4 Commercial and Industrial Measures

4.1 Agricultural End Use

4.1.1 Engine Block Timer for Agricultural Equipment

DESCRIPTION

The measure is a plug-in timer that is activated below a specific outdoor temperature to control an engine block heater in agricultural equipment. Engine block heaters are typically used during cold weather to pre-warm an engine prior to start, for convenience heaters are typically plugged in considerably longer than necessary to improve startup performance. A timer allows a user to preset the heater to come on for only the amount of time necessary to pre-warm the engine block, reducing unnecessary run time even if the baseline equipment has an engine block temperature sensor.

This measure was developed to be applicable to the following program types: RF. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient measure is an engine block heater operated by an outdoor plug-in timer (15 amp or greater) that turns on the heater only when the outdoor temperature is below 25 °F.

DEFINITION OF BASELINE EQUIPMENT

The baseline scenario is an engine block heater that is manually plugged in by the farmer to facilitate equipment startup at a later time.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life if assumed to be 3 years[32]

DEEMED MEASURE COST

The incremental cost per installed plug-in timer is $10.19[33].

COINCIDENCE FACTOR

Engine block timers only operate in the winter so the summer peak demand savings is zero.

[32]Equipment life is expected to be longer, but measure life is more conservative to account for possible attrition in use over time.

[33]Based on bulk pricing reported by EnSave, which administers the rebate in Vermont

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

ΔkWh = ISR * Use Season * %Days * HrSave/Day * kW_{heater} - ParaLd

= 78.39% * 87 days * 84.23% * 7.765 Hr/Day * 1.5 kW - 5.46 kWh

= 664 kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

N/A

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: RS-APL-ESDH-V01-120601

4.1.2 High Volume Low Speed Fans

DESCRIPTION

The measure applies to 20-24 foot diameter horizontally mounted ceiling high volume low speed (HVLS) fans that are replacing multiple non HVLS fans that have reached the end of useful life in agricultural applications.

This measure was developed to be applicable to the following program types: TOS. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to be classified as HVLS and have a VFD[34].

DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline condition is assumed to be multiple non HVLS existing fans that have reached the end of s useful life.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 10 years[35].

DEEMED MEASURE COST

The incremental capital cost for the fans are as follows[36]:

Fan Diameter Size (feet)	Incremental Cost
20	$4150
22	$4180
24	$4225

LOADSHAPE

Loadshape C34 - Industrial Motor

COINCIDENCE FACTOR

The measure has deemed kW savings therefor a coincidence factor is not applied.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS [37]

The annual electric savings from this measure are deemed values depending on fan size and apply to all building types:

[34] Act on Energy Commercial Technical Reference Manual No. 2010-4
[35] Ibid.
[36] Ibid.
[37] Ibid.

Fan Diameter Size (feet)	kWh Savings
20	6577
22	8543
24	10018

SUMMER COINCIDENT PEAK DEMAND SAVINGS[38]

The annual kW savings from this measure are deemed values depending on fan size and apply to all building types:

Fan Diameter Size (feet)	kW Savings
20	2.4
22	3.1
24	3.7

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-AGE-HVSF-V01-120601

[38] Ibid.

4.1.3 High Speed Fans

Description

The measure applies to high speed exhaust, ventilation and circulation fans that are replacing an existing unit that reached the end of its useful life in agricultural applications.

This measure was developed to be applicable to the following program types: TOS. If applied to other program types, the measure savings should be verified.

Definition of Efficient Equipment

In order for this characterization to apply, the efficient equipment is assumed to be diffuser equipped and meet the following criteria[39].

Diameter of Fan (inches)	Minimum Efficiency for Exhasut & Ventilation Fans	Minimum Efficiency for Circulation Fans
24 through 35	14.0 cfm/W at 0.10 static pressure	12.5 lbf/kW
36 through 47	17.1 cfm/W at 0.10 static pressure	18.2 lbf/kW
48 through 71	20.3 cfm/W at 0.10 static pressure	23.0 lbf/kW

Definition of Baseline Equipment

In order for this characterization to apply, the baseline condition is assumed to be an existing fan that reached the end of its useful life.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 7 years[40].

Deemed Measure Cost

The incremental capital cost for all fan sizes is $150[41].

Loadshape

Loadshape C34 - Industrial Motor

Coincidence Factor

The measure has deemed kW savings therefor a coincidence factor is not applied.

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[39] Act on Energy Commercial Technical Reference Manual No. 2010-4
[40] Ibid.
[41] Ibid.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS [42]

The annual electric savings from this measure are deemed values depending on fan size and apply to all building types:

Diameter of Fan (inches)	kWh
24 through 35	372
36 through 47	625
48 through 71	1122

SUMMER COINCIDENT PEAK DEMAND SAVINGS[43]

The annual kW savings from this measure are deemed values depending on fan size and apply to all building types:

Diameter of Fan (inches)	kW
24 through 35	0.118
36 through 47	0.198
48 through 71	0.356

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-AGE-HSF_-V01-120601

[42] Ibid.
[43] Ibid.

4.1.4 Live Stock Waterer

DESCRIPTION

This measure applies to the replacement of electric open waterers with sinking or floating water heaters with equivalent herd size watering capacity of the old unit.

This measure was developed to be applicable to the following program types: TOS. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to an electrically heated thermally insulated waterer with minimum 2 inches of insulation. A thermostat is required on unit with heating element greater than or equal to 250 watts[44].

DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline equipment is assumed to be an electric open waterer with sinking or floating water heaters that have reached the end of useful life.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 10 years[45].

DEEMED MEASURE COST

The incremental capital cost for the waters are $787.50:[46]

LOADSHAPE

Loadshape C04 - Non-Residential Electric Heating

COINCIDENCE FACTOR

The measure has deemed kW savings therefor a coincidence factor is not applied

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS [47]

The annual electric savings from this measure is a deemed value and assumed to be 1592.85 kWh.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

The annual kW savings from this measure is a deemed value and assumed to be 0.525 kW. [48]

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[44] Act on Energy Commercial Technical Reference Manual No. 2010-4
[45] Ibid.
[46] Ibid.
[47] Ibid.

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-AGE-LSW1-V01-120601

[48] Ibid.

4.2 Food Service Equipment End Use

4.2.1 Combination Oven

DESCRIPTION

This measure applies to natural gas fired high efficiency combination convection and steam ovens installed in a commercial kitchen replacing existing equipment at the end of its useful life.

This measure was developed to be applicable to the following program types: TOS. 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 new natural gas combination convection with steam oven cooking efficiency ≥ 38% and convection mode cooking efficiency ≥ 44% utilizing ASTM standard F2861 and meet idle requirements below[49]:

Idle Rate Requirements for Commercial Combination Ovens/Steamers

Combi Oven Type	Steam Mode Idle Rate	Convection Mode Idle Rate
Gas Combi < 15 pan capacity	15,000 Btu/hr	9,000 Btu/hr
Gas Combi 15-28 pan capacity	18,000 Btu/hr	11,000 Btu/hr
Gas Combi > 28 pan capacity	28,000 Btu/hr	17,000 Btu/hr

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is a new or existing natural gas combination convection and steam ovens that do not meet the efficient equipment criteria

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 12 years[50]

DEEMED MEASURE COST

The incremental capital cost for this measure is $4300[51]

LOADSHAPE

N/A

[49] http://www.fishnick.com/saveenergy/rebates/combis.pdf
[50] Deemed values from Nicor Gas were used. Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011.
[51] Ibid.

COINCIDENCE FACTOR

N/A

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

N/A

SUMMER COINCIDENT PEAK DEMAND SAVINGS

N/A

NATURAL GAS ENERGY SAVINGS

The annual natural gas energy savings from this measure is a deemed value equaling 644 therms.[52]

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-FSE-CBOV-V01-120601

[52] Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011.These deemed values should be compared to PY evaluation and revised as necessary.

4.2.2 Commercial Solid and Glass Door Refrigerators & Freezers

DESCRIPTION

This measure relates to the installation of a new reach-in commercial refrigerator or freezer meeting ENERGY STAR efficiency standards. ENERGY STAR labeled commercial refrigerators and freezers are more energy efficient because they are designed with components such as ECM evaporator and condenser fan motors, hot gas anti-sweat heaters, or high-efficiency compressors, which will significantly reduce energy consumption.

This measure was developed to be applicable to the following program types: TOS and NC. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to be a new vertical solid or glass door refrigerator or freezer or vertical chest freezer meeting the minimum ENERGY STAR efficiency level standards.

DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline equipment is assumed to be an existing solid or glass door refrigerator or freezer meeting the minimum federal manufacturing standards as specified by the Energy Policy Act of 2005.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 12 years [53].

DEEMED MEASURE COST

The incremental capital cost for this measure is provided below[54].

Type	Refrigerator incremental Cost, per unit	Freezer Incremental Cost, per unit
Solid or Glass Door		
0 < V < 15	$143	$142
15 ≤ V < 30	$164	$166
30 ≤ V < 50	$164	$166
V ≥ 50	$249	$407

[53] 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, "Effective/Remaining Useful Life Values", California Public Utilities Commission, December 16, 2008.
http://www.ctsavesenergy.org/files/Measure%20Life%20Report%202007.pdf

[54] Estimates of the incremental cost of commercial refrigerators and freezers varies widely by source. Nadel, S., Packaged Commercial Refrigeration Equipment: A Briefing Report for Program Planners and Implementers, ACEEE, December 2002, indicates that incremental cost is approximately zero. Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, February, 19, 2010, assumed incremental cost ranging from $75 to $125 depending on equipment volume. ACEEE notes that incremental cost ranges from 0 to 10% of the baseline unit cost <http://www.aceee.org/ogeece/ch5_reach.htm>. For the purposes of this characterization, assume and incremental cost adder of 5% on the full unit costs presented in Goldberg et al, State of Wisconsin Public Service Commission of Wisconsin, Focus on Energy Evaluation, Business Programs: Incremental Cost Study, KEMA, October 28, 2009.

Loadshape

Loadshape C23 - Commercial Refrigeration

Coincidence Factor

The summer peak coincidence factor for this measure is assumed to be 0.937.[55]

Algorithm

Calculation of Savings

Electric Energy Savings

ΔkWh = (kWhbase – kWhee) * 365.25

Where:

kWhbase= baseline maximum daily energy consumption in kWh

= calculated using actual chilled or frozen compartment volume (V) of the efficient unit as shown in the table below.

Type	kWhbase[56]
Solid Door Refrigerator	0.10 * V + 2.04
Glass Door Refrigerator	0.12 * V + 3.34
Solid Door Freezer	0.40 * V + 1.38
Glass Door Freezer	0.75 * V + 4.10

kWhee[57] = efficient maximum daily energy consumption in kWh

= calculated using actual chilled or frozen compartment volume (V) of the efficient unit as shown in the table below.

Type	Refrigerator kWhee	Freezer kWhee
0 < V < 15	≤ 0.089V + 1.411	≤ 0.250V + 1.250
15 ≤ V < 30	≤ 0.037V + 2.200	≤ 0.400V – 1.000
30 ≤ V < 50	≤ 0.056V + 1.635	≤ 0.163V + 6.125
V ≥ 50	≤ 0.060V + 1.416	≤ 0.158V + 6.333
Glass Door		
0 < V < 15	≤ 0.118V + 1.382	≤ 0.607V + 0.893
15 ≤ V < 30	≤ 0.140V + 1.050	≤ 0.733V – 1.000

[55] The CF for Commercial Refrigeration was calculated based upon the Ameren provided eShapes
[56] Energy Policy Act of 2005. Accessed on 7/7/10. <http://www.epa.gov/oust/fedlaws/publ_109-058.pdf>
[57] ENERGY STAR Program Requirements for Commercial Refrigerators and Freezers Partner Commitments Version 2.0, U.S. Environmental Protection Agency, Accessed on 7/7/10. < http://www.energystar.gov/ia/partners/product_specs/program_reqs/commer_refrig_glass_prog_req.pdf>

Type	Refrigerator kWhee	Freezer kWhee
30 ≤ V < 50	≤ 0.088V + 2.625	≤ 0.250V + 13.500
V ≥ 50	≤ 0.110V + 1.500	≤ 0.450V + 3.500

V = the chilled or frozen compartment volume (ft^3) (as defined in the Association of Home Appliance Manufacturers Standard HRF1–1979)

= Actual installed

365.25 = days per year

For example a solid door refrigerator with a volume of 15 would save

ΔkWh = (3.54 – 2.76) * 365.25

= 285 kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW = ΔkWh / HOURS * CF

Where:

HOURS = equipment is assumed to operate continuously, 24 hours per day, 365.25 days per year.

= 8766

CF = Summer Peak Coincidence Factor for measure

= 0.937

For example a solid door refrigerator with a volume of 15 would save

ΔkW = 285/ 8766 * .937

=0.030 kW

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-FSE-CSDO-V01-120601

4.2.3 Commercial Steam Cooker

DESCRIPTION

To qualify for this measure the installed equipment must be an ENERGY STAR® steamer in place of a standard steamer in a commercial kitchen. Savings are presented dependent on the pan capacity and corresponding idle rate at heavy load cooking capacity and if the steamer is gas or electric.

This measure was developed to be applicable to the following program types: TOS. 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 as follows:

Gas	Electric
ENERGY STAR® qualified with 38% minimum cooking energy efficiency at heavy load (potato) cooking capacity for gas steam cookers.	ENERGY STAR® qualified with 50% minimum cooking energy efficiency at heavy load (potato) cooking capacity for electric steam cookers.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is assumed to be a non-ENERGY STAR® commercial steamer at end of life. It is assumed that the efficient equipment and baseline equipment have the same number of pans.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 12 years[58]

DEEMED MEASURE COST

The incremental capital cost for this measure is $998[59] for a natural gas steam cooker or $2490[60] for an electric steam cooker.

LOADSHAPE

Loadshape C01 - Commercial Electric Cooking

COINCIDENCE FACTOR

Summer Peak Coincidence Factor for measure is provided below for different building type[61]:

Location	CF
Fast Food Limited Menu	0.32
Fast Food Expanded Menu	0.41
Pizza	0.46

[58] California DEER 2008 which is also used by both the Food Service Technology Center and ENERGY STAR®.
[59] Source for incremental cost for efficient natural gas steamer is RSG Commercial Gas Steamer Workpaper, January 2012.
[60] Source for efficient electric steamer incremental cost is $2,490 per 2009 PG&E Workpaper - PGECOFST104.1 - Commercial Steam Cooker - Electric and Gas as reference by KEMA in the ComEd C & I TRM.
[61] Minnesota 2012 Technical Reference Manual, Electric Food Service_v03.2.xls, http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech. Unknown is an average of other location types

Location	CF
Full Service Limited Menu	0.51
Full Service Expanded Menu	0.36
Cafeteria	0.36
Unknown	0.40

Algorithm

CALCULATION OF SAVINGS

Formulas below are applicable to both gas and electric steam cookers. Please use appropriate lookup values and identified flags.

ENERGY SAVINGS

ΔSavings = (ΔIdle Energy + ΔPreheat Energy + ΔCooking Energy) * Z

For a gas cooker: ΔSavings = ΔBtu * 1/100,000 *Z

For an electric steam cooker: ΔSavings = ΔkWh *Z

Where:

Z = days/yr steamer operating (use 365.25 days/yr if heavy use restaurant and exact number unknown)

ΔIdle Energy = $((((1- CSM_{\%Baseline})* IDLE_{BASE} + CSM_{\%Baseline} * PC_{BASE} * E_{FOOD} / EFF_{BASE})*(HOURS_{day} - (F / PC_{Base}) - (PRE_{number} *0.25))) - (((1- CSM_{\%ENERGYSTAR}) * IDLE_{ENERGYSTAR} + CSM_{\%ENERGYSTAR} * PC_{ENERGY} * E_{FOOD} / EFF_{ENERGYSTAR}) * (HOURS_{Day} - (F l/ PC_{ENERGY}) - (PRE_{number} * 0.25))))$

Where:

$CSM_{\%Baseline}$ = Baseline Steamer Time in Manual Steam Mode (% of time)

= 90%[62]

$IDLE_{Base}$ = Idle Energy Rate of Base Steamer[63]

Number of Pans	$IDLE_{BASE}$ - Gas, Btu/hr	$IDLE_{BASE}$ - Electric, kw
3	11,000	1.0
4	14,667	1.33
5	18,333	1.67
6	22,000	2.0

[62]Food Service Technology Center 2011 Savings Calculator
[63]Food Service Technology Center 2011 Savings Calculator

PC_{Base} = Production Capacity of Base Steamer[64]

Number of Pans	PC_{BASE}, gas (lbs/hr)	PC_{BASE}, electric (lbs/hr)
3	65	70
4	87	93
5	108	117
6	130	140

E_{FOOD}= Amount of Energy Absorbed by the food during cooking known as ASTM Energy to Food (Btu/lb or kW/lb)

=105 Btu/lb[65] (gas steamers) or 0.0308[8] (electric steamers)

EFF_{BASE} =Heavy Load Cooking Efficiency for Base Steamer

=15%[66] (gas steamers) or 26%[9] (electric steamers)

$HOURS_{day}$ = Average Daily Operation (hours)

Type of Food Service	Hoursday[67]
Fast Food, limited menu	4
Fast Food, expanded menu	5
Pizza	8
Full Service, limited menu	8
Full Service, expanded menu	7
Cafeteria	6
Unknown	6[68]
Custom	Varies

F = Food cooked per day (lbs/day)

= custom or if unknown, use 100 lbs/day[69]

[64]Production capacity per Food Service Technology Center 2011 Savings Calculator of 23.3333 lb/hr per pan for electric baseline steam cookers and 21.6667 lb/hr per pan for natural gas baseline steam cookers. ENERGY STAR® savings calculator uses 23.3 lb/hr per pan for both electric and natural gas baseline steamers.
[65]Reference ENERGY STAR® savings calculator at http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COC.
[66]Reference Food Service Technology Center 2011 Savings Calculator values as used by Consortium for Energy Efficiency, Inc. for baseline electric and natural gas steamer heavy cooking load energy efficiencies.
[67]Minnesota 2012 Technical Reference Manual, Electric Food Service_v03.2.xls, http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech
[68]Unknown is average of other locations

$CSM_{\%ENERGYSTAR}$ = ENERGY STAR Steamer's Time in Manual Steam Mode (% of time)[70]

= 0%

$IDLE_{ENERGYSTAR}$ = Idle Energy Rate of ENERGY STAR®[71]

Number of Pans	$IDLE_{ENERGY STAR}$ – gas, (Btu/hr)	$IDLE_{ENERGY STAR}$ – electric, (kW)
3	6250	0.40
4	8333	0.53
5	10417	0.67
6	12500	0.80

PC_{ENERGY} = Production Capacity of ENERGY STAR® Steamer[72]

Number of Pans	PC_{ENERGY} - gas(lbs/hr)	PC_{ENERGY} – electric (lbs/hr)
3	55	50
4	73	67
5	92	83
6	110	100

$EFF_{ENERGYSTAR}$ = Heavy Load Cooking Efficiency for ENERGY STAR® Steamer(%)

=38%[73] (gas steamer) or 50%[15] (electric steamer)

PRE_{number} = Number of preheats per day

=1[74] (if unknown, use 1)

ΔPreheat Energy = (PRE_{number} * Δ Pre_{heat})

[69]Reference amount used by both Food Service Technology Center and ENERGY STAR® savings calculator

[70]Reference information from the Food Service Technology Center siting that ENERGY STAR® steamers are not typically operated in constant steam mode, but rather are used in timed mode. Reference ENERGY STAR® savings calculator at http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COC for efficient steamer. Both baseline & efficient steamer mode values should be considered for users in Illinois market.

