

## 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 is assumed to be 3 years<sup>29</sup>

##### **DEEMED MEASURE COST**

The incremental cost per installed plug-in timer is \$10.19<sup>30</sup>.

##### **DEEMED O&M COST ADJUSTMENTS**

N/A

##### **COINCIDENCE FACTOR**

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

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<sup>29</sup>Equipment life is expected to be longer, but measure life is more conservative to account for possible attrition in use over time.

<sup>30</sup>Based on bulk pricing reported by EnSave, which administers the rebate in Vermont

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS**

$$\begin{aligned}\Delta\text{kWh} &= \text{ISR} * \text{Use Season} * \% \text{Days} * \text{HrSave/Day} * \text{kW}_{\text{heater}} - \text{ParaLd} \\ &= 78.39\% * 87 \text{ days} * 84.23\% * 7.765 \text{ Hr/Day} * 1.5 \text{ kW} - 5.46 \text{ kWh} \\ &= 664 \text{ kWh}\end{aligned}$$

**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<sup>31</sup>.

### 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<sup>32</sup>.

### DEEMED MEASURE COST

The incremental capital cost for the fans are as follows<sup>33</sup>:

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

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

Loadshape C34 - Industrial Motor

### COINCIDENCE FACTOR

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

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<sup>31</sup> Act on Energy Commercial Technical Reference Manual No. 2010-4

<sup>32</sup> Ibid.

<sup>33</sup> Ibid.

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS<sup>34</sup>**

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

Fan Diameter Size (feet)	kWh Savings
20	6576.85
22	8543.34
24	10018.22

**SUMMER COINCIDENT PEAK DEMAND SAVINGS<sup>35</sup>**

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	2.408
22	3.128
24	3.668

**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**

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<sup>34</sup> Ibid.

<sup>35</sup> 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<sup>36</sup>.

Diameter of Fan (inches)	Minimum Efficiency for Exhaust & 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<sup>37</sup>.

**DEEMED MEASURE COST**

The incremental capital cost for all fan sizes is \$150<sup>38</sup>.

**DEEMED O&M COST ADJUSTMENTS**

N/A

**LOADSHAPE**

Loadshape C34 - Industrial Motor

**COINCIDENCE FACTOR**

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

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<sup>36</sup> Act on Energy Commercial Technical Reference Manual No. 2010-4

<sup>37</sup> Ibid.

<sup>38</sup> Ibid.

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS<sup>39</sup>**

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	372.14
36 through 47	625.23
48 through 71	1122.36

**SUMMER COINCIDENT PEAK DEMAND SAVINGS<sup>40</sup>**

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

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<sup>39</sup> Ibid.

<sup>40</sup> 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<sup>41</sup>.

**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<sup>42</sup>.

**DEEMED MEASURE COST**

The incremental capital cost for the waters are \$787.50:<sup>43</sup>.

**DEEMED O&M COST ADJUSTMENTS**

N/A

**LOADSHAPE**

Loadshape C04 - Non-Residential Electric Heating

**COINCIDENCE FACTOR**

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

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<sup>41</sup> Act on Energy Commercial Technical Reference Manual No. 2010-4

<sup>42</sup> Ibid.

<sup>43</sup> Ibid.

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS**<sup>44</sup>

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.<sup>45</sup>

**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**

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<sup>44</sup> Ibid.

<sup>45</sup> 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  $\geq 38\%$  and convection mode cooking efficiency  $\geq 44\%$  utilizing ASTM standard F2861 and meet idle requirements below<sup>46</sup>:

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/h	9,000 Btu/h
Gas Combi 15-28 pan capacity	18,000 Btu/h	11,000 Btu/h
Gas Combi > 28 pan capacity	28,000 Btu/h	17,000 Btu/h

#### 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<sup>47</sup>

#### DEEMED MEASURE COST

The incremental capital cost for this measure is \$4300<sup>48</sup>

#### DEEMED O&M COST ADJUSTMENTS

N/A

#### LOADSHAPE

N/A

<sup>46</sup> <http://www.fishnick.com/saveenergy/rebates/combis.pdf>

<sup>47</sup> 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.

<sup>48</sup> Ibid.

**COINCIDENCE FACTOR**

N/A

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**Algorithm**

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**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.<sup>49</sup>

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

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

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<sup>49</sup> 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<sup>50</sup>.

