

1.7 ENERGY STAR Clothes Washer

Algorithms

$$\text{Customer kWh} = \left(\left(\frac{\text{Cap} \times N}{\text{IMEF}_{\text{Base}}} \right) \times \left(\text{CW}_{\text{Base}} + \frac{\text{DHW}_{\text{Base}} \times \% \text{ElectricDHW}}{R_{\text{Eff}}} + (\text{DryBase} \times \% \text{ElecDry}) \right) \right) - \left(\left(\frac{\text{Cap} \times N}{\text{IMEF}_{\text{EE}}} \right) \times \left(\text{CW}_{\text{EE}} + \frac{\text{DHW}_{\text{EE}} \times \% \text{ElectricDHW}}{R_{\text{Eff}}} + (\text{DryEE} \times \% \text{ElecDry}) \right) \right)$$

$$\text{Customer Coincident kW} = \frac{\text{Customer kWh}}{\text{Hours}} \times \text{Coincidence Factor}$$

$$\text{Customer Dth} = \left(\left(\frac{\text{Cap} \times N}{\text{IMEF}_{\text{Base}}} \right) \times \left(\frac{\text{DHW}_{\text{Base}} \times (1 - \% \text{ElectricDHW})}{R_{\text{Eff}}} + \text{DryBase} \times (1 - \% \text{ElecDry}) \right) \right) - \left(\left(\frac{\text{Cap} \times N}{\text{IMEF}_{\text{EE}}} \right) \times \left(\frac{\text{DHW}_{\text{EE}} \times (1 - \% \text{ElectricDHW})}{R_{\text{Eff}}} + \text{DryEE} \times (1 - \% \text{ElecDry}) \right) \right) \times 0.003412$$

$$\text{Non-Energy O\&M} = \text{Cap} \times N \times (\text{IWF}_{\text{Base}} - \text{IWF}_{\text{EE}}) \times \text{Water-Sewer-Rate}$$

Variables

Cap	3.45	Clothes washer drum capacity (ft ³). If unknown, assume 3.45ft ³ (Reference 1)
IMEF _{Base}	Table 1.7.1	Integrated Modified Energy Factor for Federal Minimum equipment (ft ³ /kWh/cycle) (Reference 1)
IMEF _{EE}	Table 1.7.1	Difference in cost between the standard equipment and the more efficient equipment
N	Table 1.7.1	Annual number of loads (Reference 1)
CW _{Base}	7%	Percentage of total energy consumption for clothes washer operation for baseline equipment (Reference 1)
CW _{EE}	6%	Percentage of total energy consumption for clothes washer operation for EnergyStar equipment (Reference 1)
DHW _{Base}	33%	Percentage of total energy consumption for water heating for baseline equipment (Reference 1)
DHW _{EE}	31%	Percentage of total energy consumption for water heating for EnergyStar equipment (Reference 1)
%Electric _{DHW}	Table 1.7.2	Percent of domestic hot water savings assumed to be electric (Reference 1)
DryBase	59%	Percent of total energy consumption for dryer operation in baseline case.
DryEE	62%	Percent of total energy consumption for dryer operation in efficient case.
%ElecDry	See Table 1.2.7	Percent of dryer operation assumed to be electric.
IWF _{Base}	See Table 1.1.7	Baseline Integrated Water Factor (Gal / cycle / cu.ft.) for a standard clothes washer with a capacity of 1.6 cu.ft. or greater
IWF _{EE}	See Table 1.1.7	EnergyStar Integrated Water Factor (Gal / cycle / cu.ft.) for a clothes washer with a capacity of 1.6 cu.ft. or greater
Water-Sewer-Rate	\$0.008797	Water rate + Sewer rate per saved gallon of water.
Conversion Factor	0.0034120	convert kWh to Dtherms (factor is Dth/kWh)
Incremental Cost	\$50.00	Incremental Cost for EnergyStar Top Loading Clothes Washer
Incremental Cost	\$190.00	Incremental Cost for EnergyStar Front Loading Clothes Washer
R _{Eff}	Table 1.7.2	Recovery efficiency (Reference 1)
Coincidence Factor	Table 1.7.1	Coincidence Factor (Reference 1)
Hours	Table 1.7.1	Annual Hours of Use (Reference 1)
Lifetime	11	Measured Lifetime (Reference 1)