[71]Food Service Technology Center 2011 Savings Calculator

[72]Production capacity per Food Service Technology Center 2011 Savings Calculator of 18.3333 lb/hr per pan for gas ENERGY STAR® steam cookers and 16.6667 lb/hr per pan for electric ENERGY STAR® steam cookers. ENERGY STAR® savings calculator uses 16.7 lb/hr per pan for electric and 20 lb/hr for natural gas ENERGY STAR® steamers.

[73]Reference Food Service Technology Center 2011 Savings Calculator values as used by Consortium for Energy Efficiency, Inc. for Tier 1A and Tier 1B qualified electric and natural gas steamer heavy cooking load energy efficiencies and http://www.energystar.gov/ia/partners/product_specs/program_reqs/Commercial_Steam_Cookers_Program_Requirements.pdf?7010-36eb

[74]Reference ENERGY STAR® savings calculator at http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COC and Food

Where:

PRE_{number} = Number of Preheats per Day

=1[75](if unknown, use 1)

PRE_{heat} = Preheat energy savings per preheat

= 11,000 Btu/preheat[76] (gas steamer) or 0.5 kWh/preheat[77] (electric steamer)

ΔCooking Energy = ((1/ EFFBASE) - (1/ EFFENERGY STAR®)) * F * E_{FOOD}

Where:

EFF_{BASE} =Heavy Load Cooking Efficiency for Base Steamer

=15%[78] (gas steamer) or 26%[28] (electric steamer)

$EFF_{ENERGYSTAR}$ =Heavy Load Cooking Efficiency for ENERGY STAR® Steamer

=38%[79] (gas steamer) or 50%[23] (electric steamer)

F = Food cooked per day (lbs/day)

= custom or if unknown, use 100 lbs/day[80]

E_{FOOD} = Amount of Energy Absorbed by the food during cooking known as ASTM Energy to Food[81]

E_{FOOD} - gas(Btu/lb)	E_{FOOD} (kWh/lb)
105[82]	0.0308[83]

[75]Reference ENERGY STAR® savings calculator at http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COC and Food

[76]Ohio TRM which references 2002 Food Service Technology Center "Commercial Cooking Appliance Technology Assessment" Chapter 8: Steamers. This is time also used by ENERGY STAR® savings calculator at http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COC. 11,000 Btu/preheat is from 72,000 Btu/hr * 15 min/hr /60 min/hr for gas steamers and 0.5 kWh/preheat is from 6 kW/preheat * 15 min/hr / 60 min/hr

[77] Reference Food Service Technology Center 2011 Savings Calculator values for Baseline Preheat Energy.

[78] Reference Food Service Technology Center 2011 Savings Calculator values as used by Consortium for Energy Efficiency, Inc. for baseline electric and natural gas steamer heavy cooking load energy efficiencies.

[79] Ibid.

[80]Amount used by both Food Service Technology Center and ENERGY STAR® savings calculator

[81]Reference ENERGY STAR® savings calculator at http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COC.

[82]Ibid.

[83]Ibid.

EXAMPLE

For a gas steam cooker: A 3 pan steamer in a full service restaurant

ΔSavings	= ΔIdle Energy + ΔPreheat Energy + ΔCooking Energy *Z * 1/100.000
ΔIdle Energy	= ((((1- 0.9)* 11000 + 0.9 * 65 * 105 /0.15)*(7 - (100 / 65)-(1*0.25))) - (((1-0) * 6250 + 0 * 55 * 105 / 0.38) * (7 - (100 / 55) - (1*0.25)))) +
ΔPreheat Energy	= (1 *11,000) +
ΔCooking Energy	= (((1/ 0.15) - (1/ 0.38)) * (100 lb/day * 105 btu/lb)))
	* 365.25 days)) *1/100,000 =
	= 883 therms

For an electric steam cooker: A 3 pan steamer in a cafeteria:

ΔSavings	= ΔIdle Energy + ΔPreheat Energy + ΔCooking Energy *Z
ΔIdle Energy	= ((((1- .9)* 1.0 + .9 * 70 * 0.0308 /.26)*(6 - (100 / 70)-(1*.25))) - (((1-0) * 0.4 + 0 * 50 * .0308 / 0.50) * (6 - (100 / 50) - (1*.25)))) +
ΔPreheat Energy	= (1 *0.5)) +
ΔCooking Energy	= (((1/ 0.26) - (1/ 0.5)) * (100 * 0.0308)))
	* 365.25 days=
	13,649 kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

This is only applicable to the electric steam cooker.

ΔkW = (ΔkWh/(HOURSDay *DaysYear)) * CF

Where:

CF =Summer Peak Coincidence Factor for measure is provided below for different locations[84]:

Location	CF
Fast Food Limited Menu	0.32
Fast Food Expanded Menu	0.41
Pizza	0.46
Full Service Limited Menu	0.51
Full Service Expanded Menu	0.36
Cafeteria	0.36

$Days_{Year}$ =Annual Days of Operation

=custom or 365.25 days a year

Other values as defined above

EXAMPLE

For 3 pan electric steam cooker located in a cafeteria:

ΔkW = (ΔkWh/($HOURS_{Day}$ *$Days_{Year}$)) * CF

= (13,649/(6 * 365.25)) * 0.36

= 2.24 kW

WATER IMPACT DESCRIPTIONS AND CALCULATION

This is applicable to both gas and electric steam cookers.

ΔWater = [(W_{BASE} -$W_{ENERGYSTAR®)*}$$HOURS_{Day}$ *$Days_{Year}$

Where

W_{BASE} = Water Consumption Rate of Base Steamer (gal/hr)

= 40[85]

$W_{ENERGYSTAR}$ = Water Consumption Rate of ENERGY STAR® Steamer look up[86]

[84]Minnesota 2012 Technical Reference Manual, Electric Food Service_v03.2.xls, http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech

[85] FSTC (2002). Commercial Cooking Appliance Technology Assessment. Chapter 8: Steamers.

[86]Source Consortium for Energy Efficiency, Inc. September 2010 "Program Design Guidance for Steamers" for Tier 1A and Tier

CEE Tier	gal/hr
Tier 1A	15
Tier 1B	4
Avg Efficient	10
Avg Most Efficient	3

$Days_{Year}$ =Annual Days of Operation

=custom or 365.25 days a year[87]

EXAMPLE

For example, an electric 3 pan steamer with average efficiency in a full service restaurant

ΔWater = (40 -10) * 7 * 365.25

= 76,703 gallons

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-FSE-STMC-V03-150601

1B water requirements. Ohio Technical Reference Manual 2010 for 10 gal/hr water consumption which can be used when Tier level is not known.

[87]Source for 365.25 days/yr is ENERGY STAR® savings calculator which references Food Service Technology research on average use, 2009.

4.2.4 Conveyor Oven

Description

This measure applies to natural gas fired high efficiency conveyor ovens installed in commercial kitchens replacing existing natural gas units with conveyor width greater than 25 inches.

Conveyor ovens are available using four different heating processes: infrared, natural convection with a ceramic baking hearth, forced convection or air impingement, or a combination of infrared and forced convection. Conveyor ovens are typically used for producing a limited number of products with similar cooking requirements at high production rates. They are highly flexible and can be used to bake or roast a wide variety of products including pizza, casseroles, meats, breads, and pastries.

Some manufacturers offer an air-curtain feature at either end of the cooking chamber that helps to keep the heated air inside the conveyor oven. The air curtain operates as a virtual oven wall and helps reduce both the idle energy of the oven and the resultant heat gain to the kitchen.

This measure was developed to be applicable to the following program types: TOS. 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 natural gas conveyor oven with a tested baking energy efficiency > 42% and an idle energy consumption rate < 57,000 Btu/hr utilizing ASTM standard F1817.

Definition of Baseline Equipment

The baseline equipment is an existing pizza deck oven at end of life.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 17 years.[88]

Deemed Measure Cost

The incremental capital cost for this measure is $1800[89].

Loadshape

N/A

Coincidence Factor

N/A

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[88]Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011
[89] Ibid.

Algorithm

Calculation of Savings

Electric Energy Savings

N/A

Summer Coincident Peak Demand Savings

N/A

Natural Gas Energy Savings

The annual natural gas energy savings from this measure is a deemed value equaling 733 Therms[90].

Water Impact Descriptions and Calculation

N/A

Deemed O&M Cost Adjustment Calculation

N/A

Measure Code: CI-FSE-CVOV-V01-120601

[90] Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011.These deemed values should be compared to PY evaluation and revised as necessary

4.2.5 ENERGY STAR Convection Oven

Description

This measure applies to natural gas fired ENERGY STAR convection ovens installed in a commercial kitchen.

This measure was developed to be applicable to the following program types: TOS. 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 natural gas convection oven with a cooking efficiency ≥ 44% utilizing ASTM standard 1496 and an idle energy consumption rate < 13,000 Btu/hr

Definition of Baseline Equipment

The baseline equipment is a natural gas convection oven that is not ENERGY STAR certified and is at end of life.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 12 years[91]

Deemed Measure Cost

The incremental capital cost for this measure is $50[92]

Loadshape

N/A

Coincidence Factor

N/A

Algorithm

Calculation of Savings

Electric Energy Savings

N/A

Summer Coincident Peak Demand Savings

N/A

[91] Lifetime from ENERGY STAR commercial griddle which cites reference as “FSTC research on available models, 2009” http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG
[92] Measure cost from ENERGY STAR which cites reference as “EPA research on available models using AutoQuotes, 2010” http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG

NATURAL GAS ENERGY SAVINGS

Custom calculation below, otherwise use deemed value of 306 therms. [93]

ΔTherms = (ΔDailyIdle Energy + ΔDailyPreheat Energy + ΔDailyCooking Energy) * Days /100000

Where:

ΔDailyIdleEnergy = (IdleBase* IdleBaseTime)- (IdleENERGYSTAR * IdleENERGYSTARTime)

ΔDailyPreheatEnergy = (PreHeatNumberBase * PreheatTimeBase / 60 * PreheatRateBase) – (PreheatNumberENERGYSTAR * PreheatTimeENERGYSTAR/60 * PreheatRateENERGYSTAR)

ΔDailyCookingEnergy = (LB * EFOOD/ EffBase) - (LB * EFOOD/ EffENERGYSTAR)

Where:

HOURSday = Average Daily Operation

= custom or if unknown, use 12 hours

Days = Annual days of operation

= custom or if unknown, use 365.25 days a year

LB = Food cooked per day

= custom or if unknown, use 100 pounds

EffENERGYSTAR = Cooking Efficiency ENERGY STAR

= custom or if unknown, use 44%

EffBase = Cooking Efficiency Baseline

= custom or if unknown, use 30%

PCENERGYSTAR = Production Capacity ENERGY STAR

= custom or if unknown, use 80 pounds/hr

PCBase = Production Capacity base

= custom or if unknown, use 70 pounds/hr

PreheatNumberENERGYSTAR = Number of preheats per day

= custom or if unknown, use 1

PreheatNumberBase = Number of preheats per day

= custom or if unknown, use 1

PreheatTimeENERGYSTAR = preheat length

= custom or if unknown, use 15 minutes

PreheatTimeBase = preheat length

= custom or if unknown, use 15 minutes

[93] Algorithms and assumptions derived from ENERGY STAR Oven Commercial Kitchen Equipment Savings Calculator.http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG

PreheatRateENERGYSTAR = preheat energy rate high efficiency

= custom or if unknown, use 44000 btu/h

PreheatRateBase = preheat energy rate baseline

= custom or if unknown, use 76000 btu/h

IdleENERGYSTAR = Idle energy rate

= custom or if unknown, use 13000 btu/h

IdleBase = Idle energy rate

= custom or if unknown, use 18000 btu/h

IdleENERGYSTARTime = ENERGY STAR Idle Time

=HOURsday-LB/PCENERGYSTAR –PreHeatTimeENERGYSTAR/60

=12 – 100/80 – 15/60

=10.5 hours

IdleBaseTime = BASE Idle Time

= HOURsday-LB/PCbase –PreHeatTimeBase/60

=Custom or if unknown, use

=12 – 100/70-15/60

=10.3 hours

EFOOD = ASTM energy to food

= 250 btu/pound

EXAMPLE

For example, an ENERGY STAR Oven with a cooking energy efficiency of 44% and default values from above would save.

ΔTherms = (ΔIdle Energy + ΔPreheat Energy + ΔCooking Energy) * Days /100000

Where:

ΔDailyIdleEnergy =(18000*10.3)- (13000*10.5)

= 49286 btu

ΔDailyPreheatEnergy = (1 * 15 / 60 *76000) – (1 * 15 / 60 *44000)

= 8000 btu

ΔDailyCookingEnergy = (100 * 250/ .30) - (100 * 250/ .44)

=26515 btu

ΔTherms = (49286+8000+26515)* 365.25 /100000

=306 therms

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-FSE-ESCV-V01-120

4.2.6 ENERGY STAR Dishwasher

Description

This measure applies to ENERGY STAR high and low temp under counter single tank door type, single tank conveyor, and multiple tank conveyor dishwashers installed in a commercial kitchen.

This measure was developed to be applicable to the following program types: TOS. 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 an ENERGY STAR certified dishwasher meeting idle energy rate (kW) and water consumption (gallons/rack) limits, as determined by both machine type and sanitation approach (chemical/low temp versus high temp).

Definition of Baseline Equipment

The baseline equipment is a dishwasher that’s not ENERGY STAR certified and at end of life.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be[94]

Dishwasher type		Equipment Life
Low Temp	Under Counter	10
	Door Type	15
	Single Tank Conventional	20
	Multi Tank Conventional	20
High Temp	Under Counter	10
	Door Type	15
	Single Tank Conventional	20
	Multi Tank Conventional	20

[94] Lifetime from ENERGY STAR HFHC which cites reference as “FSTC research on available models, 2009” http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG

DEEMED MEASURE COST

The incremental capital cost for this measure is[95]

Dishwasher type		Incremental Cost
Low Temp	Under Counter	$530
	Door Type	$530
	Single Tank Conventional	$170
	Multi Tank Conventional	$0
High Temp	Under Counter	$1000
	Door Type	$500
	Single Tank Conventional	$270
	Multi Tank Conventional	$0

LOADSHAPE

Loadshape C01 - Commercial Electric Cooking

SUMMER COINCIDENT PEAK DEMAND SAVINGS

Summer Peak Coincidence Factor for measure is provided below for different restaurant types[96]:

Location	CF
Fast Food Limited Menu	0.32
Fast Food Expanded Menu	0.41
Pizza	0.46
Full Service Limited Menu	0.51
Full Service Expanded Menu	0.36
Cafeteria	0.36

Algorithm

ENERGY SAVINGS

ENERGY STAR dishwashers save energy in three categories, building water heating, booster water heating and idle energy. Building water heating and booster water heating could be either electric or natural gas. These deemed values are presented in a table format. Savings all water heating combinations are found in the tables below. [97]

Electric building and booster water heating

[95] Measure cost from ENERGY STAR which cites reference as “EPA research on available models using AutoQuotes, 2010” http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG
[96] Minnesota 2012 Technical Reference Manual, Electric Food Service_v03.2.xls, http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech
[97] Algorithms and assumptions derived from ENERGY STAR Commercial Kitchen Equipment Savings Calculator.http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG

Dishwasher type		kWh	Therms
Low Temp	Under Counter	1,213	0
	Door Type	12,135	0
	Single Tank Conventional	11,384	0
	Multi Tank Conventional	17,465	0
High Temp	Under Counter	7471	0
	Door Type	14143	0
	Single Tank Conventional	19235	0
	Multi Tank Conventional	34153	0

Electric building and natural gas booster water heating

Dishwasher type		kWh	Therms
Low Temp	Under Counter	9089	0
	Door Type	21833	0
	Single Tank Conventional	24470	0
	Multi Tank Conventional	29718	0
High Temp	Under Counter	7208	110
	Door Type	19436	205
	Single Tank Conventional	29792	258
	Multi Tank Conventional	34974	503

Natural Gas building and electric booster water heating

Dishwasher type		kWh	Therms
Low Temp	Under Counter	0	56
	Door Type	0	562
	Single Tank Conventional	0	527
	Multi Tank Conventional	0	809
High Temp	Under Counter	2717	220
	Door Type	5269	441
	Single Tank Conventional	8110	515
	Multi Tank Conventional	12419	1007

Natural Gas building and booster water heating

Dishwasher type		kWh	Therms
Low Temp	Under Counter	0	56
	Door Type	0	562
	Single Tank Conventional	0	527
	Multi Tank Conventional	0	809
High Temp	Under Counter	0	330
	Door Type	198	617
	Single Tank Conventional	1752	773
	Multi Tank Conventional	0	1510

WATER SAVINGS

Using standard assumptions water savings would be:

Dishwasher type		Savings (gallons)
Low Temp	Under Counter	6,844
	Door Type	6,8474
	Single Tank Conventional	64,240
	Multi Tank Conventional	98,550
High Temp	Under Counter	26,828
	Door Type	50,078
	Single Tank Conventional	62,780
	Multi Tank Conventional	122,640

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW = ΔkWh/ AnnualHours

Where:

AnnualHours = Hours * Days

= 365.25 * 18

= 6575 annual hours

Example:

A low temperature undercounter dishwasher with electric building and booster water heaters would save:

$\Delta kW = \Delta kWh / AnnualHours$

$= 1213/6575$

$= 0.184$ kW

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-FSE-ESDW-V01-120601

4.2.7 ENERGY STAR Fryer

Description

This measure applies to natural gas fired ENERGY STAR fryer installed in a commercial kitchen.