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<sup>50</sup>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>

**DEEMED MEASURE COST**

The incremental capital cost for this measure is provided below<sup>51</sup>.

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

**DEEMED O&M COST ADJUSTMENTS**

N/A

**LOADSHAPE**

Loadshape C23 - Commercial Refrigeration

**COINCIDENCE FACTOR**

The summer peak coincidence factor for this measure is assumed to be 0.937.<sup>52</sup>

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS**

$$\Delta kWh = (kWh_{base} - kWh_{ee}) * 365.25$$

Where:

kWh<sub>base</sub>= 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.

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<sup>51</sup> 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](http://www.aceee.org/ogeece/ch5_reach.htm)>. For the purposes of this characterization, assume an 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.

<sup>52</sup> The CF for Commercial Refrigeration was calculated based upon the Ameren provided eShapes

Type	kWhbase <sup>53</sup>
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

kW<sub>heer</sub><sup>54</sup> = 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 kW <sub>heer</sub>	Freezer kW <sub>heer</sub>
<b>Solid Door</b>		
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
<b>Glass Door</b>		
0 < V < 15	≤ 0.118V + 1.382	≤ 0.607V + 0.893
15 ≤ V < 30	≤ 0.140V + 1.050	≤ 0.733V – 1.000
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<sup>3</sup>) (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

$$\Delta \text{kWh} = (3.54 - 2.76) * 365.25$$

$$= 285 \text{ kWh}$$

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

$$\Delta \text{kW} = \Delta \text{kWh} / \text{HOURS} * \text{CF}$$

Where:

<sup>53</sup>Energy Policy Act of 2005. Accessed on 7/7/10. <[http://www.epa.gov/oust/fedlaws/publ\\_109-058.pdf](http://www.epa.gov/oust/fedlaws/publ_109-058.pdf)>

<sup>54</sup>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](http://www.energystar.gov/ia/partners/product_specs/program_reqs/commer_refrig_glass_prog_req.pdf)>

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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

$$\begin{aligned}\Delta kW &= 285 / 8766 * .937 \\ &= 0.030 \text{ kW}\end{aligned}$$

**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<sup>55</sup>

#### DEEMED MEASURE COST

The incremental capital cost for this measure is \$998<sup>56</sup> for a natural gas steam cooker or \$2490<sup>57</sup> for an electric steam cooker.

#### DEEMED O&M COST ADJUSTMENTS

N/A

#### LOADSHAPE

Loadshape C01 - Commercial Electric Cooking

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<sup>55</sup>California DEER 2008 which is also used by both the Food Service Technology Center and ENERGY STAR®.

<sup>56</sup>Source for incremental cost for efficient natural gas steamer is RSG Commercial Gas Steamer Workpaper, January 2012.

<sup>57</sup>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.

**COINCIDENCE FACTOR**

Summer Peak Coincidence Factor for measure is provided below for different building type<sup>58</sup>:

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

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**Algorithm**

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**CALCULATION OF SAVINGS**

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

**ENERGY SAVINGS**

$$\Delta\text{Savings} = (\Delta\text{Idle Energy} + \Delta\text{Preheat Energy} + \Delta\text{Cooking Energy}) * Z$$

For a gas cooker:  $\Delta\text{Savings} = \Delta\text{Btu} * 1/100,000 * Z$

For an electric steam cooker:  $\Delta\text{Savings} = \Delta\text{kWh} * Z$

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

Where:

$$\Delta\text{Idle Energy} = (((1 - \text{CSM}_{\%Baseline}) * \text{IDLE}_{BASE} + \text{CSM}_{\%Baseline} * \text{PC}_{BASE} * E_{FOOD} / \text{EFF}_{BASE}) * (\text{HOURS}_{day} - (F / \text{PC}_{BASE}) - (\text{PRE}_{number} * 0.25))) - (((1 - \text{CSM}_{\%ENERGYSTAR}) * \text{IDLE}_{ENERGYSTAR} + \text{CSM}_{\%ENERGYSTAR} * \text{PC}_{ENERGY} * E_{FOOD} / \text{EFF}_{ENERGYSTAR}) * (\text{HOURS}_{Day} - (F / \text{PC}_{ENERGY}) - (\text{PRE}_{number} * 0.25))))$$

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<sup>58</sup>Minnesota 2012 Technical Reference Manual, [Electric Food Service v03.2.xls](http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech), <http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech>. Unknown is an average of other location types