Provided by Product Vendor or Customer

M&V Verified

Quantity of ENERGY STAR Clothes Washers Installed	Yes	
ENERGY STAR Clothes Washer Water Heater Fuel Type	Yes	Provide the Water Heater fuel type for the clothes washer's hot water; Electric or Natural Gas.
ENERGY STAR Clothes Washer-Sector	Yes	
Clothes Dryer Fuel Type	Yes	Provide the Clothes Dryer's fuel type; Electric or Natural Gas

Table 1.1.7 Sector-Breakout Clothes Washer Efficiency and Operational Information

Sector	Unit Type	IMEF _{Base}	IMEF _{EE}	N	Hours	Coincidence	IWF _{Base}	IWF _{EE}
Single-Family	Top and Front-Load-Average	1.64	2.24	258	258	3.8%		
	Top Loading	1.84	2.76	258	258	3.8%	6.5	4.3
	Front Loading	1.57	2.06	258	258	3.8%	4.7	3.7
Multi-Family	Commercial Front Load	2.00	2.20	1244	1244	4.5%		

Table 1.7.2 Washer Fuel Type by Factor

Fuel Type	%Electric _{DHW}	R _{Eff}	%ElecDry
Electric	100%	98%	100%
Gas	0%	78%	0%

References:

1. State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs Version 3.1 January 20, 2020
2. 2008 Database for Energy Efficient Resources, Version 2008.2.05, EUL/RUL Values, October 10, 2008.
3. Weighted average of 258 clothes washer cycles per year (based on 2015 Residential Energy Consumption Survey (RECS) national sample survey of housing appliances section, West North Central Region. nups4/www.eld.gov/Lurisumpuun/residential/data/2015/hc/phpi

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

4. 10 CFR Parts 429 and 430 [Docket Number EERE-2008—BT—STD— 0019] RIN 1904—AB90 Energy Conservation Program: Energy Conservation Standards
5. 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.
6. The percentage of total (gas and electric fuel types) water heating units that are electric calculated from 2015 Residential Energy Consumption Survey (RECS) data. <https://www.2ia.gov/consumption/residential/data/2015/hc/php/hc8.7.phr> Fuel used by main water heater section.
7. The percentage of total (gas and electric fuel types) dryer units that are electric calculated from 2015 Residential Energy Consumption Survey (RECS) data.
8. 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)
9. Calculated from Itron eShapes, 8,760 hourly data by end-use for Missouri, as provided by Ameren. Reference is from Illinois Technical Reference Manual June
10. Clothes Washer Program Requirements Version 7.0.
<https://www.energystar.gov/certified-products/sites/products/uploads/files/ENERGY%20STAR%20Final%20Version%207%20Clothes>
11. Clothes Washer Program Requirements Version 8.0.
12. ENERGY STAR Calculator. https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx
13. 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
14. Department of Energy. Energy Efficiency Program for certain commercial and industrial equipment
15. Department of Energy: Energy Savings Potential and RD&D Opportunities for Commercial Building Appliances Report. 2009.
16. 2015 Residential Energy Consumption Survey (RECS) Data
17. California Public Utilities District. Res Retro HIM Evaluation Report. Weighted by quantity of each efficiency level from MESP SPECTRUM. Reference it from

Changes from Recent Filing:

15.1 Modeled Residential New Construction

Algorithms

$$\text{Customer kWh} = \text{kWh}_{\text{Reference Home}} - \text{kWh}_{\text{As Built Home}}$$

$$\text{Summer Peak kW} = \text{Summer Peak kW}_{\text{Reference Home}} - \text{Summer Peak kW}_{\text{As Built Home}}$$

$$\text{Winter Peak kW} = \text{Winter Peak kW}_{\text{Reference Home}} - \text{Winter Peak kW}_{\text{As Built Home}}$$

$$\text{Customer Dth} = \text{Dth}_{\text{Reference}} - \text{Dth}_{\text{As Built Home}}$$

$$\% \text{ Better Than Code} = \frac{(\text{MMBTU}_{\text{Reference Home}} - \text{MMBTU}_{\text{As Built Home}})}{\text{MMBTU}_{\text{Reference Home}}}$$

$$\text{MMBTU}_{\text{Reference Home}} = \{ (\text{Heating kWh}_{\text{Reference Home}} + \text{Cooling kWh}_{\text{Reference Home}} + \text{Water Heating kWh}_{\text{Reference Home}} + \text{Lighting and Appliance kWh}_{\text{Reference Home}}) \times \frac{3,412}{1,000,000} \} + \{ (\text{Heating th}_{\text{Reference Home}} + \text{Water Heating th}_{\text{Reference Home}} + \text{Lighting and Appliance th}_{\text{Reference Home}}) \times \frac{1}{10} \}$$

$$\text{MMBTU}_{\text{As Built Home}} = \{ (\text{Heating kWh}_{\text{As Built Home}} + \text{Cooling kWh}_{\text{As Built Home}} + \text{Water Heating kWh}_{\text{As Built Home}} + \text{Lighting and Appliance kWh}_{\text{As Built Home}}) \times \frac{3,412}{1,000,000} \} + \{ (\text{Heating th}_{\text{As Built Home}} + \text{Water Heating th}_{\text{As Built Home}} + \text{Lighting and Appliance th}_{\text{As Built Home}}) \times \frac{1}{10} \}$$

$$\text{ICC As Built Home} = \left(\frac{\text{ICC}}{\text{SF}_a} \times \% \text{ Better Than Code}^3 + \frac{\text{ICC}}{\text{SF}_b} \times \% \text{ Better Than Code}^2 + \frac{\text{ICC}}{\text{SF}_c} \times \% \text{ Better Than Code} + \frac{\text{ICC}}{\text{SF}_d} \right) \times \text{ICC Adj Factor}$$

$$\text{ICC Adj Factor} = 1 + (\text{ICC}_{\text{Adj a}} \times \ln(\text{Home Size}) + \text{ICCA}_{\text{dj b}})$$

Variables

Coincidence Factor	90%	Deemed coincidence factor
Lifetime	20	Deemed lifetime
ARR-Gas		Deemed gas benefit allocation factor
ICC _{ADJ a}	Table 15.1.1	Constants for use in calculating an Incremental Cost / Square Foot of home. The cost curve is derived from information provided by Residential Science Resources estimates and home modeling of the most common measures implemented to improve the envelope performance over local codes (Reference 4).
ICC _{ADJ b}	Table 15.1.1	
ICC/SF _a	Table 15.1.2	Constants for use in calculating an adjustment factor to correct the incremental cost for home size. An increase in homes size reduces the cost per square foot for the same set of measures due to economies of scale. This factor is used in conjunction with the As Built ICC SF cost formula (Reference 4).
ICC/SF _b	Table 15.1.2	
ICC/SF _c	Table 15.1.2	
ICC/SF _d	Table 15.1.2	