This measure was developed to be applicable to the following program types: TOS. 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 natural gas fryer with a heavy load cooking efficiency ≥ 50% utilizing ASTM standard F1361 or F2144.

Definition of Baseline Equipment

The baseline equipment is a natural gas fryer that is not ENERGY STAR certified at end of life.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 15 years.[98]

Deemed Measure Cost

The incremental capital cost for this measure is $1200.[99]

Loadshape

N/A

Coincidence Factor

N/A

Algorithm

Calculation of Savings

Electric Energy Savings

N/A

Summer Coincident Peak Demand Savings

N/A

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[98]Lifetime from ENERGY STAR commercial griddle which cites reference as "FSTC research on available models, 2009" http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG

[99]Measure cost from ENERGY STAR which cites reference as "EPA research on available models using AutoQuotes, 2010" http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG

NATURAL GAS ENERGY SAVINGS[100]

Custom calculation below, otherwise use deemed value of 505 Therms.

ΔTherms = (ΔDailyIdle Energy + ΔDailyPreheat Energy + ΔDailyCooking Energy) * Days /100000

Where:

ΔDailyIdleEnergy =(IdleBase* IdleBaseTime) – (IdleENERGYSTAR * IdleENERGYSTARTime)

ΔDailyPreheatEnergy = (PreHeatNumberBase * PreheatTimeBase / 60 * PreheatRateBase) – (PreheatNumberENERGYSTAR* PreheatTimeENERGYSTAR/60 * PreheatRateENERGYSTAR)

ΔDailyCookingEnergy = (LB * EFOOD/ EffBase) - (LB * EFOOD/ EffENERGYSTAR)

Where:

HOURSday	= Average Daily Operation
	= custom or if unknown, use 16 hours
Days	= Annual days of operation
	= custom or if unknown, use 365.25 days a year
LB	= Food cooked per day
	= custom or if unknown, use 150 pounds
EffENERGYSTAR	= Cooking Efficiency ENERGY STAR
	= custom or if unknown, use 50%
EffBase	= Cooking Efficiency Baseline
	= custom or if unknown, use 35%
PCENERGYSTAR	= Production Capacity ENERGY STAR
	= custom or if unknown, use 65 pounds/hr
PCBase	= Production Capacity base
	= custom or if unknown, use 60 pounds/hr
PreheatNumberENERGYSTAR	= Number of preheats per day
	= custom or if unknown, use 1
PreheatNumberBase	= Number of preheats per day
	= custom or if unknown, use 1
PreheatTimeENERGYSTAR	= preheat length
	= custom or if unknown, use 15 minutes
PreheatTimeBase	= preheat length
	= custom or if unknown, use 15 minutes

[100] Algorithms and assumptions derived from ENERGY STAR fryer Commercial Kitchen Equipment Savings Calculator.http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG

PreheatRateENERGYSTAR	= preheat energy rate high efficiency
	= custom or if unknown, use 62000 btu/h
PreheatRateBase	= preheat energy rate baseline
	= custom or if unknown, use 64000 btu/h
IdleENERGYSTAR	= Idle energy rate
	= custom or if unknown, use 9000 btu/h
IdleBase	= Idle energy rate
	= custom or if unknown, use 14000 btu/h
IdleENERGYSTARTime	= ENERGY STAR Idle Time
	= HOURsday-LB/PCENERGYSTAR –PreHeatTimeENERGYSTAR/60
	=Custom or if unknown, use
	=16 – 150/65-15/60
	=13.44 hours
IdleBaseTime	= BASE Idle Time
	= HOURsday-LB/PCbase –PreHeatTimeBase/60
	=Custom or if unknown, use
	=16 – 150/60-15/60
	=13.25 hours
EFOOD	= ASTM energy to food
	= 570 btu/pound

EXAMPLE

For example, an ENERGY STAR fryer with a tested heavy load cooking energy efficiency of 50% and an idle energy rate of 120,981 btu and an Idle Energy Consumption Rate 9000 btu would save.

ΔTherms = (ΔIdle Energy + ΔPreheat Energy + ΔCooking Energy) * Days /100000

Where:

ΔDailyIdleEnergy	=(18550*13.25)- (120981 * 13.44)
	= 64519 btu
ΔDailyPreheatEnergy	= (1 * 15 / 60 *64000) – (1 * 15 / 60 *62000)
	= 500 btu
ΔDailyCookingEnergy	= (150 * 570/ .35) - (150 * 570/ .5)
	=73286 btu
ΔTherms	= (64519+500+73286)* 365.25 /100000
	=508 therms

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-FSE-ESFR-V01-120601

4.2.8 ENERGY STAR Griddle

Description

This measure applies to electric and natural gas fired high efficiency griddle installed in a commercial kitchen.

This measure was developed to be applicable to the following program types: TOS. 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 an ENERGY STAR natural gas or electric griddle with a tested heavy load cooking energy efficiency of 70 percent (electric) 38 percent (gas) or greater and an idle energy rate of 2,650 Btu/hr per square foot of cooking surface or less, utilizing ASTM F1275. The griddle must have an Idle Energy Consumption Rate < 2,600 Btu/hr per square foot of cooking surface.

Definition of Baseline Equipment

The baseline equipment is an existing natural gas or electric griddle that's not ENERGY STAR certified and is at end of use.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 12 years[101]

Deemed Measure Cost

The incremental capital cost for this measure is $0 for and electric griddle and $60 for a gas griddle.[102]

Loadshape

Loadshape C01 - Commercial Electric Cooking

Coincidence Factor

Summer Peak Coincidence Factor for measure is provided below for different building type[103]:

Location	CF
Fast Food Limited Menu	0.32
Fast Food Expanded Menu	0.41
Pizza	0.46
Full Service Limited Menu	0.51
Full Service Expanded Menu	0.36
Cafeteria	0.36

[101] Lifetime from ENERGY STAR commercial griddle which cites reference as "FSTC research on available models, 2009" http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG

[102] Measure cost from ENERGY STAR which cites reference as "EPA research on available models using AutoQuotes, 2010" http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG

[103] Minnesota 2012 Technical Reference Manual, Electric Food Service_v03.2.xls, http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech

Algorithm

CALCULATION OF SAVINGS [104]

ELECTRIC ENERGY SAVINGS

ΔkWh = (ΔIdle Energy + ΔPreheat Energy + ΔCooking Energy) * Days /1000

Where:

ΔDailyIdleEnergy	=[IdleBase * Width * Length (LB/ PCBase) – (PreheatNumberBase* PreheatTimeBase/60)]- IdleENERGYSTAR * Width * Length (LB/ PCENERGYSTAR) – (PreheatNumberENERGYSTAR* PreheatTimeENERGYSTAR/60]
ΔDailyPreheatEnergy	= (PreHeatNumberBase * PreheatTimeBase / 60 * PreheatRateBase * Width * Depth) – (PreheatNumberENERGYSTAR* PreheatTimeENERGYSTAR/60 * PreheatRateENERGYSTAR * Width * Depth)
ΔDailyCookingEnergy	= (LB * EFOOD/ EffBase) - (LB * EFOOD/ EffENERGYSTAR)

Where:

HOURSday	= Average Daily Operation
	= custom or if unknown, use 12 hours
Days	= Annual days of operation
	= custom or if unknown, use 365.25 days a year
LB	= Food cooked per day
	= custom or if unknown, use 100 pounds
Width	= Griddle Width
	= custom or if unknown, use 3 feet
Depth	= Griddle Depth
	= custom or if unknown, use 2 feet
EffENERGYSTAR	= Cooking Efficiency ENERGY STAR
	= custom or if unknown, use 70%
EffBase	= Cooking Efficiency Baseline
	= custom or if unknown, use 65%
PCENERGYSTAR	= Production Capacity ENERGY STAR
	= custom or if unknown, use 6.67 pounds/hr/sq ft
PCBase	= Production Capacity base
	= custom or if unknown, use 5.83 pounds/hr/sq ft

[104] Algorithms and assumptions derived from ENERGY STAR Griddle Commercial Kitchen Equipment Savings Calculator.http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG

PreheatNumberENERGYSTAR = Number of preheats per day

= custom or if unknown, use 1

PreheatNumberBase = Number of preheats per day

= custom or if unknown, use 1

PreheatTimeENERGYSTAR = preheat length

= custom or if unknown, use 15 minutes

PreheatTimeBase = preheat length

= custom or if unknown, use 15 minutes

PreheatRateENERGYSTAR = preheat energy rate high efficiency

= custom or if unknown, use 1333 W/sq ft

PreheatRateBase = preheat energy rate baseline

= custom or if unknown, use 2667 W/sq ft

IdleENERGYSTAR = Idle energy rate

= custom or if unknown, use 320 W/sq ft

IdleBase = Idle energy rate

= custom or if unknown, use 400 W/sq ft

EFOOD = ASTM energy to food

= 139 w/pound

For example, an ENERGY STAR griddle with a tested heavy load cooking energy efficiency of 70 percent or greater and an idle energy rate of 320 W per square foot of cooking surface or less would save.

ΔDailyIdleEnergy =[400* 3 * 2 (100/5.83) – (1* 15/60)]- [320* 3 * 2 (100/6.67) – (1* 15/60]

= 3583 W

ΔDailyPreheatEnergy = (1* 15 / 60 * 2667 * 3 * 2) – (1* 15/60 * 1333 * 3 * 2)

=2000 W

ΔDailyCookingEnergy = (100 * 139/ .65) - (100 * 139/ .70)

=1527 W

ΔkWh = (2000+1527+3583) * 365.25 /1000

=2597 kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

kW = ΔkWh/Hours * CF

For example, an ENERGY STAR griddle in a cafeteria with a tested heavy load cooking energy efficiency of 70 percent or greater and an idle energy rate of 320 W per square foot of cooking surface or less would save

=2595 kWh/4308 * .36

= 0.22 kW

NATURAL GAS ENERGY SAVINGS

Custom calculation below, otherwise use deemed value of 149 therms.

ΔTherms = (ΔIdle Energy + ΔPreheat Energy + ΔCooking Energy) * Days /100000

Where:

ΔDailyIdleEnergy =[IdleBase * Width * Length (LB/ PCBase) – (PreheatNumberBase* PreheatTimeBase/60)]- IdleENERGYSTAR * Width * Length (LB/ PCENERGYSTAR) – (PreheatNumberENERGYSTAR* PreheatTimeENERGYSTAR/60]

ΔDailyPreheatEnergy = (PreHeatNumberBase * PreheatTimeBase / 60 * PreheatRateBase * Width * Depth) – (PreheatNumberENERGYSTAR* PreheatTimeENERGYSTAR/60 * PreheatRateENERGYSTAR * Width * Depth)

ΔDailyCookingEnergy = (LB * EFOOD/ EffBase) - (LB * EFOOD/ EffENERGYSTAR)

Where (new variables only):

EffENERGYSTAR = Cooking Efficiency ENERGY STAR

= custom or if unknown, use 38%

EffBase = Cooking Efficiency Baseline

= custom or if unknown, use 32%

PCENERGYSTAR = Production Capacity ENERGY STAR

= custom or if unknown, use 7.5 pounds/hr/sq ft

PCBase = Production Capacity base

= custom or if unknown, use 4.17 pounds/hr/sq ft

PreheatRateENERGYSTAR = preheat energy rate high efficiency

= custom or if unknown, use 10000 btu/h/sq ft

PreheatRateBase = preheat energy rate baseline

= custom or if unknown, use 14000 btu/h/sq ft

IdleENERGYSTAR = Idle energy rate

= custom or if unknown, use 2650 btu/h/sq ft

IdleBase = Idle energy rate

= custom or if unknown, use 3500 btu/h/sq ft

EFOOD = ASTM energy to food

= 475 btu/pound

For example, an ENERGY STAR griddle with a tested heavy load cooking energy efficiency of 38 percent or greater and an idle energy rate of 2,650 Btu/h per square foot of cooking surface or less and an Idle Energy Consumption Rate < 2,600 Btu/h per square foot of cooking surface would save.

ΔDailyIdleEnergy =[3500* 3 * 2 (100/4.17) – (1* 15/60)]- 2650* 3 * 2 (100/7.5) – (1* 15/60]

= 11258 Btu

ΔDailyPreheatEnergy = (1* 15 / 60 * 14,000 * 3 * 2) – (1* 15/60 * 10000 * 3 * 2)

=6000 btu

ΔDailyCookingEnergy = (100 * 475/ .32) - (100 * 475/ .38)

=23438 btu

ΔTherms = (11258 + 6000 + 23438) * 365.25 /100000

=149 therms

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-FSE-ESGR-V01-120601

4.2.9 ENERGY STAR Hot Food Holding Cabinets

Description

This measure applies to electric ENERGY STAR hot food holding cabinets (HFHC) installed in a commercial kitchen.

This measure was developed to be applicable to the following program types: TOS. 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 an ENERGY STAR certified HFHC.

Definition of Baseline Equipment

The baseline equipment is an electric HFHC that's not ENERGY STAR certified and at end of life.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 12 years[105]

Deemed Measure Cost

The incremental capital cost for this measure is[106]

HFHC Size	Incremental Cost
Full Size (20 cubic feet)	$1200
¾ Size (12 cubic feet)	$1800
½ Size (8 cubic feet)	$1500

Loadshape

Loadshape C01 - Commercial Electric Cooking

[105] Lifetime from ENERGY STAR HFHC which cites reference as "FSTC research on available models, 2009" http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG

[106] Measure cost from ENERGY STAR which cites reference as "EPA research on available models using AutoQuotes, 2010" http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG

COINCIDENCE FACTOR

Summer Peak Coincidence Factor for measure is provided below for different building type[107]:

Location	CF
Fast Food Limited Menu	0.32
Fast Food Expanded Menu	0.41
Pizza	0.46
Full Service Limited Menu	0.51
Full Service Expanded Menu	0.36
Cafeteria	0.36

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Custom calculation below, otherwise use deemed values depending on HFHC size[108]

Cabinet Size	Savings (kWh)
Full Size HFHC	9308
¾ Size HFHC	3942
½ Size HFHC	2628

ΔkWh = HFHCBaselinekWh _ HFHCENERGYSTARkWh

Where:

HFHCBaselinekWh = PowerBaseline* HOURSday * Days/1000

PowerBaseline = Custom, otherwise

Cabinet Size	Power (W)
Full Size HFHC	2500
¾ Size HFHC	1200
½ Size HFHC	800

HOURSday = Average Daily Operation

= custom or if unknown, use 15 hours

[107] Minnesota 2012 Technical Reference Manual, Electric Food Service_v03.2.xls, http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech

[108] Algorithms and assumptions derived from ENERGY STAR Commercial Kitchen Equipment Savings Calculator.http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG

Days = Annual days of operation

= custom or if unknown, use 365.25 days a year

HFHCENERGYSTARkWh = PowerENERGYSTAR* HOURSday * Days/1000

PowerENERGYSTAR = Custom, otherwise

Cabinet Size	Power (W)
Full Size HFHC	800
¾ Size HFHC	480
½ Size HFHC	320

HOURSday = Average Daily Operation

= custom or if unknown, use 15 hours

Days = Annual days of operation

= custom or if unknown, use 365.25 days a year

For example, if a full size HFHC is installed the measure would save:

ΔkWh = (PowerBaseline* HOURSday * Days)/1000 – (PowerENERGYSTAR* HOURSday * Days)/1000

= (2500*15*365.25)/1000 – (800*15*365.25)/1000

= 9,314 kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW = ΔkWh/Hours * CF

Where:

Hours = Hoursday *Days

For example, if a full size HFHC is installed in a cafeteria the measure would save:

= 9,314 kWh / (15*365.25)* .36

=0 .61 kW

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-FSE-ESHH-V01-120601

4.2.10 ENERGY STAR Ice Maker

DESCRIPTION

This measure relates to the installation of a new ENERGY STAR qualified commercial ice machine. The ENERGY STAR label applied to air-cooled, cube-type machines including ice-making head, self-contained, and remote-condensing units. This measure excludes flake and nugget type ice machines. This measure could relate to the replacing of an existing unit at the end of its useful life, or the installation of a new system in a new or existing building.

This measure was developed to be applicable to the following program types: TOS and NC. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to be a new commercial ice machine meeting the minimum ENERGY STAR efficiency level standards.

DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline equipment is assumed to be a commercial ice machine meeting federal equipment standards established January 1, 2010.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 10 years[109].

DEEMED MEASURE COST

The incremental capital cost for this measure is provided below.[110]

Harvest Rate (H)	Incremental Cost
100-200 lb ice machine	$296
201-300 lb ice machine	$312
301-400 lb ice machine	$559
401-500 lb ice machine	$981
501-1000 lb ice machine	$1,485
1001-1500 lb ice machine	$1,821
>1500 lb ice machine	$2,194

LOADSHAPE

Loadshape C23 - Commercial Refrigeration

[109] DEER 2008

[110] These values are from electronic work papers prepared in support of San Diego Gas & Electric's "Application for Approval of Electric and Gas Energy Efficiency Programs and Budgets for Years 2009-2011", SDGE, March 2, 2009. Accessed on 7/7/10 <http://www.sdge.com/regulatory/documents/ee2009-2011Workpapers/SW-ComB/Food%20Service/Food%20Service%20Electic%20Measure%20Workpapers%2011-08-05.DOC>.

COINCIDENCE FACTOR

The Summer Peak Coincidence Factor is assumed to equal 0.937

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$\Delta kWH = [(kWh_{base} – kWh_{ee}) / 100] * (DC * H) * 365.25$

Where:

kWh_{base} = maximum kWh consumption per 100 pounds of ice for the baseline equipment

= calculated as shown in the table below using the actual Harvest Rate (H) of the efficient equipment.

kWh_{ee} = maximum kWh consumption per 100 pounds of ice for the efficient equipment

= calculated as shown in the table below using the actual Harvest Rate (H) of the efficient equipment.