Where:

$CSM_{\%Baseline}$  = Baseline Steamer Time in Manual Steam Mode (% of time)  
 = 90%<sup>59</sup>

$IDLE_{Base}$  = Idle Energy Rate of Base Steamer<sup>60</sup>

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

$PC_{Base}$  = Production Capacity of Base Steamer<sup>61</sup>

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<sup>62</sup> (gas steamers) or 0.0308<sup>8</sup> (electric steamers)

<sup>59</sup>Food Service Technology Center 2011 Savings Calculator

<sup>60</sup>Food Service Technology Center 2011 Savings Calculator

<sup>61</sup>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.

$EFF_{BASE}$  = Heavy Load Cooking Efficiency for Base Steamer  
 = 15%<sup>63</sup> (gas steamers) or 26%<sup>9</sup> (electric steamers)

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

Type of Food Service	Hours <sup>64</sup>
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 <sup>65</sup>
Custom	Varies

$F$  = Food cooked per day (lbs/day)  
 = custom or if unknown, use 100 lbs/day<sup>66</sup>

$CSM_{\%ENERGYSTAR}$  = ENERGY STAR Steamer's Time in Manual Steam Mode (% of time)<sup>67</sup>  
 = 0%

$IDLE_{ENERGYSTAR}$  = Idle Energy Rate of ENERGY STAR<sup>68</sup>

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<sup>62</sup>Reference ENERGY STAR® savings calculator at

[http://www.energystar.gov/index.cfm?fuseaction=find\\_a\\_product.showProductGroup&pgw\\_code=COC](http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COC).

<sup>63</sup>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.

<sup>64</sup>Minnesota 2012 Technical Reference Manual, Electric Food Service\_v03.2.xls, <http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech>

<sup>65</sup>Unknown is average of other locations

<sup>66</sup>Reference amount used by both Food Service Technology Center and ENERGY STAR® savings calculator

<sup>67</sup>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](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.

<sup>68</sup>Food Service Technology Center 2011 Savings Calculator

Number of Pans	IDLE <sub>ENERGY STAR</sub> – gas, (Btu/hr)	IDLE <sub>ENERGY STAR</sub> – electric, (kW)
3	6250	0.40
4	8333	0.53
5	10417	0.67
6	12500	0.80

PC<sub>ENERGY</sub> = Production Capacity of ENERGY STAR® Steamer<sup>69</sup>

Number of Pans	PC <sub>ENERGY</sub> – gas(lbs/hr)	PC <sub>ENERGY</sub> – electric (lbs/hr)
3	55	50
4	73	67
5	92	83
6	110	100

EFF<sub>ENERGYSTAR</sub> = Heavy Load Cooking Efficiency for ENERGY STAR® Steamer(%)  
 =38%<sup>70</sup> (gas steamer) or 50%<sup>15</sup> (electric steamer)

PRE<sub>number</sub> = Number of preheats per day  
 =1<sup>71</sup> (if unknown, use 1)

Where:

$$\Delta\text{Preheat Energy} = (\text{PRE}_{\text{number}} * \Delta \text{Pre}_{\text{heat}})$$

Where:

PRE<sub>number</sub> = Number of Preheats per Day

<sup>69</sup>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.

<sup>70</sup>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](http://www.energystar.gov/ia/partners/product_specs/program_reqs/Commercial_Steam_Cookers_Program_Requirements.pdf?7010-36eb)

<sup>71</sup>Reference ENERGY STAR® savings calculator at

[http://www.energystar.gov/index.cfm?fuseaction=find\\_a\\_product.showProductGroup&pgw\\_code=COC](http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COC) and Food

=1<sup>72</sup>(if unknown, use 1)

PRE<sub>heat</sub> = Preheat energy savings per preheat  
 = 11,000 Btu/preheat<sup>73</sup> (gas steamer) or 0.5 kWh/preheat<sup>74</sup> (electric steamer)

Where:

$$\Delta\text{Cooking Energy} = ((1/\text{EFF}_{\text{BASE}}) - (1/\text{EFF}_{\text{ENERGY STAR}})) * F * E_{\text{FOOD}}$$

Where:

EFF<sub>BASE</sub> = Heavy Load Cooking Efficiency for Base Steamer  
 =15%<sup>75</sup> (gas steamer) or 26%<sup>28</sup> (electric steamer)

