CLOTHES DRYER

Measure Description

This measure covers residential grade clothes dryers meeting the criteria established under the ENERGY STAR® Program, Version 1.1, effective May 5, 2017 installed in small commercial settings.[1] ENERGY STAR® clothes dryers have a higher combined energy factor (CEF), and save energy through a combination of more efficient drying and reduced runtime of the drying cycle. More efficient drying is achieved through increased insulation, modifying operating conditions, improving air circulation, and improved efficiency of motors. Reduced dryer runtime is achieved through automatic termination of the dryer cycles based on temperature and moisture sensors. Clothes dryers originally qualified for the ENERGY STAR® label in May 2014. Clothes dryers that have earned this label are approximately 20% more efficient than non-qualified models.[2]

The algorithms, inputs, and savings presented below assume a normal replacement scenario.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times Cycles_{annual} \times Load \times \left[\frac{F_{elec,baseline}}{CEF_{baseline}} - \frac{F_{elec,ee}}{CEF_{ee}}\right]$$

Peak Coincident Demand Savings

$$\Delta kW = \frac{\Delta kWh}{hrs} \times CF$$

Annual Gas Energy Savings

$$\Delta therms = units \times Cycles_{annual} \times Load \times \left[\frac{F_{gas,baseline}}{CEF_{baseline}} - \times \frac{F_{gas,ee}}{CEF_{ee}}\right] \times \frac{3{,}412}{100{,}000}$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
$Cycles_{annual}$	= Number of dryer cycles per year
Load	= Average total weight (lbs) of clothes per drying cycle
baseline	= Baseline condition or measure
ee	= Energy efficient condition or measure

[1] ENERGY STAR® Program Requirements Product Specification for Clothes Dryers, Eligibility Criteria Version 1.1, May 2017

[2] Efficiency of ENERGY STAR® products: https://www.energystar.gov/products/appliances/clothes_dryers

F_{elec} = Percentage of energy consumed that is derived from electricity
F_{gas} = Percentage of energy consumed that is derived from gas
CEF = Combined energy factor (lb/kWh)
hrs = Annual run hours of clothes dryer
CF = Coincidence Factor
3,412 = Conversion factor, one kWh equals 3,412 BTU
100,000 = Conversion factor (BTU/therm), one therm equals 100,000 BTU

Summary of Variables and Data Sources

Variable	Value	Notes
$Cycles_{annual}$		From application, or lookup based on proposed dryer type in table below.[3]
Load		Lookup based on proposed dryer type in table below.[4]
$F_{elec,baseline}$		Lookup based on proposed dryer type in table below.[5]
$F_{elec,ee}$		Lookup based on proposed dryer type in table below.[6]
$F_{gas,baseline}$		Lookup based on proposed dryer type in table below.[7]
$F_{gas,ee}$		Lookup based on proposed dryer type in table below.[8]
$CEF_{baseline}$		Lookup based on proposed dryer type in table below.[9]
CEF_{ee}		Lookup based on proposed dryer type in table below.[10]
hrs		From application, or lookup based on proposed dryer type in table below.[11]
CF	0.042	

[3] Savings calculator for ENERGY STAR® Qualified Appliances (accessed 10/18/2017)
[4] Ibid.
[5] ENERGY STAR® Program Requirements Product Specification for Clothes Dryers, Eligibility Criteria Version 1.1, May 2017
[6] Ibid.
[7] Ibid.
[8] Ibid.
[9] 10 CFR 430.32 (h)(3)
[10] ENERGY STAR® Program Requirements Product Specification for Clothes Dryers, Eligibility Criteria Version 1.1, May 2017
[11] Savings calculator for ENERGY STAR® Qualified Appliances (accessed 10/18/2017)

Key Variables Lookup Table

Variable	Dryer Type				
	Vented Gas Dryer	*Ventless or Vented Electric, Standard ≥ 4.4 ft^3*	*Ventless or Vented Electric, Compact (120V) < 4.4 ft^3*	*Vented Electric, Compact (240V) < 4.4 ft^3*	*Ventless Electric, Compact (240V) < 4.4 ft^3*
$Cycles_{annual}$	283	283	283	283	283
Load	8.45	8.45	3.00	3.00	3.00
$F_{elec,baseline}$	0.05	1.00	1.00	1.00	1.00
$F_{elec,ee}$	0.05	1.00	1.00	1.00	1.00
$F_{gas,baseline}$	0.95	0.00	0.00	0.00	0.00
$F_{gas,ee}$	0.95	0.00	0.00	0.00	0.00
$CEF_{baseline}$	3.30	3.73	3.61	3.27	2.55
CEF_{ee}	3.48	3.93	3.80	3.45	2.68
hrs	290	290	290	290	290

Coincidence Factor (CF)

The recommended value for the coincidence factor is 0.042.[12]

Baseline Efficiencies from which Savings are Calculated

The baseline condition is a standard efficiency, residential grade clothes dryer with operating specifications as defined in the Key Variables Lookup Table above.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a residential grade clothes dryer appearing on the ENERGY STAR® qualified products list.