Ice Machine Type	kWhbase[111]	kWhee[112]
Ice Making Head (H < 450)	10.26 - 0.0086*H	9.23 - 0.0077*H
Ice Making Head (H ≥ 450)	6.89 – 0.0011*H	6.20 - 0.0010*H
Remote Condensing Unit, without remote compressor (H < 1000)	8.85 – 0.0038*H	8.05 - 0.0035*H
Remote Condensing Unit, without remote compressor (H ≥ 1000)	5.1	4.64
Remote Condensing Unit, with remote compressor (H < 934)	8.85 – 0.0038*H	8.05 - 0.0035*H
Remote Condensing Unit, with remote compressor (H ≥ 934)	5.3	4.82
Self Contained Unit (H < 175)	18 - 0.0469*H	16.7 - 0.0436*H
Self Contained Unit (H ≥ 175)	9.8	9.11

100 = conversion factor to convert kWhbase and kWhee into maximum kWh consumption per pound of ice.

DC = Duty Cycle of the ice machine

[111] Baseline reflects federal standards which apply to units manufactured on or after January 1, 2010 <http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&rgn=div6&view=text&node=10:3.0.1.4.17.8&idno=10>.

[112] ENERGY STAR Program Requirements for Commercial Ice Machines, Partner Commitments, U.S. Environmental Protection Agency, Accessed on 7/7/10 <http://www.energystar.gov/ia/partners/product_specs/program_reqs/ice_machine_prog_req.pdf>

= 0.57[113]

H = Harvest Rate (pounds of ice made per day)

= Actual installed

365.35 = days per year

For example an ice machine with an ice making head producing 450 pounds of ice would save

ΔkWH = [(6.4 – 5.8) / 100] * (0.57 * 450) * 365.25

= 562 kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW = ΔkWh / (HOURS * DC) * CF

Where:

HOURS = annual operating hours

= 8766[114]

CF = 0.937

For example an ice machine with an ice making head producing 450 pounds of ice would save

ΔkW = 562/(8766 * 0.57) * .937

= 0.105 kW

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

While the ENERGY STAR labeling criteria require that certified commercial ice machines meet certain "maximum potable water use per 100 pounds of ice made" requirements, such requirements are intended to prevent equipment manufacturers from gaining energy efficiency at the cost of water consumptions. A review of the AHRI Certification Directory[115] indicates that approximately 81% of air-cooled, cube-type machines meet the ENERGY STAR potable water use requirement. Therefore, there are no assumed water impacts for this measure.

[113]Duty cycle varies considerably from one installation to the next. TRM assumptions from Vermont, Wisconsin, and New York vary from 40 to 57%, whereas the ENERGY STAR Commercial Ice Machine Savings Calculator < http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_Ice_Machines.xls> assumes a value of 75%. A field study of eight ice machines in California indicated an average duty cycle of 57% ("A Field Study to Characterize Water and Energy Use of Commercial Ice-Cube Machines and Quantify Saving Potential", Food Service Technology Center, December 2007). Furthermore, a report prepared by ACEEE assumed a value of 40% (Nadel, S., Packaged Commercial Refrigeration Equipment: A Briefing Report for Program Planners and Implementers, ACEEE, December 2002). The value of 57% was utilized since it appears to represent a high quality data source.

[114]Unit is assumed to be connected to power 24 hours per day, 365.25 days per year.

[115]AHRI Certification Directory, Accessed on 7/7/10. <http://www.ahridirectory.org/ahridirectory/pages/home.aspx>

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-FSE-ESIM-V01-120601

4.2.11 High Efficiency Pre-Rinse Spray Valve

DESCRIPTION

Pre-rise valves use a spray of water to remove food waste from dishes prior to cleaning in a dishwasher. More efficient spray valves use less water thereby reducing water consumption, water heating cost, and waste water (sewer) charges. Pre-rinse spray valves include a nozzle, squeeze lever, and dish guard bumper. The primary impacts of this measure are water savings. Reduced hot water consumption saves either natural gas or electricity, depending on the type of energy the hot water heater uses.

This measure was developed to be applicable to the following program types: TOS, RF, and DI. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure, the new or replacement pre-rinse spray nozzle must use less than 1.6 gallons per minute with a cleanability performance of 26 seconds per plate or less.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment will vary based on the delivery method and is defined below:

Time of Sale	Retrofit, Direct Install
The baseline equipment is assumed to be 1.6 gallons per minute. The Energy Policy Act (EPAct) of 2005 sets the maximum flow rate for pre-rinse spray valves at 1.6 gallons per minute at 60 pounds per square inch of water pressure when tested in accordance with ASTM F2324-03. This performance standard went into effect January 1, 2006.	The baseline equipment is assumed to be an existing pre-rinse spray valve with a flow rate of 1.9 gallons per minute.[116] If existing pre-rinse spray valve flow rate is unknown, then existing pre-rinse spray valve must have been installed prior to 2006. The Energy Policy Act (EPAct) of 2005 sets the maximum flow rate for pre-rinse spray valves at 1.6 gallons per minute at 60 pounds per square inch of water pressure when tested in accordance with ASTM F2324-03. This performance standard went into effect January 1, 2006. However, field data shows that not all nozzles in use have been replaced with the newer flow rate nozzle. Products predating this standard can use up to five gallons per minute

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 5 years[117]

DEEMED MEASURE COST

The cost of this measure is assumed to be $100[118]

LOADSHAPE

Loadshape C01 - Commercial Electric Cooking

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[116] Verification measurements taken at 195 installations showed average pre and post flowrates of 2.23 and 1.12 gallon per minute, respectively." from IMPACT AND PROCESS EVALUATION FINAL REPORT for CALIFORNIA URBAN WATER CONSERVATION COUNCIL 2004-5 PRE-RINSE SPRAY VALVE INSTALLATION PROGRAM (PHASE 2) (PG&E Program # 1198-04; SoCalGas Program 1200-04) ("CUWCC Report", Feb 2007)

[117] Reference 2010 Ohio Technical Reference Manual, Act on Energy Business Program Technical Reference Manual Rev05, and Federal Energy Management Program (2004), "How to Buy a Low-Flow Pre-Rinse Spray Valve."

[118] Costs range from $60 Chicagoland (Integrys for North Shore & People's Gas) to $150 referenced by Nicor's CLEAResultWorkpaper WPRSGCCODHW102 "Pre-Rinse Spray Valve." Act on Energy references $100.

COINCIDENCE FACTOR

N/A

Algorithm

CALCULATION OF ENERGY SAVINGS

ELECTRIC ENERGY SAVINGS (NOTE WATER SAVINGS MUST FIRST BE CALCULATED)

$$\Delta kWH = \Delta Gallons \times 8.33 \times 1 \times (Tout - Tin) \times (1/EFF\ electric) / 3{,}413 \times FLAG$$

Where:

ΔGallons = amount of water saved as calculated below

8.33 lbm/gal = specific mass in pounds of one gallon of water

1 Btu/lbm°F = Specific heat of water: 1 Btu/lbm/°F

Tout = Water Heater Outlet Water Temperature

= custom, otherwise assume Tin + 70°F temperature rise from Tin[119]

Tin = Inlet Water Temperature

= custom, otherwise assume 54.1 °F[120]

EFF = Efficiency of electric water heater supplying hot water to pre-rinse spray valve

=custom, otherwise assume 97%[121]

Flag = 1 if electric or 0 if gas

EXAMPLE

Time of Sale: For example, a new spray nozzle with 1.06 gal/min flow replacing a nozzle with 1.6 gal/min flow at a large institutional establishments with a cafeteria with 70 degree temperature rise of water used by the pre-rinse spray valve that is heated by electric hot water saves annually :

ΔkWH = 30,326x 8.33 x 1 x ((70+54.1) - 54.1) x (1/.97) /3,413 x 1

= 5,341kWh

Retrofit: For example, a new spray nozzle with 1.06 gal/min flow replacing a nozzle with 1.9 gal/min flow at a large institutional establishments with a cafeteria with 70 degree temperature rise of water used by the pre-rinse spray valve that is heated by electric hot water equals:

ΔkWH = 47,175 x 8.33 x 1 x ((70+ 54.1) - 54.1) x (1/.97) /3,413 x 1

=8309 kWh

[119] If unknown, assume a 70 degree temperature rise from Tin per Food Service Technology Center calculator assumptions to account for variations in mixing and water heater efficiencies

[120] August 31, 2011 Memo of Savings for Hot Water Savings Measures to Nicor Gas from Navigant states that 54.1°F was calculated from the weighted average of monthly water mains temperatures reported in the 2010 Building America Benchmark Study for Chicago-Waukegan, Illinois.

[121] This efficiency value is based on IECC 2012 performance requirement for electric resistant water heaters rounded without the slight adjustment allowing for reduction based on size of storage tank.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

N/A

NATURAL GAS ENERGY SAVINGS

ΔTherms = ΔGallons x 8.33 x 1 x (Tout - Tin) x (1/EFF) /100,000 Btu

Where (new variables only):

EFF = Efficiency of gas water heater supplying hot water to pre-rinse spray valve

= custom, otherwise assume 75%[122]

EXAMPLE

Time of Sale: For example, a new spray nozzle with 1.06 gal/min flow replacing a nozzle with 1.6 gal/min flow at a large institutional establishments with a cafeteria with 70 degree temperature of water used by the pre-rinse spray valve that is heated by fossil fuel hot water saves annually:

ΔTherms = 30,326 x 8.33 x 1 x ((70+54.1) - 54.1) x (1/.75)/100,000 x 1.0

= 236 Therms

Retrofit: For example, a new spray nozzle with 1.06 gal/min flow replacing a nozzle with 1.9 gal/min flow at a busy large institutional establishments with a cafeteria with 70 degree temperature rise of water used by the pre-rinse spray valve that is heated by fossil fuel hot water saves annually:

ΔTherms = 47,175 x 8.33 x 1 x ((70+54.1) - 54.1) x (1/.75)/100,000 x (1-0)

=368 Therms

WATER IMPACT CALCULATION[123]

ΔGallons = (FLObase - FLOeff)gal/min x 60 min/hr x HOURSday x DAYSyear

Where:

FLObase = Base case flow in gallons per minute, or custom

Time of Sale	Retrofit, Direct Install
1.6 gal/min124	1.9 gal/min125

FLOeff = Efficient case flow in gallons per minute or custom

[122] IECC 2012, Table C404.2, Minimum Performance of Water-Heating Equipment

[123] In order to calculate energy savings, water savings must first be calculated

[124] The baseline equipment is assumed to be 1.6 gallons per minute. The Energy Policy Act (EPAct) of 2005 sets the maximum flow rate for pre-rinse spray valves at 1.6 gallons per minute at 60 pounds per square inch of water pressure when tested in accordance with ASTM F2324-03. This performance standard went into effect January 1, 2006. www1.eere.energy.gov/femp/pdfs/spec_prerinsesprayvavles.pdf.

[125] Verification measurements taken at 195 installations showed average pre and post flowrates of 2.23 and 1.12 gallon per minute, respectively." from IMPACT AND PROCESS EVALUATION FINAL REPORT for CALIFORNIA URBAN WATER CONSERVATION COUNCIL 2004-5 PRE-RINSE SPRAY VALVE INSTALLATION PROGRAM (PHASE 2) (PG&E Program # 1198-04; SoCalGas Program 1200-04) ("CUWCC Report", Feb 2007)

Time of Sale	Retrofit, Direct Install
1.06 gal/min[126]	1.06 gal/min[127]

HOURSday = Hours per day that the pre-rinse spray valve is used at the site, custom, otherwise[128]:

Application	Hours/day
Small, quick- service restaurants	1/2
Medium-sized casual dining restaurants	1.5
Large institutional establishments with cafeteria	3

DAYSyear = Days per year pre-rinse spray valve is used at the site, custom, otherwise 312 days/yr based on assumed 6 days/wk x 52 wk/yr = 312 day/yr.

EXAMPLE

Time of Sale: For example, a new spray nozzle with 1.06 gal/min flow replacing a nozzle with 1.6 gal/min flow at a large institutional establishment with a cafeteria equals

= (1.6 – 1.06) * 60 * 3 * 312

= 30,326 gal/yr

Retrofit: For example, a new spray nozzle with 106 gal/min flow replacing a nozzle with 1.9 gal/min flow at a large institutional establishments with a cafeteria equals

= (1.9 – 1.06) * 60 * 3 * 312

= 47,175 gal/yr

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-FSE-SPRY-V02-120601

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[126] 1.6 gallons per minute used to be the high efficiency flow, but more efficient spray valves are available ranging down to 0.64 gallons per minute per Federal Energy Management Program which references the Food Services Technology Center web site with the added note that even more efficient models may be available since publishing the data. The average of the nozzles listed on the FSTC website is 1.06.

[127] 1.6 gallons per minute used to be the high efficiency flow, but more efficient spray valves are available ranging down to 0.64 gallons per minute per Federal Energy Management Program which references the Food Services Technology Center web site with the added note that even more efficient models may be available since publishing the data. The average of the nozzles listed on the FSTC website is 1.06.

[128] Hours primarily based on PG& E savings estimates, algorithms, sources (2005), Food Service Pre-Rinse Spray Valves with review of 2010 Ohio Technical Reference Manual and Act on Energy Business Program Technical Resource Manual Rev05.

4.2.12 Infrared Charbroiler

Description

This measure applies to natural gas fired charbroilers that utilize infrared burners installed in a commercial kitchen

This measure was developed to be applicable to the following program types: TOS. 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 new natural gas charbroiler with infrared burners.

Definition of Baseline Equipment

The baseline equipment is an existing natural gas charbroiler without infrared burners.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 12 years[129]

Deemed Measure Cost

The incremental capital cost for this measure is $2200[130]

Loadshape

N/A

Coincidence Factor

N/A

Algorithm

Calculation of Savings

Electric Energy Savings

N/A

Summer Coincident Peak Demand Savings

N/A

Natural Gas Energy Savings

The annual natural gas energy savings from this measure is a deemed value equaling 661 Therms.[131]

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[129] Food Service Technology Center, ENERGY STAR and CEE do not currently provide calculators for this type of equipment therefore deemed values from Nicor Gas were used. Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011

[130] Ibid.

[131] Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011.These deemed values should be compared to PY evaluation and revised as necessary.

Water Impact Descriptions and Calculation

N/A

Deemed O&M Cost Adjustment Calculation

N/A

Measure Code: CI-FSE-IRCB-V01-120601

4.2.13 Infrared Rotisserie Oven

Description

This measure applies to natural gas fired high efficiency rotisserie ovens utilizing infrared burners and installed in a commercial kitchen.

This measure was developed to be applicable to the following program types: TOS. 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 new natural gas rotisserie oven with infrared burners.

Definition of Baseline Equipment

The baseline equipment is an existing natural gas rotisserie oven without infrared burners.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 12 years[132]

Deemed Measure Cost

The incremental capital cost for this measure is $2700[133]

Loadshape

N/A

Coincidence Factor

N/A

Algorithm

Calculation of Savings

Electric Energy Savings

N/A

Summer Coincident Peak Demand Savings

N/A

Natural Gas Energy Savings

The annual natural gas energy savings from this measure is a deemed value equaling 554 Therms[134]

[132] Food Service Technology Center, ENERGY STAR and CEE do not currently provide calculators for this type of equipment therefore deemed values from Nicor Gas were used. Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011

[133] Ibid.

Water Impact Descriptions and Calculation

N/A

Deemed O&M Cost Adjustment Calculation

N/A

Measure Code: CI-FSE-IROV-V01-120601

[134]Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011.These deemed values should be compared to PY evaluation and revised as necessary.

4.2.14 Infrared Salamander Broiler

DESCRIPTION

This measure applies to natural gas fired high efficiency salamander broilers utilizing infrared burners installed in a commercial kitchen.

This measure was developed to be applicable to the following program types: TOS. 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 new natural gas salamander broiler with infrared burners

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is an existing natural gas salamander broiler without infrared burners

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 12 years[135]

DEEMED MEASURE COST

The incremental capital cost for this measure is $1000[136]

LOADSHAPE

N/A

COINCIDENCE FACTOR

N/A

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

N/A

SUMMER COINCIDENT PEAK DEMAND SAVINGS

N/A

NATURAL GAS ENERGY SAVINGS

The annual natural gas energy savings from this measure is a deemed value equaling 239 therms[137]

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[135]Food Service Technology Center, ENERGY STAR and CEE do not currently provide calculators for this type of equipment therefore deemed values from Nicor Gas were used. Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011

[136]Ibid.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-FSE-IRBL-V01-120601

[137] Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011.These deemed values should be compared to PY evaluation and revised as necessary.

4.2.15 Infrared Upright Broiler

Description

This measure applies to natural gas fired high efficiency upright broilers utilizing infrared burners and installed in a commercial kitchen.

This measure was developed to be applicable to the following program types: TOS. 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 new natural gas upright broiler with infrared burners.

Definition of Baseline Equipment

The baseline equipment is an existing natural gas upright broiler without infrared burners.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 10 years[138]

Deemed Measure Cost

The incremental capital cost for this measure is $5900[139]

Loadshape

N/A

Coincidence Factor

N/A

Algorithm

Calculation of Savings

Electric Energy Savings

N/A

Summer Coincident Peak Demand Savings

N/A

Natural Gas Energy Savings

The annual natural gas energy savings from this measure is a deemed value equaling 1089 therms[140].

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[138] Food Service Technology Center, ENERGY STAR and CEE do not currently provide calculators for this type of equipment therefore deemed values from Nicor Gas were used. Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011

[139] Ibid.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-FSE-IRUB-V01-120601

[140] Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011.These deemed values should be compared to PY evaluation and revised as necessary

4.2.16 Kitchen Demand Ventilation Controls

Description

Installation of commercial kitchen demand ventilation controls that vary the ventilation based on cooking load and/or time of day.

This measure was developed to be applicable to the following program types: TOS. 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 control system that varies the exhaust rate of kitchen ventilation (exhaust and/or makeup air fans) based on the energy and effluent output from the cooking appliances (i.e., the more heat and smoke/vapors generated, the more ventilation needed). This involves installing a new temperature sensor in the hood exhaust collar and/or an optic sensor on the end of the hood that sense cooking conditions which allows the system to automatically vary the rate of exhaust to what is needed by adjusting the fan speed accordingly.