EFF<sub>ENERGYSTAR</sub> = Heavy Load Cooking Efficiency for ENERGY STAR® Steamer  
 =38%<sup>76</sup> (gas steamer) or 50%<sup>23</sup> (electric steamer)

F = Food cooked per day (lbs/day)  
 = custom or if unknown, use 100 lbs/day<sup>77</sup>

E<sub>FOOD</sub> = Amount of Energy Absorbed by the food during cooking known as ASTM Energy to Food<sup>78</sup>

E <sub>FOOD</sub> - gas(Btu/lb)	E <sub>FOOD</sub> (kWh/lb)
105 <sup>79</sup>	0.0308 <sup>80</sup>

<sup>72</sup>Reference ENERGY STAR® savings calculator at [http://www.energystar.gov/index.cfm?fuseaction=find\\_a\\_product.showProductGroup&pgw\\_code=COC](http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COC) and Food

<sup>73</sup>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](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

<sup>74</sup>Reference Food Service Technology Center 2011 Savings Calculator values for Baseline Preheat Energy.

<sup>75</sup>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.

<sup>76</sup>Ibid.

<sup>77</sup>Amount used by both Food Service Technology Center and ENERGY STAR® savings calculator

<sup>78</sup>Reference ENERGY STAR® savings calculator at [http://www.energystar.gov/index.cfm?fuseaction=find\\_a\\_product.showProductGroup&pgw\\_code=COC](http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COC).

<sup>79</sup>Ibid.

<sup>80</sup>Ibid.

**EXAMPLE**

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

$$\Delta\text{Savings} = \Delta\text{Idle Energy} + \Delta\text{Preheat Energy} + \Delta\text{Cooking Energy} * Z * 1/100.000$$

$$\Delta\text{Idle Energy} = (((1 - .9) * 11000 + .9 * 65 * 105 / .15) * (12 - (100 / 65) - (1 - .25))) - (((1 - 0) * 6250 + 0 * 55 * 105 / 0.38) * (12 - (100 / 55) - (1 - 0.25))) +$$

$$\Delta\text{Preheat Energy} = (1 * 11,000) +$$

$$\Delta\text{Cooking Energy} = (((1 / 0.15) - (1 / 0.38)) * (100 \text{ lb/day} * 105 \text{ btu/lb}))$$

$$* 365.25 \text{ days}) * 1/100,000 =$$

$$= 1536 \text{ therms}$$

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

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

This is only applicable to the electric steam cooker.

$$\Delta\text{kW} = (\Delta\text{kWh} / (\text{HOURS}_{\text{Day}} * \text{Days}_{\text{Year}})) * \text{CF}$$

Where:

CF = Summer Peak Coincidence Factor for measure is provided below for different locations<sup>81</sup>:

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<sub>Year</sub> = Annual Days of Operation

= custom or 365.25 days a year<sup>82</sup>

<sup>81</sup>Minnesota 2012 Technical Reference Manual, Electric Food Service\_v03.2.xls, <http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech>

Other values as defined above

**EXAMPLE**

For 3 pan electric steam cooker located in a cafeteria:

$$\begin{aligned} \Delta kW &= (\Delta kWh / (\text{HOURS}_{\text{Day}} * \text{Days}_{\text{Year}})) * CF = \\ &= (30,533 / (12 * 365.25)) * .36 = \\ &= 2.51 \text{ kW} \end{aligned}$$

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

This is applicable to both gas and electric steam cookers.

$$\Delta \text{Water} = [(W_{\text{BASE}} - W_{\text{ENERGYSTAR}}) * \text{HOURS}_{\text{Day}} * \text{Days}_{\text{Year}}$$

Where

$$\begin{aligned} W_{\text{BASE}} &= \text{Water Consumption Rate of Base Steamer (gal/hr)} \\ &= 40^{83} \end{aligned}$$

$$W_{\text{ENERGYSTAR}} = \text{Water Consumption Rate of ENERGY STAR® Steamer look up}^{84}$$

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

$$\begin{aligned} \text{Days}_{\text{Year}} &= \text{Annual Days of Operation} \\ &= \text{custom or } 365.25 \text{ days a year}^{85} \end{aligned}$$

<sup>83</sup> FSTC (2002). Commercial Cooking Appliance Technology Assessment. Chapter 8: Steamers.

