2009/](http://www.focusonenergy.com/files/Document_Management_System/Evaluation/bpdeemedsavingsmanuav10_evaluationreport.pdf)

   If utilities have specific evaluation results providing a more appropriate assumption for single-family or multi-family homes, in a particular market, or geographical area then that should be used. [↑](#footnote-ref-9)
10. IMEF values are the weighted average of the new ENERGY STAR specifications. Weighting is based upon the relative top v front loading percentage of available ENERGY STAR and ENERGY STAR Most Efficient product in the CEC database. See “CW Analysis\_09092014.xls” for the calculation. [↑](#footnote-ref-10)
11. The percentage of total energy consumption that is used for the machine, heating the hot water or by the dryer is different depending on the efficiency of the unit. Values are based on a weighted average of top loading and front loading units based on data from Life-Cycle Cost and Payback Period Excel-based analytical tool, available online at: [http://www1.eere.energy.gov/buildings/appliance\_standards/residential/clothes\_washers\_support\_stakeholder\_negotiations.html](http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDehumidifier.xls). See “CW Analysis\_09092014.xls” for the calculation. [↑](#footnote-ref-11)
12. 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-12)
13. Default assumption for unknown is based on percentage of homes with electric dryer from 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-13)
14. Based on a weighted average of 295 clothes washer cycles per year assuming an average load runs for one hour (2009 Residential Energy Consumption Survey (RECS) national sample survey of housing appliances section: [http://www.eia.gov/consumption/residential/data/2009/](http://ilsag.org/yahoo_site_admin/assets/docs/ComEd_PY2_CACES_Evaluation_Report_2010-10-18.299122020.pdf)) [↑](#footnote-ref-14)
15. Calculated from Itron eShapes, 8760 hourly data by end use for Missouri, as provided by Ameren. [↑](#footnote-ref-15)
16. To account for the different efficiency of electric and Natural Gas hot water heaters (gas water heater: recovery efficiencies ranging from 0.74 to 0.85 (0.78 used), and electric water heater with 0.98 recovery efficiency ([http://www.energystar.gov/ia/partners/bldrs\_lenders\_raters/downloads/Waste\_Water\_Heat\_Recovery\_Guidelines.pdf](http://www.energystar.gov) ). Therefore a factor of 0.98/0.78 (1.26) is applied. [↑](#footnote-ref-16)
17. Default assumption for unknown fuel is based on percentage of homes with gas dryer from 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-17)
18. Ibid. [↑](#footnote-ref-18)
19. Weighted average IWF of Federal Standard rating for Front Loading and Top Loading units. Weighting is based upon the relative top v front loading percentage of available non-ENERGY STAR product in the CEC database. [↑](#footnote-ref-19)
20. IWF values are the weighted average of the new ENERGY STAR specifications. Weighting is based upon the relative top v front loading percentage of available ENERGY STAR and ENERGY STAR Most Efficient product in the CEC database. See “CW Analysis\_09092014.xls” for the calculation. [↑](#footnote-ref-20)