Definition of Baseline Equipment

The baseline equipment is kitchen ventilation that has constant speed ventilation motor.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 15 years.[141]

Deemed Measure Cost

The incremental capital cost for this measure is[142]

Measure Category	Incremental Cost , $/fan
DVC Control Retrofit	$1,988
DVC Control New	$1,000

Loadshape

Loadshape C23 - Commercial Ventilation

Coincidence Factor

The measure has deemed peak kW savings therefore a coincidence factor does not apply

[141] PG&E Workpaper: Commercial Kitchen Demand Ventilation Controls-Electric, 2004 - 2005
[142] Ibid.

Algorithm

Calculation of Savings

Annual energy use was based on monitoring results from five different types of sites, as summarized in PG&E Food Service Equipment work paper.

Electric Energy Savings

The following table provides the kWh savings

Measure Name	Annual Energy Savings Per Unit (kWh/fan)
DVC Control Retrofit	4,486
DVC Control New	4,486

Summer Coincident Peak Demand Savings

The following table provides the kW savings

Measure Name	Coincident Peak Demand Reduction (kW)
DVC Control Retrofit	0.76
DVC Control New	0.76

Natural Gas Energy Savings

ΔTherms = CFM * HP* Annual Heating Load /(Eff(heat) * 100,000)

Where:

CFM = the average airflow reduction with ventilation controls per hood

= 611 cfm/HP[143]

HP = actual if known, otherwise assume 7.75 HP

Annual Heating Load = Annual heating energy required to heat fan exhaust make-up air, Btu/cfm dependent on location[144]:

[143] PGE Workpaper, Commercial Kitchen Demand Ventilation Controls, PGECOFST116, June 1, 2009, 4,734 cfm reduction on average , with 7.75 fan horsepower on average.

[144] Food Service Technology Center Outside Air Load Calculator, http://www.fishnick.com/ventilation/oalc/oac.php, with inputs of one cfm, and hours from Commercial Kitchen Demand Ventilation Controls (Average 17.8 hours a day 4.45 am to 10.30 pm). Savings for Rockford, Chicago, and Springfield were obtained from the calculator; values for Belleview and Marion were obtained by using the average savings per HDD from the other values.

Zone	Annual Heating Load, Btu/cfm
1 (Rockford)	154,000
2-(Chicago)	144,000
3 (Springfield)	132,000
4-(Belleville)	102,000
5-(Marion)	104,000

Eff(heat) = Heating Efficiency

= actual if known, otherwise assume 80%[145]

100,000 = conversion from Btu to Therm

EXAMPLE

For example, a kitchen hood in Rockford, IL with a 7.75 HP ventilation motor

ΔTherms = 611 * 7.75*154,000 / (0.80 * 100,000)

= 9,115 Therms

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-FSE-VENT-V02-140601

[145] Work Paper WPRRSGNGRO301 CLEAResult"Boiler Tune-Up" which cites Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0, PA Consulting, KEMA, March 22, 2010

4.2.17 Pasta Cooker

Description

This measure applies to natural gas fired dedicated pasta cookers as determined by the manufacturer and installed in a commercial kitchen.

This measure was developed to be applicable to the following program types: TOS. 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 new natural gas fired paste cooker.

Definition of Baseline Equipment

The baseline equipment is an existing natural gas fired stove where pasta is cooked in a pan.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 12[146].

Deemed Measure Cost

The incremental capital cost for this measure is $2400[147].

Loadshape

N/A

Coincidence Factor

N/A

Algorithm

Calculation of Savings

Electric Energy Savings

N/A

Summer Coincident Peak Demand Savings

N/A

Natural Gas Energy Savings

The annual natural gas energy savings from this measure is a deemed value equaling 1380 Therms[148].

---

[146] Food Service Technology Center, ENERGY STAR and CEE do not currently provide calculators for this type of equipment therefore deemed values from Nicor Gas were used. Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011

[147] Ibid.

[148] Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011.These

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-FSE-PCOK-V01-120601

deemed values should be compared to PY evaluation and revised as necessary.

4.2.18 Rack Oven - Double Oven

Description

This measure applies to natural gas fired high efficiency rack oven - double oven installed in a commercial kitchen.

This measure was developed to be applicable to the following program types: TOS. 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 new natural gas rack oven –double oven with a baking efficiency ≥ 50% utilizing ASTM standard 2093

Definition of Baseline Equipment

The baseline equipment is an existing natural gas rack oven – double oven with a baking efficiency < 50%.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 12 years.[149]

Deemed Measure Cost

The incremental capital cost for this measure is $8646.[150]

Loadshape

N/A

Coincidence Factor

N/A

Algorithm

Calculation of Savings

Electric Energy Savings

N/A

Summer Coincident Peak Demand Savings

N/A

Natural Gas Energy Savings

The annual natural gas energy savings from this measure is a deemed value equaling 2064 therms[151]

---

[149] Food Service Technology Center, ENERGY STAR and CEE do not currently provide calculators for this type of equipment therefore deemed values from Nicor Gas were used. Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011

[150] Ibid.

[151] Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011.These

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-FSE-RKOV-V01-120601

deemed values should be compared to PY evaluation and revised as necessary

4.2.19 ENERGY STAR Electric Convection Oven

Description

Commercial convection ovens that are ENERGY STAR certified have higher heavy load cooking efficiencies, and lower idle energy rates, making them on average about 20 percent more efficient than standard models. Energy savings estimates are for ovens using full size (18" x 36") sheet pans.

This measure was developed to be applicable to the following program types; TOS.

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

Definition of Efficient Equipment

The efficient equipment is assumed to be an ENERGY STAR qualified electric convection oven.

Definition of Baseline Equipment

The baseline equipment is assumed to be a standard convection oven with a heavy load efficiency of 65%.

Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 12 years.[152]

Deemed Measure Cost

The incremental cost for this measure is assumed to be $800 for half size units and $1000 for full size[153]

Loadshape

Loadshape C01 - Commercial Electric Cooking

Coincidence Factor

Summer Peak Coincidence Factor for measure is provided below for different building type[154]:

Location	CF
Fast Food Limited Menu	0.32
Fast Food Expanded Menu	0.41
Pizza	0.46
Full Service Limited Menu	0.51

[152] Food Service Technology Center (FSTC). Default value from life cycle cost calculator. http://www.fishnick.com/saveenergy/tools/calculators/eovencalc.php

[153] Based on data from the Regional Technical Forum for the Northwest Council (http://rtf.nwcouncil.org/measures/com/ComCookingConvectionOven_v2_0.xlsm) using actual list prices for 23 units from 2012, see "ComCookingConvectionOven_v2_0.xlsm".

[154] Minnesota 2012 Technical Reference Manual, Electric Food Service_v03.2.xls, http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech. Unknown is an average of other location types

Full Service Expanded Menu	0.36
Cafeteria	0.36
Unknown	0.40

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$\Delta kWh = kWH_{base} - kWh_{eff}$

$kWh = [(LB * E_{FOOD}/EFF) + (IDLE * (HOURS_{DAY} – LB/PC – PRE_{TIME}/60)) + PRE_{ENERGY}] * DAYS$

Where:

kWH_{base} = the annual energy usage of the baseline equipment calculated using baseline values

kWH_{eff} = the annual energy usage of the efficient equipment calculated using efficient values

$HOURS_{DAY}$ = daily operating hours

= Actual, defaults:

Type of Food Service	$HOURS_{DAY}$ [155]
Fast Food, limited menu	4
Fast Food, expanded menu	5
Pizza	8
Full Service, limited menu	8
Full Service, expanded menu	7
Cafeteria	6
Unknown	6[156]
Custom	Varies

DAYS = Days per year of operation

= Actual, default = 365[157]

[155] Minnesota 2012 Technical Reference Manual, Electric Food Service_v03.2.xls, http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech

[156] Unknown is average of other locations

PRE_{TIME} = Preheat time (min/day), the amount of time it takes a steamer to reach operating temperature when turned on

= 15 min/day[158]

E_{FOOD} = ASTM Energy to Food (kWh/lb); the amount of energy absorbed by the food during cooking, per pound of food

= 0.0732[159]

LB = pounds of food cooked per day (lb/day)

= Actual, default = 100[160]

EFF = Heavy load cooking energy efficiency (%). See table below.

IDLE = Idle energy rate. See table below.

PC = Production capacity (lbs/hr). See table below.

PRE_{ENERGY} = Preheat energy (kWh/day). See table below.

Performance Metrics: Baseline and Efficient Values

Metric	Baseline Model [161]	Energy Efficient Model [162]
PRE_{ENERGY} (kWh)	1.5	1
IDLE (kW)	2	Actual, default = 1.0
EFF	65%	Actual, default = 74%
PC (lb/hr)	70	Actual, default = 79

[157] Food Service Technology Center (FSTC). Default value from life cycle cost calculator. http://www.fishnick.com/saveenergy/tools/calculators/eovencalc.php

[158] Food Service Technology Center (2002). *Commercial Cooking Appliance Technology Assessment*. Prepared by Don Fisher. Chapter 7: Ovens

[159] American Society for Testing and Materials. Industry standard for Commercial Ovens

[160] Food Service Technology Center (FSTC). Default value from life cycle cost calculator. http://www.fishnick.com/saveenergy/tools/calculators/eovencalc.php

[161] Food Service Technology Center (FSTC). Default values from life cycle cost calculator. http://www.fishnick.com/saveenergy/tools/calculators/eovencalc.php

[162] Average ratings of units on ENERGY STAR qualified list as of 10/2014. Preheat energy is not provided so default is provided based on FSTC life cycle cost calculator.

EXAMPLE

Using defaults provided above, the savings for a ENERGY STAR Electric Convection Oven in unknown location are:

kWH_{base} = [(100 * 0.0732/0.65) + (2 * (6 – 100/70 – 15/60)) + 1.5] * 365

= 7,813 kWh

kWh_{eff} = [(100 * 0.0732/0.74) + (1 * (6 – 100/79 – 15/60)) + 1.0] * 365

= 5,612 kWh

ΔkWh = kWH_{base} - kWh_{eff}

= 7,813 – 5,612

= 2200 kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = (\Delta kWh / (HOURS_{DAY} * DAYS)) * CF$$

Where:

ΔkWh = Annual energy savings (kWh)

CF = Summer Peak Coincidence Factor for measure is provided below for different building type[163]:

Location	CF
Fast Food Limited Menu	0.32
Fast Food Expanded Menu	0.41
Pizza	0.46
Full Service Limited Menu	0.51
Full Service Expanded Menu	0.36
Cafeteria	0.36
Unknown	0.40

[163] Minnesota 2012 Technical Reference Manual, Electric Food Service_v03.2.xls, http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech. Unknown is an average of other location types

EXAMPLE

Using defaults provided above, the savings for a ENERGY STAR Electric Convection Oven in unknown location are:

$$\Delta kW = (2200 / (6 * 365)) * 0.40$$

$$= 0.40$$

FOSSIL FUEL IMPACT DESCRIPTIONS AND CALCULATION

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-FSE-ECON-V01-150601

4.3 Hot Water

4.3.1 Storage Water Heater

Description

This measure is for upgrading from minimum code to a storage-type water heaters. Storage water heaters are used to supply hot water for a variety of commercial building types. Storage capacities vary greatly depending on the application. Large consumers of hot water include (but not limited to) industries, hotels/motels and restaurants.

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

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

Definition of Efficient Equipment

Gas, High Efficiency	Gas, Standard	Electric
In order for this characterization to apply, the efficient equipment is assumed to have heating capacity over 75,000 Btu/hr and a Thermal Efficiency (TE) greater than or equal to 88%	In order for this characterization to apply, the efficient equipment is assumed to be a gas-fired storage water heaters with 0.67 EF or better installed in a non-residential application Primary applications would include (but not limited to) hotels/motels, small commercial spaces, offices and restaurants	In order for this characterization to apply, the efficient equipment is assumed to have[164]: Energy factor greater than or equal to 0.95 Minimum Thermal Efficiency of 0.98 Less than 3% standby loss (standby loss is calculated as percentage of annual (energy usage) Equivalent storage capacity to unit being replaced Qualified units must be GAMA/AHRI efficiency rating certified

Definition of Baseline Equipment

Gas, High Efficiency	Gas, Standard	Electric
In order for this characterization to apply, the baseline condition is assumed to be a water heater with heating capacity over 75,000 Btu/hr and a Thermal Efficiency (TE) of 80%	In order for this characterization to apply, the baseline condition is assumed to be the minimum code compliant unit with 0.575 EF.	In order for this characterization to apply, the baseline equipment is assumed to be an electric storage water heater with 50 or more gallon capacity in input wattage between 12kW and 54kW.

[164] Act on Energy Commercial Technical Reference Manual No. 2010-4

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

Gas, High Efficiency	Gas, Standard	Electric
The expected measure life is assumed to be 15 Years[165]	The expected measure life is assumed to be 15 years[166]	The expected measure life is assumed to be 5 years[167].

DEEMED MEASURE COST

<table>
<tr><th>Gas, High Efficiency</th><th>Gas, Standard</th><th>Electric</th></tr>
<tr><td>The incremental capital cost for this measure is $209</td><td>The deemed measure cost is assumed to be $400</td><td>The incremental capital cost for this measure is assumed to be[168]
<table>
<tr><th>Tank Size</th><th>Incremental Cost</th></tr>
<tr><td>50 gallons</td><td>$1050</td></tr>
<tr><td>80 gallons</td><td>$1050</td></tr>
<tr><td>100 gallons</td><td>$1950</td></tr>
</table>
</td></tr>
</table>

LOADSHAPE

Gas, High Efficiency	Gas, Standard	Electric
N/A	N/A	Loadshape C02 - Non-Residential Electric DHW

COINCIDENCE FACTOR

Gas, High Efficiency	Gas, Standard	Electric
N/A	N/A	The measure has deemed kW savings therefor a coincidence factor is not applied

[165] Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011
[166] Gas Storage Water Heater 0.67. Work Paper WPRSGNGDHW106. Resource Solutions Group. December 2010
[167] Ibid.
[168] Ibid.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS [169]

The annual electric savings the electric water storage tank and heater is a deemed value and assumed to be:

Tank Size	Savings (kWh)
50 gallons	1,781
80 gallons	4,963
100 gallons	8,274

SUMMER COINCIDENT PEAK DEMAND SAVINGS[170]

The annual kW savings from this measure is a deemed value and assumed to be:

Tank Size	Savings (kW)
50 gallons	0.20
80 gallons	0.57
100 gallons	0.94

[169] Ibid.
[170] Ibid.

NATURAL GAS ENERGY SAVINGS

<table>
<tr><th>Gas, High Efficiency</th><th>Gas, Standard</th></tr>
<tr><td>The annual natural gas energy savings from this measure is a deemed value equaling 251[171]</td><td>Gas savings depend on building type and are based on measure case energy factor of 0.67 and a heating capacity of 75 MBtu/hr. These values are averages of qualifying units. Savings values are derived from 2008 DEER Miser, which provides MBtu/hr gas savings per MBtu/hr capacity. Savings presented here are per water heater.[172]
<table>
<tr><th>Building Type</th><th>Energy Savings (therms/unit)</th></tr>
<tr><td>Assembly</td><td>185</td></tr>
<tr><td>Education – Primary/Secondary</td><td>124</td></tr>
<tr><td>Education – Post Secondary</td><td>178</td></tr>
<tr><td>Grocery</td><td>191</td></tr>
<tr><td>Health/Medical - Hospital</td><td>297</td></tr>
<tr><td>Lodging - Hotel</td><td>228</td></tr>
<tr><td>Manufacturing - Light Industrial</td><td>140</td></tr>
<tr><td>Office – > 60,000 sq-ft</td><td>164</td></tr>
<tr><td>Office – < 60,000 sq-ft</td><td>56</td></tr>
<tr><td>Restaurant - FastFood</td><td>109</td></tr>
<tr><td>Restaurant – Sit Down</td><td>166</td></tr>
<tr><td>Retail</td><td>105</td></tr>
<tr><td>Storage</td><td>150</td></tr>
<tr><td>Multi-Family</td><td>119</td></tr>
<tr><td>Other</td><td>148</td></tr>
</table>
</td></tr>
</table>

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-HW_-STWH-V01-120601

[171] Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011. These deemed values should be compared to PY evaluation and revised as necessary

[172] Gas Storage Water Heater 0.67. Work Paper WPRSGNGDHW106. Resource Solutions Group. December 2010

4.3.2 Low Flow Faucet Aerators

DESCRIPTION

This measure relates to the direct installation of a low flow faucet aerator in a commercial building. Expected applications include small business, office, restaurant, or motel. For multifamily or senior housing, the residential low flow faucet aerator should be used.

This measure was developed to be applicable to the following program types, DI.

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 an energy efficient faucet aerator, for bathrooms rated at 1.5 gallons per minute (GPM) or less, or for kitchens rated at 2.2 GPM or less. Savings are calculated on an average savings per faucet fixture basis.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is assumed to be a standard bathroom faucet aerator rated at 2.25 GPM or more, or a standard kitchen faucet aerator rated at 2.75 GPM or more. Note if flow rates are measured, for example through a Direct Install program, then actual baseline flow rates should be used as opposed to the deemed values.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 9 years.[173]

DEEMED MEASURE COST

The incremental cost for this measure is $8[174] or program actual.

LOADSHAPE

Loadshape C02 - Commercial Electric DHW

COINCIDENCE FACTOR

The coincidence factor for this measure is dependent on building type as presented below.

[173] Table C-6, Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007. "http://neep.org/Assets/uploads/files/emv/emv-library/measure_life_GDS%5B1%5D.pdf"

[174] Direct-install price per faucet assumes cost of aerator and install time. (2011, Market research average of $3 and assess and install time of $5 (20min @ $15/hr)

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

NOTE THESE SAVINGS ARE *PER* FAUCET RETROFITTED[175].

ΔkWh = %ElectricDHW * ((GPM_base - GPM_low)/GPM_base) * Usage * EPG_electric * ISR

Where:

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

DHW fuel	%Electric_DHW
Electric	100%
Fossil Fuel	0%

GPM_base = Average flow rate, in gallons per minute, of the baseline faucet "as-used"

= 1.39[176] or custom based on metering studies[177] or if measured during DI:

= Measured full throttle flow * 0.83 throttling factor[178]

GPM_low = Average flow rate, in gallons per minute, of the low-flow faucet aerator "as-used"

= 0.94[179] or custom based on metering studies[180] or if measured during DI:

= Rated full throttle flow * 0.95 throttling factor[181]

---

[175] This algorithm calculates the amount of energy saved per aerator by determining the fraction of water consumption savings for the upgraded fixture. Due to the distribution of water consumption by fixture type, as well as the different number of fixtures in a building, several variables must be incorporated.