<sup>84</sup>Source Consortium for Energy Efficiency, Inc. September 2010 "Program Design Guidance for Steamers" for Tier 1A and Tier 1B water requirements. Ohio Technical Reference Manual 2010 for 10 gal/hr water consumption which can be used when Tier level is not known.

**EXAMPLE**

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

$\Delta\text{Water} =$

$\Delta\text{Water} = [(40 - 10) * 12 * 365.25$

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**REFERENCE TABLES**

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-FSE-STMC-V02-120601**

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<sup>85</sup>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/h 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.<sup>86</sup>

### DEEMED MEASURE COST

The incremental capital cost for this measure is \$1800<sup>87</sup>.

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

N/A

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<sup>86</sup>Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011

<sup>87</sup>Ibid.

**COINCIDENCE FACTOR**

N/A

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**Algorithm**

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**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<sup>88</sup>.

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-FSE-CVOV-V01-120601**

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<sup>88</sup>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  $\geq 44\%$  utilizing ASTM standard 1496 and an idle energy consumption rate  $< 13,000$  Btu/h

### 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<sup>89</sup>

### DEEMED MEASURE COST

The incremental capital cost for this measure is \$50<sup>90</sup>

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

N/A

### COINCIDENCE FACTOR

N/A

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### Algorithm

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### CALCULATION OF SAVINGS

### ELECTRIC ENERGY SAVINGS

N/A

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<sup>89</sup> 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](http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG)

<sup>90</sup> 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](http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG)

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

N/A

**NATURAL GAS ENERGY SAVINGS**

Custom calculation below, otherwise use deemed value of 306 therms.<sup>91</sup>

$$\Delta\text{Therms} = (\Delta\text{DailyIdle Energy} + \Delta\text{DailyPreheat Energy} + \Delta\text{DailyCooking Energy}) * \text{Days} / 100000$$

Where:

$$\Delta\text{DailyIdleEnergy} = (\text{IdleBase} * \text{IdleBaseTime}) - (\text{IdleENERGYSTAR} * \text{IdleENERGYSTARTime})$$

$$\Delta\text{DailyPreheatEnergy} = (\text{PreHeatNumberBase} * \text{PreheatTimeBase} / 60 * \text{PreheatRateBase}) - (\text{PreheatNumberENERGYSTAR} * \text{PreheatTimeENERGYSTAR} / 60 * \text{PreheatRateENERGYSTAR})$$

$$\Delta\text{DailyCookingEnergy} = (\text{LB} * \text{EFOOD} / \text{EffBase}) - (\text{LB} * \text{EFOOD} / \text{EffENERGYSTAR})$$

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

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<sup>91</sup> 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](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 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 = $\text{HOURSday-LB/PCENERGYSTAR} - \text{PreHeatTimeENERGYSTAR}/60$ = $12 - 100/80 - 15/60$ =10.5 hours
IdleBaseTime	= BASE Idle Time = $\text{HOURSday-LB/PCbase} - \text{PreHeatTimeBase}/60$ =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.

$$\Delta\text{Therms} = (\Delta\text{Idle Energy} + \Delta\text{Preheat Energy} + \Delta\text{Cooking Energy}) * \text{Days} / 100000$$

Where:

$\Delta\text{DailyIdleEnergy}$	$= (18000 * 10.3) - (13000 * 10.5)$ $= 49286 \text{ btu}$
$\Delta\text{DailyPreheatEnergy}$	$= (1 * 15 / 60 * 76000) - (1 * 15 / 60 * 44000)$ $= 8000 \text{ btu}$
$\Delta\text{DailyCookingEnergy}$	$= (100 * 250 / .30) - (100 * 250 / .44)$ $= 26515 \text{ btu}$
$\Delta\text{Therms}$	$= (49286 + 8000 + 26515) * 365.25 / 100000$ $= 306 \text{ therms}$

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-FSE-ESCV-V01-120601**

## 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<sup>92</sup>

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

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<sup>92</sup> 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](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<sup>93</sup>

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

**DEEMED O&M COST ADJUSTMENTS**

N/A

**LOADSHAPE**

Loadshape C01 - Commercial Electric Cooking

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

Summer Peak Coincidence Factor for measure is provided below for different restaurant types<sup>94</sup>:

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

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**Algorithm**

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**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.<sup>95</sup>