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Modeler Inputs	M&V Verified	
Percent Better Than Code	No Yes	Calculated percent better than baseline code.
Baseline Energy Code	No Yes	IECC2006 thru IECC2018.
Home Area (sq/ft)	No Yes	Total modeled conditioned space of home (sqft)
Final HERS Index NoPV	No Yes	As-Built Home's HERS Index Score calculated by the Home Rater using a software modeling tool and provided under HERS Index (Final)
EStar Certified	No Yes	Energy Star v3 certified
Ref Home Heat Therms	No Yes	Reference home gas heating energy
Ref Home Heat kWh	No Yes	Reference home electric heating energy
Ref Home Cool kWh	No Yes	Reference home electric cooling energy
Ref Home Water Heat Therms	No Yes	Reference home gas water heating energy
Ref Home Water Heat kWh	No Yes	Reference home electric water heating energy
Ref Home LightApp Therms	No Yes	Reference home gas lights & appliance energy
Ref Home LightApp kWh	No Yes	Reference home electric lights & appliance energy
As Built Home Heat Therms	No Yes	As-built home gas heating energy
As Built Home Heat kWh	No Yes	As-built home electric heating energy
As Built Home Cool kWh	No Yes	As-built home electric cooling energy
As Built Home Water Heat Therms	No Yes	As-built home gas water heating energy
As Built Home Water Heat kWh	No Yes	As-built home electric water heating energy
As Built Home LightApp Therms	No Yes	As-built home gas lights & appliance energy
As Built Home LightApp kWh	No Yes	As-built home electric lights & appliance energy
Ref Home Peak kW Winter	No Yes	Reference home winter demand
Ref Home Peak kW Summer	No Yes	Reference home summer demand
As Built Home Peak kW Winter	No Yes	As-built home winter demand
As Built Home Peak kW Summer	No Yes	As-built home summer demand

Table 15.1.1 Incremental Cost per Square Foot Adjustment Factor Constants

Customer Type	Cost / SF Adjustment Factor Constants	ICC _{ADJ a}	ICC _{ADJ b}
Combo & Gas Only	IECC 2006	-0.7237094011964	5.8253260979282
	IECC 2009	-0.7237094011964	5.8253260979282
	IECC 2012	-0.2389969816525	1.9388419806113
	IECC 2015	-0.2389969816525	1.9388419806113
	IECC 2018	-0.2389969816525	1.9388419806113
Electric Only	IECC 2006	-0.0331223345001	0.2235513199389
	IECC 2009	-0.0331223345001	0.2235513199389
	IECC 2012	-0.0331223345001	0.2235513199389
	IECC 2015	-0.0331223345001	0.2235513199389
	IECC 2018	-0.0331223345001	0.2235513199389

Table 15.1.2 Incremental Cost per Square Foot Formula Constants

Customer Type	Cost / SF Adjustment Factor Constants	ICC/SF _a	ICC/SF _b	ICC/SF _c	ICC/SF _d
Combo & Gas Only	IECC 2006	0.0000000000000	-1.5873776258178	3.7927326153691	-0.0238069137844
	IECC 2009	0.0000000000000	-1.5873776258178	3.7927326153691	-0.0238069137844
	IECC 2012	0.0000000000000	27.2773059522290	-1.5760510381200	0.1307241656023
	IECC 2015	0.0000000000000	27.2773059522290	-1.5760510381200	0.1307241656023
	IECC 2018	135.4064974001910	-32.1556080746469	3.6616218361661	-0.0002624153096
Electric Only	IECC 2006	0.0000000000000	56.7265518419520	-0.7931310460476	0.0501196304125
	IECC 2009	0.0000000000000	56.7265518419520	-0.7931310460476	0.0501196304125
	IECC 2012	0.0000000000000	56.7265518419520	-0.7931310460476	0.0501196304125
	IECC 2015	0.0000000000000	56.7265518419520	-0.7931310460476	0.0501196304125
	IECC 2018	0.0000000000000	13.3182292174891	3.9975225576078	-0.0978142722627

References:

1. California Measurement Advisory Committee (CALMAC) Protocols, Appendix F (www.calmac.org/events/APX_F.pdf).
2. RSR (Residential Science Resources) energy savings measure modeling, 2016
3. RSR (Residential Science Resources) energy savings measure modeling, 2019
4. RSR (Residential Science Resources) energy savings measure modeling, 2020 and 2021

Changes from Recent Filing:

Added Tankless Water Heaters (Tables 15.1.1, 15.1.2) into the envelope cost curves