[176] Email message from Maureen Hodgins, Research Manager for Water Research Foundation, to TAC/SAG, August 26, 2014

[177] Measurement should be based on actual average flow consumed over a period of time rather than a onetime spot measurement for maximum flow. Studies have shown maximum flow rates do not correspond well to average flow rate due to occupant behavior which does not always use maximum flow.

[178] 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. Page 1-265. www.seattle.gov/light/Conserve/Reports/paper_10.pdf

[179] Average retrofit flow rate for kitchen and bathroom faucet aerators from sources 2, 4, 5, and 7. This accounts for all throttling and differences from rated flow rates. Assumes all kitchen aerators at 2.2 gpm or less and all bathroom aerators at 1.5 gpm or less. The most comprehensive available studies did not disaggregate kitchen use from bathroom use, but instead looked at total flow and length of use for all faucets. This makes it difficult to reliably separate kitchen water use from bathroom water use. It is possible that programs installing low flow aerators lower than the 2.2 gpm for kitchens and 1.5 gpm for bathrooms will see a lower overall average retrofit flow rate.

[180] Measurement should be based on actual average flow consumed over a period of time rather than a onetime spot measurement for maximum flow. Studies have shown maximum flow rates do not correspond well to average flow rate due to occupant behavior which does not always use maximum flow.

Usage = Estimated usage of mixed water (mixture of hot water from water heater line and cold water line) per faucet (gallons per year)

= If data is available to provide a reasonable custom estimate it should be used, if not use the following defaults (or substitute custom information in to the calculation):

Building Type	Gallons hot water per unit per day[182] (A)	Unit	Estimated % hot water from Faucets [183] (B)	Multiplier [184] (C)	Unit	Days per year (D)	Annual gallons mixed water per faucet (A*B*C*D)
Small Office	1	person	100%	10	employees per faucet	250	2,500
Large Office	1	person	100%	45	employees per faucet	250	11,250
Fast Food Rest	0.7	meal/day	50%	75	meals per faucet	365	9,581
Sit-Down Rest	2.4	meal/day	50%	36	meals per faucet	365	15,768
Retail	2	employee	100%	5	employees per faucet	365	3,650
Grocery	2	employee	100%	5	employees per faucet	365	3,650
Warehouse	2	employee	100%	5	employees per faucet	250	2,500
Elementary School	0.6	person	50%	50	students per faucet	200	3,000
Jr High/High School	1.8	person	50%	50	students per faucet	200	9,000
Health	90	patient	25%	2	Patients per faucet	365	16,425
Motel	20	room	25%	1	faucet per room	365	1,825
Hotel	14	room	25%	1	faucet per room	365	1,278
Other	1	employee	100%	20	employees per faucet	250	5,000

EPG_electric = Energy per gallon of mixed water used by faucet (electric water heater)

= (8.33 * 1.0 * (WaterTemp - SupplyTemp)) / (RE_electric * 3412)

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[181] 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. Page 1-265. www.seattle.gov/light/Conserve/Reports/paper_10.pdf

[182] Table 2-45 Chapter 49, Service Water Heating, 2007 ASHRAE Handbook, HVAC Applications.

[183] Estimated based on data provided in Appendix E; “Waste Not, Want Not: The Potential for Urban Water Conservation in California”; http://www.pacinst.org/reports/urban_usage/appendix_e.pdf

[184] Based on review of the Illinois plumbing code (Employees and students per faucet). Retail, grocery, warehouse and health are estimates. Meals per faucet estimated as 4 bathroom and 3 kitchen faucets and average meals per day of 250 (based on California study above) – 250/7 = 36. Fast food assumption estimated.

= (8.33 * 1.0 * (90 – 54.1)) / (0.98 * 3412)

= 0.0894 kWh/gal

8.33 = Specific weight of water (lbs/gallon)

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

WaterTemp = Assumed temperature of mixed water

= 86F for Bath, 93F for Kitchen 91F for Unknown[185]

SupplyTemp = Assumed temperature of water entering building

= 54.1°F [186]

RE_electric = Recovery efficiency of electric water heater

= 98% [187]

3412 = Converts Btu to kWh (Btu/kWh)

ISR = In service rate of faucet aerators dependant on install method as listed in table below[188]

Selection	ISR
Direct Install - Deemed	0.95

[185] Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum dated June 2013, directed to Michigan Evaluation Working Group. If the aerator location is unknown an average of 91% should be used which is based on the assumption that 70% of household water runs through the kitchen faucet and 30% through the bathroom (0.7*93)+(0.3*86)=0.91.

[186] US DOE Building America Program. Building America Analysis Spreadsheet. For Chicago, IL http://www1.eere.energy.gov/buildings/building_america/analysis_spreadsheets.html.

[187] Electric water heaters have recovery efficiency of 98%: http://www.ahridirectory.org/ahridirectory/pages/home.aspx

[188] 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 http://ilsagfiles.org/SAG_files/Evaluation_Documents/ComEd/ComEd%20EPY2%20Evaluation%20Reports/ComEd_All_Electric_Single_Family_HEP_PY2_Evaluation_Report_Final.pdf

EXAMPLE

For example, a direct installed faucet in a large office with electric DHW:

ΔkWh = 1 * ((1.39 – 0.94)/1.39) * 11,250 * 0.0894 * 0.95

= 309 kWh

For example, a direct installed faucet in an Elementary School with electric DHW:

ΔkWh = 1 * ((1.39 – 0.94)/1.39) * 3,000 * 0.0894 * 0.95

= 82.5 kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW = (ΔkWh / Hours) * CF

Where:

ΔkWh = calculated value above on a per faucet basis

Hours = Annual electric DHW recovery hours for faucet use

= (Usage * 0.545[189])/GPH

= Calculate if usage is custom, if using default usage use:

Building Type	Annual Recovery Hours
Small Office	24
Large Office	109
Fast Food Rest	93
Sit-Down Rest	153
Retail	36
Grocery	36
Warehouse	24
Elementary School	29
Jr High/High School	88
Health	160
Motel	18

[189] 54.5% is the proportion of hot 120F water mixed with 54.1F supply water to give 90°F mixed faucet water.

Building Type	Annual Recovery Hours
Hotel	12
Other	49

Where:

GPH = Gallons per hour recovery of electric water heater calculated for 85.9F temp rise (140-54.1), 98% recovery efficiency, and typical 12kW electric resistance storage tank.

= 56

CF = Coincidence Factor for electric load reduction

= Dependent on building type[190]

Building Type	Coincidence Factor
Small Office	0.0064
Large Office	0.0288
Fast Food Rest	0.0084
Sit-Down Rest	0.0184
Retail	0.0043
Grocery	0.0043
Warehouse	0.0064
Elementary School	0.0096
Jr High/High School	0.0288
Health	0.0144
Motel	0.0006
Hotel	0.0004
Other	0.0128

[190] Calculated as follows: Assumptions for percentage of usage during peak period (1-5pm) were made and then multiplied by 65/365 (65 being the number of days in peak period) and by the number of total annual recovery hours to give an estimate of the number of hours of recovery during peak periods. There are 260 hours in the peak period so the probability you will see savings during the peak period is calculated as the number of hours of recovery during peak divided by 260. See 'C&I Faucet Aerator.xls' for details.

EXAMPLE

For example, a direct installed faucet in a large office with electric DHW:

ΔkW = 309/109 * 0.0288

= 0.0816 kW

For example, a direct installed faucet in an Elementary School with electric DHW:

ΔkW = 82.5/29 * 0.0096

= 0.0273 kW

FOSSIL FUEL IMPACT DESCRIPTIONS AND CALCULATION

ΔTherms = %FossilDHW * ((GPM_base - GPM_low)/GPM_base) * Usage * EPG_gas * ISR

Where:

%FossilDHW = proportion of water heating supplied by fossil fuel heating

DHW fuel	%Fossil_DHW
Electric	0%
Fossil Fuel	100%

EPG_gas = Energy per gallon of mixed water used by faucet (gas water heater)

= (8.33 * 1.0 * (WaterTemp - SupplyTemp)) / (RE_gas * 100,000)

= 0.00446 Therm/gal

Where:

RE_gas = Recovery efficiency of gas water heater

` = 67% [191]

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

Other variables as defined above.

[191] 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 75%. Commercial properties are more similar to MF homes than SF homes. MF hot water is often provided by a larger commercial boiler. This suggests that the average recovery efficiency is somewhere between a typical central boiler efficiency of .59 and the .75 for single family home. An average is used for this analysis by default.

EXAMPLE

For example, a direct installed faucet in a large office with gas DHW:

ΔTherms = 1 * ((1.39 – 0.94)/1.39) * 11,250 * 0.00446 * 0.95

= 15.4 Therms

For example, a direct installed faucet in a Elementary School with gas DHW:

ΔTherms = 1 * ((1.39 – 0.94)/1.39) * 3,000 * 0.00446 * 0.95

= 4.12 Therms

WATER IMPACT DESCRIPTIONS AND CALCULATION

Δgallons = ((GPM_base - GPM_low)/GPM_base) * Usage * ISR

Variables as defined above

EXAMPLE

For example, a direct installed faucet in a large office:

Δgallons = ((1.39 – 0.94)/1.39) * 11,250 * 0.95

= 3,640 gallons

For example, a direct installed faucet in a Elementary School:

Δgallons = ((1.39 – 0.94)/1.39) * 3,000 * 0.95

= 971 gallons

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

SOURCES USED FOR GPM ASSUMPTIONS

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: CI-HWE-LFFA-V05-140601

4.3.3 Low Flow Showerheads

DESCRIPTION

This measure relates to the direct installation of a low flow showerhead in a commercial building. Expected applications include small business, office, restaurant, or small motel. For multifamily or senior housing, the residential low flow showerhead should be used.

This measure was developed to be applicable to the following program types: DI.

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 an energy efficient showerhead rated at 2.0 gallons per minute (GPM) or less. Savings are calculated on a per showerhead fixture basis.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is assumed to be a standard showerhead rated at 2.5 GPM.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 10 years.[192]

DEEMED MEASURE COST

The incremental cost for this measure is $12[193] or program actual.

LOADSHAPE

Loadshape C02 - Commercial Electric DHW

COINCIDENCE FACTOR

The coincidence factor for this measure is assumed to be 2.78%[194].

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[192] 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"

[193] Direct-install price per showerhead assumes cost of showerhead (Market research average of $7 and assess and install time of $5 (20min @ $15/hr)

[194] 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. 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

Algorithm

CALCULATION OF SAVINGS [195]

ELECTRIC ENERGY SAVINGS

Note these savings are per showerhead fixture

ΔkWh =

%ElectricDHW * ((GPM_base * L_base - GPM_low * L_low) * NSPD * 365.25) * EPG_electric * ISR

Where:

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

= 1 if electric DHW, 0 if fuel DHW, if unknown assume 16% [196]

GPM_base = Flow rate of the baseline showerhead

= 2.67 for Direct-install programs[197]

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[198]

L_base = Shower length in minutes with baseline showerhead

= 8.20 min[199]

L_low = Shower length in minutes with low-flow showerhead

= 8.20 min[200]

365.25 = Days per year, on average.

NSPD = Estimated number of showers taken per day for one showerhead

EPG_electric = Energy per gallon of hot water supplied by electric

---

[195]Based on excel spreadsheet 120911.xls …on SharePoint

[196] Table HC8.9. Water Heating in U.S. Homes in Midwest Region, Divisions, and States, 2009 (RECS)

[197] Based on measured data from Ameren IL EM&V of Direct-Install program. Program targets showers that are rated 2.5 GPM or above.

[198] 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.

[199] Representative value from sources 1, 2, 3, 4, 5, and 6 (See Source Table at end of measure section)

[200] Set equal to L_base.

= (8.33 * 1.0 * (ShowerTemp - SupplyTemp)) / (RE_electric * 3412)

= (8.33 * 1.0 * (105 – 54.1)) / (0.98 * 3412)

= 0.127 kWh/gal

8.33 = Specific weight of water (lbs/gallon)

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

ShowerTemp = Assumed temperature of water

= 105°F [201]

SupplyTemp = Assumed temperature of water entering house

= 54.1°F [202]

RE_electric = Recovery efficiency of electric water heater

= 98% [203]

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[204]
Direct Install - Deemed	0.98

EXAMPLE

For example, a direct-installed 1.5 GPM showerhead in an office with electric DHW where the number of showers is estimated at 3 per day:

ΔkWh = 1 * ((2.67*8.20)- (1.5*8.20)) * 3*365.25) *0.127 * 0.98

= 1308.4 kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW = ΔkWh/Hours * CF

Where:

ΔkWh = calculated value above

Hours = Annual electric DHW recovery hours for showerhead use

[201] Shower temperature cited from SBW Consulting, Evaluation for the Bonneville Power Authority, 1994, http://www.bpa.gov/energy/n/reports/evaluation/residential/faucet_aerator.cfm

[202] US DOE Building America Program. Building America Analysis Spreadsheet. For Chicago, IL http://www1.eere.energy.gov/buildings/building_america/analysis_spreadsheets.html.

[203] Electric water heaters have recovery efficiency of 98%: http://www.ahridirectory.org/ahridirectory/pages/home.aspx

[204] 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.

= ((GPM_base * L_base) *NSPD * 365.25) * 0.773[205] / GPH

Where:

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[206]

EXAMPLE

For example, a direct-installed 1.5 GPM showerhead in an office with electric DHW where the number of showers is estimated at 3 per day:

ΔkW = (1308.4 / 674.1)*0.0278

= 0.054 kW

FOSSIL FUEL IMPACT DESCRIPTIONS AND CALCULATION

ΔTherms = %FossilDHW * ((GPM_base * L_base - GPM_low * L_low) * NSPD* 365.25) * EPG_gas * ISR

Where:

%FossilDHW = proportion of water heating supplied by fossil fuel heating

DHW fuel	%Fossil_DHW
Electric	0%
Fossil Fuel	100%
Unknown	84%[207]

EPG_gas = Energy per gallon of Hot water supplied by gas

= (8.33 * 1.0 * (ShowerTemp - SupplyTemp)) / (RE_gas * 100,000)

= 0.0063 Therm/gal

[205] 77.3% is the proportion of hot 120F water mixed with 54.1°F supply water to give 105°F shower water

[206] 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*65/365.25 = 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

[207] 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

Where:

RE_gas = Recovery efficiency of gas water heater

= 67% [208]

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

Other variables as defined above.

EXAMPLE

For example, a direct-installed 1.5 GPM showerhead in an office with gas DHW where the number of showers is estimated at 3 per day:

ΔTherms = 1.0 * ((2.67 *8.2) – (1.5 * 8.2)) * 3 * 365.25 * 0.0063 * 0.98

= 64.9 therms

WATER IMPACT DESCRIPTIONS AND CALCULATION

Δgallons = ((GPM_base * L_base - GPM_low * L_low) * NSPD * 365.25 * ISR

Variables as defined above

EXAMPLE

For example, a direct-installed 1.5 GPM showerhead in an office with where the number of showers is estimated at 3 per day:

Δgallons = ((2.67 * 8.20)-(1.5 * 8.20)) * 3 * 365.25 * 0.98

= 10,302 gallons

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

[208] 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 75%. Commercial properties are more similar to MF homes than SF homes. MF hot water is often provided by a larger commercial boiler. This suggests that the average recovery efficiency is somewhere between a typical central boiler efficiency of .59 and the .75 for single family home. An average is used for this analysis by default.

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: CI-HW_-LFSH-V03-150601

4.3.4 Commercial Pool Covers

Description

This measure refers to the installation of covers on commercial use pools that are heated with gas-fired equipment located either indoors or outdoors. By installing pool covers, the heating load on the pool boiler will be reduced by reducing the heat loss from the water to the environment and the amount of actual water lost due to evaporation (which then requires additional heated water to make up for it).

The main source of energy loss in pools is through evaporation. This is particularly true of outdoor pools where wind plays a larger role. The point of installing pool covers is threefold. First, it will reduce convective losses due to the wind by shielding the water surface. Second, it will insulate the water from the colder surrounding air. And third, it will reduce radiative losses to the night sky. In doing so, evaporative losses will also be minimized, and the boiler will not need to work as hard in replenishing the pool with hot water to keep the desired temperature.

This measure can be used for pools that (1) currently do not have pool covers, (2) have pool covers that are past the useful life of the existing cover, or (3) have pool covers that are past their warranty period and have failed.

Definition of Efficient Equipment

For indoor pools, the efficient case is the installation of an indoor pool cover with a 5 year warranty on an indoor pool that operates all year.

For outdoor pools, the efficient case is the installation of an outdoor pool cover with a 5 year warranty on an outdoor pool that is open through the summer season.

Definition of Baseline Equipment

For indoor pools, the base case is an uncovered indoor pool that operates all year.

For outdoor pools, the base case is an outdoor pool that is uncovered and is open through the summer season.

Deemed Lifetime of Efficient Equipment

The useful life of this measure is assumed to be 6 years [209]

Deemed Measure Cost

The table below shows the costs for the various options and cover sizes. Since this measure covers a mix of various sizes, the average cost of these options is taken to be the incremental measure cost. [210].