<sup>93</sup> 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](http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG)

<sup>94</sup> Minnesota 2012 Technical Reference Manual, Electric Food Service\_v03.2.xls, <http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech>

<sup>95</sup> 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](http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG)

Electric building and booster water heating

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**

$$\Delta kW = \Delta kWh / \text{AnnualHours}$$

Where:

$$\begin{aligned} \text{AnnualHours} &= \text{Hours} * \text{Days} \\ &= 365.25 * 18 \\ &= 6575 \text{ annual hours} \end{aligned}$$

Example:

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

$$\begin{aligned} \Delta kW &= \Delta kWh / \text{AnnualHours} \\ &= 1213 / 6575 \\ &= 0.184 \text{ kW} \end{aligned}$$

**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  $\geq 50\%$  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.<sup>96</sup>

### DEEMED MEASURE COST

The incremental capital cost for this measure is \$1200.<sup>97</sup>

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

N/A

### COINCIDENCE FACTOR

N/A

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### Algorithm

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### CALCULATION OF SAVINGS

### ELECTRIC ENERGY SAVINGS

N/A

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<sup>96</sup>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](http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG)

<sup>97</sup>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](http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG)

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

N/A

**NATURAL GAS ENERGY SAVINGS<sup>98</sup>**

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

$$\Delta\text{Therms} = (\Delta\text{DailyIdle Energy} + \Delta\text{DailyPreheat Energy} + \Delta\text{DailyCooking Energy}) * \text{Days} / 100000$$

Where:

$$\Delta\text{DailyIdleEnergy} = (\text{IdleBase} * \text{IdleBaseTime}) - (\text{IdleENERGYSTAR} * \text{IdleENERGYSTARTime})$$

$$\Delta\text{DailyPreheatEnergy} = (\text{PreHeatNumberBase} * \text{PreheatTimeBase} / 60 * \text{PreheatRateBase}) - (\text{PreheatNumberENERGYSTAR} * \text{PreheatTimeENERGYSTAR} / 60 * \text{PreheatRateENERGYSTAR})$$

$$\Delta\text{DailyCookingEnergy} = (\text{LB} * \text{EFOOD} / \text{EffBase}) - (\text{LB} * \text{EFOOD} / \text{EffENERGYSTAR})$$

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

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<sup>98</sup> 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](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 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 = $\text{HOURSday-LB/PCENERGYSTAR} - \text{PreHeatTimeENERGYSTAR}/60$ = Custom or if unknown, use = $16 - 150/65 - 15/60$ = 13.44 hours
IdleBaseTime	= BASE Idle Time = $\text{HOURSday-LB/PCbase} - \text{PreHeatTimeBase}/60$ = 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.

$$\Delta\text{Therms} = (\Delta\text{Idle Energy} + \Delta\text{Preheat Energy} + \Delta\text{Cooking Energy}) * \text{Days} / 100000$$

Where:

$\Delta\text{DailyIdleEnergy}$	$= (18550 * 13.25) - (120981 * 13.44)$ = 64519 btu
$\Delta\text{DailyPreheatEnergy}$	$= (1 * 15 / 60 * 64000) - (1 * 15 / 60 * 62000)$ = 500 btu
$\Delta\text{DailyCookingEnergy}$	$= (150 * 570 / .35) - (150 * 570 / .5)$ = 73286 btu
$\Delta\text{Therms}$	$= (64519 + 500 + 73286) * 365.25 / 100000$ = 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/h per square foot of cooking surface or less, utilizing ASTM F1275. The griddle must have an Idle Energy Consumption Rate < 2,600 Btu/h 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<sup>99</sup>

### DEEMED MEASURE COST

The incremental capital cost for this measure is \$0 for an electric griddle and \$60 for a gas griddle.<sup>100</sup>

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

Loadshape C01 - Commercial Electric Cooking

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<sup>99</sup> 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](http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG)

<sup>100</sup> 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](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<sup>101</sup>:

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<sup>102</sup>**

**ELECTRIC ENERGY SAVINGS**

$$\Delta kWh = (\Delta Idle \text{ Energy} + \Delta Preheat \text{ Energy} + \Delta Cooking \text{ Energy}) * \text{Days} / 1000$$