Operating Hours

Operating hours for residential clothes dryers are provided in the Key Variables Lookup Table above. In the absence of justifiable default operating characteristics for residential grade clothes dryers installed in small commercial facilities, residential values are assumed.

Effective Useful Life (EUL)

See Appendix P.

[12] Based on Central Maine Power Company "Residential End-Use Metering Project", 1988. Using 8,760 data for electric clothes dryers, calculating the CF according to the PJM peak definition. This study is not publicly available, but is referenced by the Pennsylvania Technical Reference Manual, State of Pennsylvania, 2016. http://www.puc.state.pa.us/filing_resources/issues_laws_regulations/act_129_information/technical_reference_manual.aspx

Ancillary Fossil Fuel Savings Impacts

A clothes dryer releases heat to the surrounding environment. Conventional vented dryers also vent air outside the building. The associated HVAC impact of dryers depends upon a number of variables including climate and placement of a dryer (i.e., in a conditioned or unconditioned space). It is an area of ongoing research.[13] These impacts are excluded from the methodology prescribed herein until they can be quantified and substantiated through independent research.

Ancillary Electric Savings Impacts

See Ancillary Fossil Fuel Savings Impacts section above.

References

1. ENERGY STAR® Program Requirements Product Specification for Clothes Dryers, Eligibility Criteria Version 1.1, May 2017
   Available from:
   https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Final%20Version%201.1%20Clothes%20Dryers%20Specification%20-%20Program%20Commitment%20Criteria%20and%20Eligibility%20Criteria.pdf
2. Savings calculator for ENERGY STAR® Qualified Appliances
   Available from:
   https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx
3. 10 CFR 430.32 Energy and water conservation standards and their compliance dates.
   Available from: http://www.ecfr.gov/cgi-bin/text-idx?SID=a9921a66f2b4f66a32ec851916b7b9d9&mc=true&node=se10.3.430_132&rgn=div8
4. Pennsylvania Technical Reference Manual, State of Pennsylvania, 2016.
   Available from: http://www.puc.pa.gov/pcdocs/1370278.docx
5. ENERGY STAR® Market & Industry Scoping Report: Residential Clothes Dryers, November 2011
   Available from:
   https://www.energystar.gov/sites/default/files/asset/document/ENERGY_STAR_Scoping_Report_Residential_Clothes_Dryers.pdf

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[13] ENERGY STAR® Market & Industry Scoping Report: Residential Clothes Dryers, November 2011

TIER 1 ADVANCED POWER STRIP

Measure Description

This measure covers the installation of Tier 1 Advanced Power Strips (APS) in office workstations. The Tier 1 APS makes use of a control outlet to disconnect the controlled plugs when the load on the control outlet (usually a computer) is reduced below a threshold. In this case, the reduction below threshold of the control plug happens when the computer shuts down or enters standby mode. Therefore, the overall load of a centralized group of equipment (e.g. monitors and other peripherals for the computer) can be reduced.

Method for Calculating Annual Energy and Peak Coincident Demand Savings[1]

Annual Electric Energy Savings

$$\Delta kWh = units \times \begin{bmatrix} \Delta kW_{wkday} \times \left(hrs_{wkday} - hrs_{wkday-open}\right) \\ + \\ \Delta kW_{wkend} \times \left(hrs_{wkend} - hrs_{wkend-open}\right) \end{bmatrix} \times \frac{8{,}760}{168}$$

Peak Coincident Demand Savings

$$\Delta kW = N/A$$

Annual Gas Energy Savings

$$\Delta therms = N/A$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
ΔkW_{wkday}	= Average power reduction during weekday off hours
ΔkW_{wkend}	= Average power reduction during weekend off hours
hrs_{wkday}	= Total hours during the work week (Monday 7:30 AM to Friday 5:30 PM)
hrs_{wkend}	= Total hours during the weekend (Friday 5:30 PM to Monday 7:30 AM)
$hrs_{wkday,open}$	= Hours the office is open during the work week
$hrs_{wkend,open}$	= Hours the office is open during the weekend
8,760	= Hours in one year
168	= Hours in one week

[1] Savings algorithm reconstructed from weekday and weekend savings information in Sheppy *et. al*, and verified against savings in Acker *et. al* and savings in: BPA, "Smart Power Strip Energy Savings Evaluation: Ross Complex," (2011). Office stations are assumed to have zero or minimal standby losses during normal operating hours.