[209] The effective useful life of a pool cover is typically one year longer than its warranty period. SolaPool Covers. Pool Covers Website, FAQ- "How long will my SolaPool cover blanket last?". Pool covers are typically offered with 3 and 5 year warranties with at least one company offering a 6 year warranty. Conversation with Trade Ally. Knorr Systems

[210] Pool Cover Costs: Lincoln Commercial Pool Equipment website. Accessed 8/26/11. http://www.lincolnaquatics.com/shop/catalog/Pool+and+Spa+Covers+and+Accessories/product.html?ProductID=84-010

Cover Size	Edge Style	
	Hemmed (indoor)	Weighted (outdoor)
1000-1,999 sq. ft.	$2.19	$2.24
2,000-2,999 sq. ft.	$2.01	$2.06
3,000+ sq. ft.	$1.80	$1.83
Average	$2.00	$2.04

LOADSHAPE

N/A

COINCIDENCE FACTOR

N/A

NET TO GROSS RATIO

Algorithm

CALCULATION OF ENERGY SAVINGS

ELECTRIC ENERGY SAVINGS

N/A

SUMMER COINCIDENT PEAK DEMAND SAVINGS

N/A

NATURAL GAS SAVINGS

The calculations are based on modeling runs using RSPEC! Energy Smart Pools Software that was created by the U.S. Department of Energy. [211]

ΔTherms = SavingFactor x Size of Pool

Where

Savings factor = dependant on pool location and listed in table below[212]

Location	Therm / sq-ft
Indoor	2.61
Outdoor	1.01

Size of Pool = custom input

[211] Full method and supporting information found in reference document: IL TRM - Business Pool Covers WorkPaper.docx. Note that the savings estimates are based upon Chicago weather data.
[212] Business Pool Covers.xlsx

WATER IMPACT DESCRIPTIONS AND CALCULATION

ΔTherms = WaterSavingFactor x Size of Pool

Where

WaterSavingFactor = Water savings for this measure dependant on pool location and listed in table below.[213].

Location	Annual Savings Gal / sq-ft
Indoor	15.28
Outdoor	8.94

Size of Pool = Custom input

DEEMED O&M COST ADJUSTMENT CALCULATION

There are no O&M cost adjustments for this measure.

MEASURE CODE: CI-HW_-PLCV-V01-130601

[213] Ibid.

4.3.5 Tankless Water Heater

DESCRIPTION

This measure covers the installation of on-demand or instantaneous tankless water heaters. Tankless water heaters function similar to standard hot water heaters except they do not have a storage tank. When there is a call for hot water, the water is heated instantaneously as it passes through the heating element and then proceeds to the user or appliance calling for hot water. Tankless water heaters achieve savings by eliminating the standby losses that occur in stand-alone or tank-type water heaters and by being more efficient than the baseline storage hot water heater.

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

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

DEFINITION OF EFFICIENT EQUIPMENT

Electric	Gas
To qualify for this measure, the tankless water heater shall be a new electric powered tankless hot water heater with an energy factor greater than or equal to 0.98 with an output greater than or equal to 5 GPM output at 70° F temperature rise.	To qualify for this measure, the tankless water heater shall meet or exceed the efficiency requirements for tankless hot water heaters mandated by the International Energy Conservation Code (IECC) 2012, Table C404.2.

DEFINITION OF BASELINE EQUIPMENT

Electric	Gas
The baseline condition is assumed to be an electric commercial-grade tanked water heater 50 or more gallon storage capacity with an energy factor less than or equal to 0.9 or the water heater is five or more years old.	The baseline condition is assumed to be a gas-fired tank-type water heater meeting the efficiency requirements mandated by the International Energy conservation Code (IECC) 2012, Table C404.2.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

Electric	Gas
The expected measure life is assumed to be 5 years[214].	The expected measure life is assumed to be 20 years[215]

DEEMED MEASURE COST

The incremental capital cost for an electric tankless heater this measure is assumed to be[216]

[214] Ohio Technical Reference Manual 8/2/2010 referencing CenterPoint Energy-Triennial CIP/DSM Plan 2010-2012 Report; Additional reference stating >20 years is at Energy Savers.Gov online at http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12820

[215] Ibid.

[216] Act on Energy Technical Reference Manual, Table 9.6.2-3

Output (gpm) at delta T 70	Incremental Cost
5	$1050
10	$1050
15	$1950

The incremental capital cost for a gas fired tankless heater is as follows:

Program	Capital Cost, $ per unit
Retrofit	$3,255[217]
Time of Sale or New Construction	$2,526[218]

DEEMED O&M COST ADJUSTMENTS

$100[219]

LOADSHAPE

Loadshape C02 - Commercial Electric DHW

COINCIDENCE FACTOR

The measure has deemed kW savings therefor a coincidence factor is not applied

[217] Based on AOE historical average installation data of 42 tankless gas hot water heaters

[218] http://www.mncee.org/getattachment/7b8982e9-4d95-4bc9-8e64-f89033617f37/, Low contractor estimate used to reflect less labor required in new construction of venting.

[219] Water heaters (WH) require annual maintenance. There are different levels of effort for annual maintenance depending if the unit is gas or electric, tanked or tankless. Electric and gas tank water heater manufacturers recommend an annual tank drain to clear sediments. Also recommended are "periodic" inspections by qualified service professionals of operating controls, heating element and wiring for electric WHs and thermostat, burner, relief valve internal flue-way and venting systems for gas WHs. Tankless WH require annual maintenance by licensed professionals to clean control compartments, burners, venting system and heat exchangers. This information is from WH manufacturer product brochures including GE, Rennai, Rheem, Takagi and Kenmore. References for incremental O&M costs were not found. Therefore the incremental cost of the additional annual maintenance for tankless WH is estimated at $100.

Algorithm

CALCULATION OF ENERGY SAVINGS

ELECTRIC ENERGY SAVINGS [220]

The annual electric savings from an electric tankless heater is a deemed value and assumed to be:

Output (gpm) at delta T 70	Savings (kWh)
5.0	2,992
10.0	7,905
15.0	12,879

SUMMER COINCIDENT PEAK DEMAND SAVINGS[221]

The annual kW savings from an electric tankless heater is a deemed value and assumed to be:

Output (gpm) at delta T 70	Savings (kW)
5.0	0.34
10.0	0.90
15.0	1.47

NATURAL GAS SAVINGS

ΔTherms =[[Wgal x 8.33 x 1 x (Tout - Tin) x [(1/Eff base) - (1/Eff ee)]]/100,000] +[[(SL x 8,766)/Eff base]] / 100,000 Btu/Therms]

Where:

Wgal = Annual water use for equipment in gallons

= custom, otherwise assume 21,915 gallons [222]

8.33 lbm/gal = weight in pounds of one gallon of water

1 Btu/lbm°F = Specific heat of water: 1 Btu/lbm/°F

8,766 hr/yr = hours a year

Tout = Unmixed Outlet Water Temperature

= custom, otherwise assume 130 °F[223]

[220] Act on Energy Technical Reference Manual, Table 9.6.2-3
[221] Ibid.
[222] 21,915 gallons is an estimate of 60 gal/day for 365.25 days/yr. If building type is known, reference 2007 ASHRAE Handbook HVAC Applications p. 49.14 Table 7 Hot Water Demands and Use for Various Types of Buildings to help estimate hot water consumption.
[223] Based on 2010 Ohio Techical Reference Manual and NAHB Research Center, (2002) Performance Comparison of Residential hot Water Systems. Prepared for National Renewable Energy Laboratory, Golden, Colorado.

Tin = Inlet Water Temperature

= custom, otherwise assume 54.1 °F[224]

Eff base = Rated efficiency of baseline water heater expressed as Energy Factor (EF) or Thermal Efficiency (Et); see table below[225]

Input Btu/hr of existing, tanked water heater	Eff base	Units
Size: ≤ 75,000 Btu/hr	0.67 -0.0019*Tank Volume	Energy Factor
Size: >75,000 Btu/hr and ≤ 155,000 Btu/hr	80%	Thermal Efficiency
Size: >155,000 Btu/hr	80%	Thermal Efficiency

Where:

Tank Volume = custom input, if unknown assume 60 gallons for Size: ≤ 75,000 Btu/hr

Please note: Units in base case must match units in efficient case. If Energy Factor used in base case, Energy Factor to be used in efficient case. If Themal Efficiency is used in base case, Thermal Efficiency must be used in efficient case.

Eff ee = Rated efficiency of efficient water heater expressed as Energy Factor (EF) or Thermal Efficiency (Eff t)

= custom input, if unknown assume 0.84[226]

SL = Stand-by Loss in Base Case Btu/hr

= custom input based on formula in table below, if unknown assume unit size in table below[227]

Input Btu/h of new, tankless water heater	Standby Loss (SL)
Size: ≤ 75,000 Btu/hr	0
Size: >75,000 Btu/hr	(Input rating/800)+(110*√Tank Volume))

Where:

Tank Volume = custom input, if unknown assume, 60 gallons for <75,000 Btu/hr, 75 gallons for >75,000 Btu/hr and ≤ 155,000 Btu/hr and 150 for Size >155,000 Btu/hr

Input Rating = nameplate Btu/hr rating of water heater

[224] August 31, 2011 Memo of Savings for Hot Water Savings Measures to Nicor Gas from Navigant states that 54.1°F was calculated from the weighted average of monthly water mains temperatures reported in the 2010 Building America Benchmark Study for Chicago-Waukegan, Illinois.

[225] IECC 2012, Table C404.2, Minimum Performance of Water-Heating Equipment

[226] Specifications of energy efficient tankless water heater. Reference Consortium for Energy Efficiency (CEE) which maintains a list of high efficiency tankless water heaters which currently have Energy Factors up to .96. Ameren currently requires minimum .82 energy factor.

[227] Stand-by loss is provided 2012 International Energy Conservation Code (IECC2012), Table C404.2, Minimum Performance of Water-Heating Equipment

EXAMPLE

For example, a 75,000 Btu/hr tankless unit using 21,915 gal/yr with outlet temperature at 130.0 and inlet temperature at 54.1, replacing a baseline unit with 0.8 thermal efficiency and standby losses of 1008.3 btu/hr:

ΔTherms =[[(21,915 x 8.33x 1 x (130 – 54.1) x [(1/.8) - (1/.84)]/100,000] +[(1008.3 x 8,766)/.8]] / 100,000

=115 Therms

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

The deemed O&M cost adjustment for a gas fired tankless heater is $100

REFERENCE TABLES

Minimum Performance Water Heating Equipment[228]

[228] International Energy Conservation Code (IECC)2012

TABLE C404.2
MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT

EQUIPMENT TYPE	SIZE CATEGORY (input)	SUBCATEGORY OR RATING CONDITION	PERFORMANCE REQUIRED[a, b]	TEST PROCEDURE
Water heaters, electric	≤ 12 kW	Resistance	$0.97 - 0.00132V$, EF	DOE 10 CFR Part 430
	> 12 kW	Resistance	$1.73V + 155$ SL, Btu/h	ANSI Z21.10.3
	≤ 24 amps and ≤ 250 volts	Heat pump	$0.93 - 0.00132V$, EF	DOE 10 CFR Part 430
Storage water heaters, gas	≤ 75,000 Btu/h	≥ 20 gal	$0.67 - 0.0019V$, EF	DOE 10 CFR Part 430
	> 75,000 Btu/h and ≤ 155,000 Btu/h	< 4,000 Btu/h/gal	80% E_t $(Q/800 + 110\sqrt{V})$ SL, Btu/h	ANSI Z21.10.3
	> 155,000 Btu/h	< 4,000 Btu/h/gal	80% E_t $(Q/800 + 110\sqrt{V})$ SL, Btu/h	
Instantaneous water heaters, gas	> 50,000 Btu/h and < 200,000 Btu/h[c]	≥ 4,000 (Btu/h)/gal and < 2 gal	$0.62 - 0.0019V$, EF	DOE 10 CFR Part 430
	≥ 200,000 Btu/h	≥ 4,000 Btu/h/gal and < 10 gal	80% E_t	ANSI Z21.10.3
	≥ 200,000 Btu/h	≥ 4,000 Btu/h/gal and ≥ 10 gal	80% E_t $(Q/800 + 110\sqrt{V})$ SL, Btu/h	
Storage water heaters, oil	≤ 105,000 Btu/h	≥ 20 gal	$0.59 - 0.0019V$, EF	DOE 10 CFR Part 430
	≥ 105,000 Btu/h	< 4,000 Btu/h/gal	78% E_t $(Q/800 + 110\sqrt{V})$ SL, Btu/h	ANSI Z21.10.3
Instantaneous water heaters, oil	≤ 210,000 Btu/h	≥ 4,000 Btu/h/gal and < 2 gal	$0.59 - 0.0019V$, EF	DOE 10 CFR Part 430
	> 210,000 Btu/h	≥ 4,000 Btu/h/gal and < 10 gal	80% E_t	ANSI Z21.10.3
	> 210,000 Btu/h	≥ 4,000 Btu/h/gal and ≥ 10 gal	78% E_t $(Q/800 + 110\sqrt{V})$ SL, Btu/h	
Hot water supply boilers, gas and oil	≥ 300,000 Btu/h and < 12,500,000 Btu/h	≥ 4,000 Btu/h/gal and < 10 gal	80% E_t	ANSI Z21.10.3
Hot water supply boilers, gas	≥ 300,000 Btu/h and < 12,500,000 Btu/h	≥ 4,000 Btu/h/gal and ≥ 10 gal	80% E_t $(Q/800 + 110\sqrt{V})$ SL, Btu/h	
Hot water supply boilers, oil	> 300,000 Btu/h and < 12,500,000 Btu/h	> 4,000 Btu/h/gal and > 10 gal	78% E_t $(Q/800 + 110\sqrt{V})$ SL, Btu/h	
Pool heaters, gas and oil	All	—	78% E_t	ASHRAE 146
Heat pump pool heaters	All	—	4.0 COP	AHRI 1160
Unfired storage tanks	All	—	Minimum insulation requirement R-12.5 $(h \cdot ft^2 \cdot °F)/Btu$	(none)

For SI: °C = [(°F) - 32]/1.8, 1 British thermal unit per hour = 0.2931 W, 1 gallon = 3.785 L, 1 British thermal unit per hour per gallon = 0.078 W/L.

a. Energy factor (EF) and thermal efficiency (E_t) are minimum requirements. In the EF equation, V is the rated volume in gallons.

b. Standby loss (SL) is the maximum Btu/h based on a nominal 70°F temperature difference between stored water and ambient requirements. In the SL equation, Q is the nameplate input rate in Btu/h. In the SL equation for electric water heaters, V is the rated volume in gallons. In the SL equation for oil and gas water heaters and boilers, V is the rated volume in gallons.

c. Instantaneous water heaters with input rates below 200,000 Btu/h must comply with these requirements if the water heater is designed to heat water to temperatures 180°F or higher.

MEASURE CODE: CI-HW_-TKWH-V02-120601

4.3.6 Ozone Laundry

DESCRIPTION

A new ozone laundry system(s) is added-on to new or existing commercial washing machine(s) using hot water heated with natural gas. The system generates ozone (O_3), a naturally occurring molecule, which helps clean fabrics by chemically reacting with soils in cold water. Adding an ozone laundry system(s) will reduce the amount of chemicals, detergents, and hot water needed to wash linens. Using ozone also reduces the total amount of water consumed, saving even more in energy.

Natural gas energy savings will be achieved at the hot water heater/boiler as they will be required to produce less hot water to wash each load of laundry. The decrease in hot water usage will increase cold water usage, but overall water usage at the facility will decrease.

Electric savings can be realized through reduced washer cycle length and reduced pumping load at the boiler feeding the commercial washers. The increased usage associated with operating the ozone system should also be accounted for when determining total kWh impact. Data reviewed for this measure characterization indicated that pumping savings should be accounted for, but washer savings and ozone generator consumption are comparatively so small that they can be ignored.

The reduced washer cycle length may decrease the dampness of the clothes when they move to the dryer. This can result in shorter runtimes which result in gas and electrical savings. However, at this time, there is inconclusive evidence that energy savings are achieved from reduced dryer runtimes so the resulting dryer effects are not included in this analysis. Additionally, there would be challenges verifying that dryer savings will be achieved throughout the life of the equipment.

This incentive only applies to the following facilities with on-premise laundry operations:

- Hotels/motels
- Fitness and recreational sports centers.
- Healthcare (excluding hospitals)
- Assisted living facilities

Ozone laundry system(s) could create significant energy savings opportunities at other larger facility types with on-premise laundry operations (such as correctional facilities, universities, and staff laundries), however, the results included in this analysis are based heavily on past project data for the applicable facility types listed above and may not apply to facilities outside of this list due to variances in number of loads and average pound (lbs.)-capacity per project site. Projects at these facilities should continue to be evaluated through custom programs and the applicable facility types and the resulting analysis should be updated based on new information.

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

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

DEFINITION OF EFFICIENT EQUIPMENT

A new ozone laundry system(s) is added-on to new or existing commercial washing machine(s) using hot water heated with natural gas. The ozone laundry system(s) must transfer ozone into the water through:

- Venturi Injection
- Bubble Diffusion
- Additional applications may be considered upon program review and approval on a case by case basis

DEFINITION OF BASELINE EQUIPMENT

The base case equipment is a conventional washing machine system with no ozone generator installed. The washing machines are provided hot water from a gas-fired boiler.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The measure equipment effective useful life (EUL) is estimated at 10 years based on typical lifetime of the ozone generator's corona discharge unit.[229]

DEEMED MEASURE COST

The actual measure costs should be used if available. If not a deemed value of $79.84 / lbs capacity should be used[230].

LOADSHAPE

Loadshape C53 – Flat

COINCIDENCE FACTOR

Past project documentation and data collection is not sufficient to determine a coincidence factor for this measure. Value should continue to be studied and monitored through additional studies due to limited data points used for this determination

Algorithm

CALCULATION OF ENERGY SAVINGS

ELECTRIC ENERGY SAVINGS

Electric savings can be realized through reduced washer cycle length and reduced pumping load at the boiler feeding the commercial washers. There is also an increased usage associated with operating the ozone system. Data reviewed for this measure characterization indicated that while pumping savings is significant and should be accounted for, washer savings and ozone generator consumption are negligible, counter each other out and are well within the margin of error so these are not included to simplify the characterization[231].

$$\Delta kWh_{PUMP} = HP * HP_{CONVERSION} * Hours * \%water\_savings$$

[229] Aligned with other national energy efficiency programs and confirmed with national vendors

[230] Average costs per unit of capacity were generated using data collected from existing ozone laundry projects that received incentives under the Non-Residential Retrofit Demand Reduction program (NRR-DR), as well as from the Nicor Custom Incentive Program, and the Nicor Emerging Technology Program (ETP). See referenced document Table 2 and RSMeans Mechanical Cost Data, 31st Annual Edition (2008)

[231] Washer savings were reviewed but were considered negligible and not included in the algorithm (0.00082 kWh / lbs-capacity, determined through site analysis through Nicor Emerging Technology Program (ETP) and confirmed with national vendors). Note that washer savings from Nicor's site analysis are smaller than those reported in a WI Focus on Energy case study (0.23kWh/100lbs, Hampton Inn Brookfield, November 2010). Electric impact of operating ozone generator (0.0021 kWh / lbs-capacity same source as washer savings) was also considered negligible and not included in calculations. Values should continue to be studied and monitored through additional studies due to limited data points used for this determination.

