1.7 ENERGY STAR Clothes Washer

Algorithms

$$Customer\ kWh = \left(\left(\frac{Cap \times N}{IMEF_{Base}}\right) \times \left(CW_{Base} + \frac{DHW_{Base} \times \%\ ElectricDHW}{R_{Eff}} + (DryBase\ x\ \%ElecDry)\right)\right) - \left(\left(\frac{Cap \times N}{IMEF_{EE}}\right) \times \left(CW_{EE} + \frac{DHW_{EE} \times \%\ ElectricDHW}{R_{Eff}} + (DryEE\ x\ \%ElecDry)\right)\right)$$

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

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

$$Non\text{-}Energy\ O\&M = Cap \times N \times (IWFBase - IWFEE) \times Water\text{-}Sewer\text{-}Rate$$

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 (Reference1)
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~~	~~1241~~	~~1241~~	~~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.guviLurisumpuun/residential/data/2015/hc/phpi

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.govicertified-products/sites/products/uploads/files/ENERGY%2OSTAR%20Final%20Version%207 0%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 Efficiiency 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:

18.7 Residential Smart Thermostats

Algorithms

$$Customer\ kWh = Customer\ Cooling\ kWh + Customer\ Heating\ kWh$$

$$Customer\ Coincident\ kW = Customer\ kW * Coincidence\ Factor$$

Smart Thermostat Savings:

$$Customer\ kW = (Cooling\ kW * TStat\ Qty\ Factor) \times ES\ Reduction_{cooling} * Cooling\ Scaling\ Factor$$

$$Customer\ Cooling\ kWh = (Cooling\ Tons * TStat\ Qty\ Factor) * \frac{12}{SEER_{Avg}} * EFLH_{Cooling} * ES\ Reduction_{cooling} * Cooling\ Scaling\ Factor$$

~~$Customer\ Heating\ kWh = (Heating\ kW * TStat\ Qty\ Factor) * ES\ Reduction_{heating} * EFLH\_Heat * Heating\ Scaling\ Factor$~~

$$Customer\ DTh = (Baseline\ DTh * TStat\ Qty\ Factor) * ES\ Reduction_{heating} * Heating\ Scaling\ Factor$$

Thermostat Optimization Savings:

$$Customer\ kW = Cooling\ kW * (1 - ES\ Reduction\_cooling) * Tstat\_Optimzation\_Reduction * Cooling\ Scaling\ Factor$$

$$Customer\ Cooling\ kWh = Cooling\ Tons * \frac{12}{SEER_{Avg}} * EFLH_{Cooling} * (1 - ES\ Reduction_{cooling}) * Tstat\_Optimzation\_Reduction * Cooling\ Scaling\ Factor$$

$$Customer\ Heating\ kWh = Heating\ kW * EFLH\_Heat * (1 - ES\ Reduction_{heating}) * Tstat\_Optimzation\_Reduction * Heating\ Scaling\ Factor$$

$$Customer\ Dth = Baseline\ Dth * (1 - ES\ Reduction_{heating}) * Tstat\_Optimzation\_Reduction * Heating\ Scaling\ Factor$$

Variables

ES Reduction Heating	8%	Energy Star Connected Thermostat criteria for annual heating equipment runtime reduction (Reference 1)
ES Reduction Cooling	10%	Energy Star Connected Thermostat criteria for annual cooling equipment runtime reduction (Reference 1)
Typical Res Gas Heating System Effiiciency	80%	gas heating system effiiciency in existing homes
Typical Res Electric Heating System Effiiciency	100%	electric resistance heating system effiiciency in existing homes
Cooling Tons	2.690	Avgerage Home model capacity for Res Cooling (Tons)
SEER_Avg	13.400	Avgerage Home model SEER rating
EER_Avg	11.417	Avgerage Home model EER rating (converted from SEER)
Cooling kW	2.827	Forecasted High Efficiency Thermostat demand
EFLH_Cooling	See Table 18.0.1	Forecasted High Efficiency Thermostat hours use Cooling EFLH
Baseline Dth	101.1	Forecasted Home gas use estimated from average furnace program participation
Heating kW	12.989	Full load kW for electric resistance heating based on forecasted gas usage and annual operating hours.
EFLH_Heat	See Table 18.0.1	Forecasted High Efficiency Thermostat hours use Heating EFLH
TStat Qty Factor	See Table 18.7.3	The Primary Thermostat in a home saves the full EnergyStar heating or cooling criteria. A Secondary Thermostat in a home saves half of the energy and demand of a Primary Thermostat. The baseline cooling and heating demands will be adjusted by the factor based on the type of thermostat (Primary or Secondary) selected.
EnergyStar_CF	76%	Coindicence Factor for High Efficiency Thermostat
Cooling Scaling Factor	See Table 18.7.1	Cooling energy and demand percent adjustment for home types
Heating Scaling Factor	See Table 18.7.1	Heating energy percent adjustment for home types
Tstat_Optimzation_Reduction	3%	Assumed percent savings by participating in manufacturer's optimzation algorithm updates.
Lifetime	10	Measure life for ENERGY STAR Smart Thermostat (Reference 4)
Incremental Cost	See Table 18.7.2	Incremental cost for ENERGY STAR Smart Thermostat (Reference 4)

Customer Inputs	**M&V Verified**	
Certified Energy Star Connected Thermostat	Yes	
County	No	
Home Type	No	

Table 18.7.1

Home type	Single Family	Multifamily	Townhome
Cooling Scaling Factor	100%	35%	64%
Heating Scaling Factor	100%	15%	52%

Table 18.7.2	Incremental Cost
LI SFW EnergyStar Smart Thermostat	$100.00
ENERGY STAR smart thermostat (Reference	$200.00
Home Energy Squad Smart Thermostat	$125.00
Home Energy Squad upgraded Smart	$225.00

Table 18.7.3	TStat Qty Factor
Primary EnergyStar Smart Thermostat	1.0
Sedondary EnergyStar Smart Thermostat	0.5

References:

1. ENERGY STAR Connected Thermostat Key Product Criteria - https://www.energystar.gov/products/heating_cooling/smart_thermostats/key_product_criteria

2. 2017 Seasonal Savings Evaluation, Navigant, 3/5/2018
3. Xcel Study of Winter Seasonal Savings, 2017-2018, Initial Estimates
4. Lifetime of 10 years for programmable T-Stats from "Measure Life Report Residential and Commercial/Industrial Lighting and HVAC Measures", June 2007 by GDS Associates.

Changes from Recent Filing:

1. included electric heating savings
2. added Thermostat Optimization savings measure
3. clarified secondary thermostat savings for smart thermostat measures.