Summary of Variables and Data Sources

Variable	Value	Notes
ΔkW_{wkday}	0.0315	Deemed value from IDL and NREL/NAVFAC study, determined by reduction in off-hours demand. See Deemed Savings Background section below for additional detail.
ΔkW_{wkend}	0.0067	Deemed value from IDL and NREL/NAVFAC study, determined by reduction in off-hours demand. See Deemed Savings Background section below for additional detail.
hrs_{wkday}	106	
$hrs_{wkday,open}$		From application. If unknown, use 50 hours.[2]
hrs_{wkend}	62	
$hrs_{wkend,open}$		From application. If unknown, use 0 hours.[3]

Deemed Savings Background

Since the introduction of the Tier 1 APS for commercial applications, three studies of its performance in commercial office settings have been conducted. Their ex-post estimates for savings are in relative agreement, between 134 and 149 kWh. The three studies are:

1. A University of Idaho Integrated Design Lab (IDL) project studying 49 load-sensing power strips in a large, private office building. Baseline data was gathered for one year and post-period data was gathered for 3 months. The study broke out findings into weekday, weekend, and holiday categories.[4]
2. A National Renewable Energy Laboratory (NREL) and Naval Facilities Engineering Command (NAVFAC) joint APS evaluation, with 100 load-sensing power strips. Whole building load shapes were monitored pre and post. This study had five weeks of baseline data and six weeks of treatment data.[5]
3. A Bonneville Power Administration APS evaluation at the Ross Complex, in which 48 strips were installed for a pre- and post-treatment period of three weeks each. Data for this study was measured at the individual power strip level.[6]

The calculation for energy savings uses the detailed breakdowns of energy savings from the IDL study and the assumption that savings only occur outside of normal business hours. The value of 31.5 watts reduced during off-hours on weekdays was calculated with data from the IDL study and aligns with the graphically shown load reduction in the NREL/NAVFAC study. The same method was performed for the weekends to obtain the wattage reduced. The number from the IDL study of 6.7 watts reduced on weekends is more conservative than the NREL/NAVFAC results and is used for this calculation.

Coincidence Factor (CF)

The recommended value for the coincidence factor is N/A. The majority of kWh savings are assumed to occur during off-hours, so no peak coincident demand savings are deemed.

[2] Assumes an office operating schedule of M - F, 7:30AM – 5:30PM
[3] Assumes an office operating schedule of M - F, 7:30AM – 5:30PM
[4] Acker *et al*
[5] Sheppy *et al*
[6] BPA, "Smart Power Strip Energy Savings Evaluation," Ross Complex, Vancouver, WA (2011)

Baseline Efficiencies from which Savings are Calculated

The baseline condition is an office workstation with no plug load control system.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is an office workstation with a tier 1 plug load control advanced power strip.

Operating Hours

The annual operating hours of the measure, assuming that the APS is operating when it is reducing load, can be calculated by:

$$hours = \begin{bmatrix} (hrs_{wkday} - hrs_{wkday-open}) \\ + \\ (hrs_{wkend} - hrs_{wkend-open}) \end{bmatrix} \times \frac{8{,}760}{168}$$

Which is equal to 6,153 hours, assuming that the office is open for 50 hours on weekdays and 0 hours on weekends. Alternatively, the operating hours of the workstation standby loads are reduced by this amount, to 2,607 hours from 8,760 hours.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

N/A

References

1. Acker, Brad et. al, "Office Space Plug Load Profiles and Energy Saving Interventions," IDL, 2012 ACEEE Summer Study on Energy Efficiency in Buildings (2012) Available from: https://fortress.wa.gov/ga/apps/SBCC/File.ashx?cid=5572
2. Sheppy, M. et al, "Reducing Plug Loads in Office Spaces" Hawaii and Guam Energy Improvement Technology Demonstration Project, NREL/NAVFAC (January 2014) Available from: https://www.nrel.gov/docs/fy14osti/60382.pdf
3. Bonneville Power Administration, "Smart Power Strip Energy Savings Evaluation," Ross Complex, Vancouver, WA (2011) Available from: http://studylib.net/doc/8460015/smart-strip-energy-savings-evaluation-%E2%80%93-ross-complex--van...

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