Where:

ΔkWh_{PUMP} = Electric savings from reduced pumping load

HP = Brake horsepower of boiler feed water pump;

= Actual or use 5 HP if unknown[232]

$HP_{CONVERSION}$ = Conversion from Horsepower to Kilowatt

= 0.746

Hours = Actual associated boiler feed water pump hours

= 800 hours if unknown[233]

%water_savings = water reduction factor: how much more efficient an ozone injection washing machine is compared to a typical conventional washing machine as a rate of hot and cold water reduction.

= 25%[234]

Using defaults above:

ΔkWh_{PUMP} = 5 * 0.746 * 800 * 0.25

= 746 kWh

Default per lb capacity: = ΔkWh_{PUMP} / lb capacity

Where:

Lbs-Capacity = Average Capacity in lbs of washer

=254.38[235]

ΔkWh_{PUMP} / lb capacity = 746/254.38

= 2.93 kWh/lb-capacity

SUMMER COINCIDENT PEAK DEMAND SAVINGS

Past project documentation and data collection is not sufficient to determine summer coincident peak demand savings for this measure. Value should continue to be studied and monitored through additional studies due to limited data points used for this determination. In absence of site-specific data, the summer coincident peak demand savings should be assumed to be zero.

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232 Assumed average horsepower for boilers connected to applicable washer

233 Engineered estimate provided by CLEAResult review of Nicor custom projects. Machines spent approximately 7 minutes per hour filling with water and were in operation approximately 20 hours per day. Total pump time therefore estimated as 7/60 * 20 * 365 = 852 hours, and rounded down conservatively to 800 hours.

234 Average water reduction factors were generated using data collected from existing ozone laundry projects that received incentives under the Non-Residential Retrofit Demand Reduction program (NRR-DR). Table 6 summarizes data gathered from several NRR-DR projects, Nicor Custom projects, and Nicor ETP projects. Nicor Savings Numbers are associated with ACEE_AWE_Ozone Laundry / From Gas Savings Calculations

235 Average lbs-capacity per project site was generated using data collected from existing ozone laundry projects that received incentives under the Non-Residential Retrofit Demand Reduction program (NRR-DR), as well as from the Nicor Custom Incentive Program, and the Nicor Emerging Technology Program (ETP). See referenced document Table 2

ΔkW = 0

NATURAL GAS SAVINGS

ΔTherm = $Therm_{Baseline}$ * %hot_water_savings

Where:

ΔTherm = Gas savings resulting from a reduction in hot water use, in therm.

$Therm_{Baseline}$ = Annual Baseline Gas Consumption

= WHE * WUtiliz * WUsage_hot

Where:

WHE = water heating energy: energy required to heat the hot water used

= 0.00885 therm/gallon[236]

WUtiliz = washer utilitzation factor: the annual pounds of clothes washed per year

= actual, if unknown use 916,150 lbs laundry[237], approximately equivalent to 13 cycles/day

WUsage_hot = hot water usage factor: how much hot water a typical conventional washing machine utilizes, normalized per pounds of clothes washed

= 1.19 gallons/lbs laundry[238]

Using defaults above:

$Therm_{Baseline}$ = 0.00885 * 916,150 * 1.19

= 9,648 therms

Default per lb capacity:

$Therm_{Baseline}$ / lb capacity = 9,648 / 254.38

= 37.9 therms / lb-capacity

%hot_water_savings = hot water reduction factor: how much more efficient an ozone injection washing machine is, compared to a typical conventional washing machine, as a rate of hot water reduction

= 81%[239]

[236] Assuming boiler efficiency is the regulated minimum efficiency (80%), per Title 20 Appliance Standard of the California Energy Regulations (October 2007). The incoming municipal water temperature is assumed to be 55 °F with an average hot water supply temperature of 140°F, based on default test procedures on clothes washers set by the Department of Energy's Office of Energy Efficiency and Renewable Energy (Federal Register, Vol. 52, No. 166). Enthalpies for these temperatures (107 btu/lbs at 140F, 23.07 btu/lbs at 55F) were obtained from ASHRAE Fundamentals

[237] Average utilization factors were generated using data collected from existing ozone laundry projects that received incentives under the NRR-DR program. Table 3 summarizes data gathered from several NRR-DR projects, Nicor Custom projects, and Nicor ETP projects

[238] Average hot water usage factors were generated using data collected from existing ozone laundry projects that received incentives under the NRR-DR program. summarizes data gathered from several NRR-DR projects:

[239] Average hot water reduction factors were generated using data collected from existing ozone laundry projects that received incentives under the Non-Residential Retrofit Demand Reduction program (NRR-DR). Table 5 summarizes data gathered from

Savings using defaults above:

ΔTherm = $Therm_{Baseline}$ * %hot_water_savings

= 9648 * 0.81

= 7,815 therms

Default per lb capacity:

ΔTherm / lb-capacity = 7815 / 254.38

= 30.7 therms / lb-capacity

WATER IMPACT DESCRIPTIONS AND CALCULATION

The water savings calculations listed here account for the combination of hot and cold water used. Savings calculations for this measure were based on the reduction in total water use from implementing an ozone washing system to the base case. There are three main components in obtaining this value:

Δgallons = WUsage * WUtiliz * %water_savings

Where:

Δgallons = reduction in total water use from implementing an ozone washing system to the base case

WUsage = water usage factor: how efficiently a typical conventional washing machine utilized hot and cold water normalized per unit of clothes washed

= 2.03 gallons/lbs laundry[240]

WUtiliz = washer utilitzation factor: the annual pounds of clothes washed per year

= actual, if unknown use 916,150 lbs laundry[241], approximately equivalent to 13 cycles/day

%water_savings = water reduction factor: how much more efficient an ozone injection washing machine is compared to a typical conventional washing machine as a rate of hot and cold water reduction.

= 25%[242]

Savings using defaults above:

ΔGallons = WUsage * WUtiliz * %water_savings

= 2.03 * 916,150 * 0.25

= 464,946 gallons

Default per lb capacity:

---

several NRR-DR projects, Nicor Custom projects, and Nicor ETP projects. Nicor Savings Numbers are associated with ACEE_AWE_Ozone Laundry / From Gas Savings Calculations

[240] Average water usage factors were generated using data collected from existing ozone laundry projects that received incentives under the NRR-DR program. summarizes data gathered from several NRR-DR projects

[241] Average utilization factors were generated using data collected from existing ozone laundry projects that received incentives under the NRR-DR program. Table 3 summarizes data gathered from several NRR-DR projects, Nicor Custom projects, and Nicor ETP projects

[242] Average water reduction factors were generated using data collected from existing ozone laundry projects that received incentives under the Non-Residential Retrofit Demand Reduction program (NRR-DR). Table 6 summarizes data gathered from several NRR-DR projects, Nicor Custom projects, and Nicor ETP projects. Nicor Savings Numbers are associated with ACEE_AWE_Ozone Laundry / From Gas Savings Calculations

Δ Gallons / lb-capacity = 464,946 / 254.38

= 1,828 gallons / lb-capacity

Deemed O&M Cost Adjustment Calculation

Maintenance is required for the following components annually:[243]

- Ozone Generator: filter replacement, check valve replacement, fuse replacement, reaction chamber inspection/cleaning, reaction chamber o-ring replacement
- Air Preparation – Heat Regenerative: replacement of two medias
- Air Preparation – Oxygen Concentrators: filter replacement, pressure relief valve replacement, compressor rebuild
- Venturi Injector: check valve replacement

Maintenance is expected to cost $0.79 / lbs capacity.

References

1 "Lodging Report", December 2008, California Travel & Tourism Commission, http://tourism.visitcalifornia.com/media/uploads/files/editor/Research/CaliforniaTourism_200812.pdf

2 "Health, United States, 2008" Table 120, U.S. Department of Health & Human Services, Centers for Disease Control & Prevention, National Center for Health Statistics, http://www.cdc.gov/nchs/data/hus/hus08.pdf#120

3 Fourth Quarter 2008 Facts and Fictures, California Department of Corrections & Rehabilitation (CDCR), http://www.cdcr.ca.gov/Divisions_Boards/Adult_Operations/docs/Fourth_Quarter_2008_Facts_and_Figures.pdf

4 Jail Profile Survey (2008), California Department of Corrections & Rehabilitation (CDCR), http://www.cdcr.ca.gov/Divisions_Boards/CSA/FSO/Docs/2008_4th_Qtr_JPS_full_report.pdf

5 DEER2011_NTGR_2012-05-16.xls from DEER Database for Energy-Efficient Resources; Version 2011 4.01 found at :http://www.deeresources.com/index.php?option=com_content&view=article&id=68&Itemid=60

Under: DEER2011 Update Documentation linked at: DEER2011 Update Net-To-Gross table Cells: T56 and U56

6 The Benefits of Ozone in Hospitality On-Premise Laundry Operations, PG&E Emerging Technologies Program, Application Assessment Report #0802, April 2009.

7 Federal Register, Vol. 52, No. 166

8 2009 ASHRAE Handbook – Fundamentals, Thermodynamic Properties of Water at Saturation, Section 1.1 (Table 3), 2009

9 Table 2 through 6: Excel file summarizing data collected from existing ozone laundry projects that received incentives under the NRR-DR program

Measure code CI-HW-OZLD-V01-140601

[243] Confirmed through communications with national vendors and available references E.g. http://ozonelaundry.wordpress.com/2010/11/17/the-importance-of-maintenance/

4.3.7 Multifamily Central Domestic Hot Water Plants

Description

This measure covers multifamily central domestic hot water (DHW) plants with thermal efficiencies greater than or equal to 88%. This measure is applicable to any combination of boilers and storage tanks provided the thermal efficiency of the boilers is greater than 88%. Plants providing other than solely DHW are not applicable to this measure.

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

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

Definition of Efficient Equipment

To qualify the boiler(s) must have a Thermal Efficiency of 88% or greater and supply domestic hot water to multi-family buildings.

Definition of Baseline Equipment

For TOS the baseline boiler is assumed to have a Thermal Efficiency of 80%.[244]

For Early Replacement the savings are calculated between existing unit and efficient unit consumption during the remaining life of the existing unit, and between new baseline unit as above and efficient unit consumption for the remainder of the measure life.

Deemed Lifetime of Efficient Equipment

The measure life for the domestic hot water boilers is 15 years.[245]

Deemed Measure Cost

TOS: The actual install cost should be used for the efficient case, minus the baseline cost assumption provided below:

Capacity Range	Baseline Installed Cost per kBtuh[246]
<300kBtuh	$65 per kBTUh
300 – 2500 kBtuh	$38 per kBTUh
>2500 kBtuh	$32 per kBTUh

Loadshape

N/A

Coincidence Factor

[244] IECC 2012, Table C404.2, Minimum Performance of Water-Heating Equipment
[245] Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011.
[246] Baseline install costs are based on data from the W017 Itron California Measure Cost Study, accessed via http://www.energydataweb.com/cpuc/search.aspx. The data is provided in a file named “MCS Results Matrix – Volume I”.

N/A

Algorithm

CALCULATION OF ENERGY SAVINGS

ELECTRIC ENERGY SAVINGS

There are no anticipated electrical savings from this measure.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

N/A

NATURAL GAS SAVINGS

Time of Sale:

ΔTherms = Hot Water Savings + Standby Loss Savings

= [(MFHH * #Units * GPD * Days/yr * γWater * (Tout – Tin) * (1/Eff_base – 1/Eff_ee)) / 100,000] + [((SL * Hours/yr * (1/Eff_base – 1/Eff_ee)) / 100,000]

Early Replacment[247]:

ΔTherms for remaining life of existing unit (1st 5 years):

= [(MFHH * #Units * GPD * Days/yr * γWater * (Tout – Tin) * (1/Eff_exist – 1/Eff_ee)) / 100,000] + [((SL * Hours/yr * (1/Eff_exist – 1/Eff_ee)) / 100,000]

ΔTherms for remaining measure life (next 10 years):

= [(MFHH * #Units * GPD * Days/yr * γWater * (Tout – Tin) * (1/Eff_base – 1/Eff_ee)) / 100,000] + [((SL * Hours/yr * (1/Eff_base – 1/Eff_ee)) / 100,000]

Where:

MFHH = number of people in Multi-Family House Hold

= Actual. If unknown assume 2.1 persons/unit[248]

#Units = Number of units served by hot water boiler

[247] The two equations are provided to show how savings are determined during the initial phase of the measure (existing to efficient) and the remaining phase (new baseline to efficient). In practice, the screening tools used may either require a First Year savings (using the first equation) and then a "number of years to adjustment" and "savings adjustment" input which would be the (new base to efficient savings)/(existing to efficient savings).

[248] Navigant, ComEd PY3 Multi-Family Home Energy Savings Program Evaluation Report Final, May 16, 2012.

	= Actual
GPD	= Gallons of hot water used per person per day
	= Actual. If unknown assume 17.6 gallons per person per day[249]
Days/yr	= 365.25
ʋWater	= Specific Weight of Water
	= 8.33 gal/lb
Tout	= tank temperature of hot water
	= 125°F or custom
Tin	= Incoming water temperature from well or municiple system
	= 54°F[250]
Eff_base	= thermal efficiency of base unit
	= 80%[251]
Eff_ee	= thermal efficiency of efficient unit complying with this measure
	= Actual. If unknown assume 88%
Eff_exist	= thermal efficiency of existing unit
	= Actual. If unknown assume 73%[252]
SL	= Standby Loss[253]
	= (Input rating / 800) + (110 * √Tank Volume)
	Input rating = Name plate input capacity in Btuh
	Tank Volume = Rated volume of the tank in gallons
Hours / yr	= 8766 hours

[249] Email message from Maureen Hodgins, Research Manager for Water Research Foundation, to TAC/SAG, August 26, 2014
[250] US DOE Building America Program. Building America Analysis Spreadsheet. For Chicago, IL http://www1.eere.energy.gov/buildings/building_america/analysis_spreadsheets.html
[251] IECC 2012, Table C404.2, Minimum Performance of Water-Heating Equipment
[252] Based upon DCEO data provided 10/2014; average age adjusted efficiency of existing units replaced through the program. Efficiency age adjustment of 0.5% per year based upon NREL "Building America Performance Analysis Procedures for Existing Homes".
[253] Stand-by loss is provided in 2012 International Energy Conservation Code (IECC2012), Table C404.2, Minimum Performance of Water-Heating Equipment

100,000 = btu/therm

EXAMPLES

Time of Sale:

For example, an 88% 1000 gallon boiler with 150,000 Btuh input rating installed serving 50 units.

ΔTherms = Hot Water Savings + Standby Loss Savings

= [(MFHH * #Units * GPD * Days/yr * γWater * (Tout – Tin) * (1/Eff_base – 1/Eff_ee)) / 100,000] + [((SL * Hours/yr * (1/Eff_base – 1/Eff_ee)) / 100,000]

=[(2.1 * 50 * 17.6 * 8.33 * 365.25 * 1.0 * (125-54) * (1/0.8 – 1/0.88)) / 100000] + [((150000/800 + (110 * √1000)) * 8766 * (1/0.8 – 1/0.88)) / 100000]

= 454 + 37

= 490 therms

Early Replacement:

For example, an 88% 1000 gallon boiler with 150,000 Btuh input rating installed serving 50 units replaces a working unit with unknown efficiency.

ΔTherms for remaining life of existing unit (1st 5 years):

=[(2.1 * 50 * 17.6 * 8.33 * 365.25 * 1.0 * (125-54) * (1/0.73 – 1/0.88)) / 100000] + [((150000/800 + (110 * √1000)) * 8766 * (1/0.73 – 1/0.88)) / 100000]

= 932 + 75

= 1007 therms

ΔTherms for remaining measure life (next 10 years):

= 454 + 37 (as above)

= 490 therms

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-HW_-MDHW-V01-150601

4.3.8 Controls for Central Domestic Hot Water

Description

Demand control recirculation pumps seek to reduce inefficiency by combining control via temperature and demand inputs, whereby the controller will not activate the recirculation pump unless both (a) the recirculation loop return water has dropped below a prescribed temperature (e.g. 100°F) and (b) a CDHW demand is sensed as water flow through the CDHW system.

This measure was developed to be applicable to the following program types: TOS, RF, NC. If applied to other program types, the measure savings should be verified.

Definition of Efficient Equipment

Re-circulating pump shall cycle on based on (a) the recirculation loop return water dropping below a prescribed temperature (e.g. 100°F) and (b) a CDHW demand is sensed as water flow through the CDHW system.

Definition of Baseline Equipment

The base case for this measure category are existing, un-controlled Recirculation Pumps on gas-fired Central Domestic Hot Water Systems.

Deemed Lifetime of Efficient Equipment

The effective useful life is 15 years[254].

Deemed Measure Cost

Incremental Cost: $1,200 [255]

Loadshape

N/A

Coincidence Factor

N/A

[254] Benningfield Group. (2009). *PY 2009 Monitoring Report: Demand Control for Multifamily Central Domestic Hot Water.* Folsom, CA: Prepared for Southern California Gas Company, October 30, 2009.
[255] Gas Technology Institute. (2014). *1003: Demand-based domestic hot water recirculation Public project report.* Des Plaines, IL: Prepared for Nicor Gas, January 7, 2014.

Algorithm

CALCULATION OF ENERGY SAVINGS[256]

ELECTRIC ENERGY SAVINGS

Deemed at 651 kWh[257].

SUMMER COINCIDENT PEAK DEMAND SAVINGS

N/A

NATURAL GAS SAVINGS

ΔTherms = 55.9[258] * number of dwelling units

EXAMPLE

For example, an apartment building with 53 units:

ΔTherms = 55.9 * 53

= 2,962.7 therms

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-HW_-CDHW-V01-150601

[256] See Illinois_Statewide_TRM_Workpaper_Demand Control Central DHW for more details

[257] Based on results from the Nicor Gas Emerging Technology Program study, this value is the average kWh saved per pump. Note this value does not reflect savings from electric units but electrical savings from gas-fired units.

[258] Based on results from the Nicor Gas Emerging Technology Program study, this value is the average therms saved per dwelling unit.