Where:

$$\Delta \text{DailyIdleEnergy} = [ \text{IdleBase} * \text{Width} * \text{Length} (\text{LB} / \text{PCBase}) - (\text{PreheatNumberBase} * \text{PreheatTimeBase} / 60) ] - \text{IdleENERGYSTAR} * \text{Width} * \text{Length} (\text{LB} / \text{PCENERGYSTAR}) - (\text{PreheatNumberENERGYSTAR} * \text{PreheatTimeENERGYSTAR} / 60)$$

$$\Delta \text{DailyPreheatEnergy} = (\text{PreHeatNumberBase} * \text{PreheatTimeBase} / 60 * \text{PreheatRateBase} * \text{Width} * \text{Depth}) - (\text{PreheatNumberENERGYSTAR} * \text{PreheatTimeENERGYSTAR} / 60 * \text{PreheatRateENERGYSTAR} * \text{Width} * \text{Depth})$$

$$\Delta \text{DailyCookingEnergy} = (\text{LB} * \text{EFOOD} / \text{EffBase}) - (\text{LB} * \text{EFOOD} / \text{EffENERGYSTAR})$$

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

<sup>101</sup> Minnesota 2012 Technical Reference Manual, [Electric Food Service\\_v03.2.xls](http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech),

<http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech>

<sup>102</sup> 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](http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG)

	= 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
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.

$$\begin{aligned} \Delta\text{DailyIdleEnergy} &= [400 * 3 * 2 (100/5.83) - (1 * 15/60)] - [320 * 3 * 2 (100/6.67) - (1 * 15/60)] \\ &= 3583 \text{ W} \\ \Delta\text{DailyPreheatEnergy} &= (1 * 15 / 60 * 2667 * 3 * 2) - (1 * 15/60 * 1333 * 3 * 2) \\ &= 2000 \text{ W} \\ \Delta\text{DailyCookingEnergy} &= (100 * 139 / .65) - (100 * 139 / .70) \\ &= 1527 \text{ W} \\ \Delta\text{kWh} &= (2000+1527+3583) * 365.25 / 1000 \\ &= 2597 \text{ kWh} \end{aligned}$$

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

$$\text{kW} = \Delta\text{kWh/Hours} * \text{CF}$$

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

$$\begin{aligned} &= 2595 \text{ kWh} / 4308 * .36 \\ &= 0.22 \text{ kW} \end{aligned}$$

**NATURAL GAS ENERGY SAVINGS**

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

$$\Delta\text{Therms} = (\Delta\text{Idle Energy} + \Delta\text{Preheat Energy} + \Delta\text{Cooking Energy}) * \text{Days} / 100000$$

Where:

$$\begin{aligned} \Delta\text{DailyIdleEnergy} &= [ \text{IdleBase} * \text{Width} * \text{Length} (\text{LB/ PCBase}) - (\text{PreheatNumberBase} * \\ &\text{PreheatTimeBase}/60)] - [ \text{IdleENERGYSTAR} * \text{Width} * \text{Length} (\text{LB/ PCENERGYSTAR}) - \\ &(\text{PreheatNumberENERGYSTAR} * \text{PreheatTimeENERGYSTAR}/60) \end{aligned}$$

$$\Delta\text{DailyPreheatEnergy} = (\text{PreHeatNumberBase} * \text{PreheatTimeBase} / 60 * \text{PreheatRateBase} * \text{Width} * \text{Depth}) - (\text{PreheatNumberENERGYSTAR} * \text{PreheatTimeENERGYSTAR} / 60 * \text{PreheatRateENERGYSTAR} * \text{Width} * \text{Depth})$$

$$\Delta\text{DailyCookingEnergy} = (\text{LB} * \text{EFOOD} / \text{EffBase}) - (\text{LB} * \text{EFOOD} / \text{EffENERGYSTAR})$$

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.

$$\begin{aligned} \Delta \text{DailyIdleEnergy} &= [3500 * 3 * 2 (100/4.17) - (1 * 15/60)] - 2650 * 3 * 2 (100/7.5) - (1 * 15/60) \\ &= 11258 \text{ Btu} \\ \Delta \text{DailyPreheatEnergy} &= (1 * 15 / 60 * 14,000 * 3 * 2) - (1 * 15/60 * 10000 * 3 * 2) \\ &= 6000 \text{ btu} \\ \Delta \text{DailyCookingEnergy} &= (100 * 475 / .32) - (100 * 475 / .38) \\ &= 23438 \text{ btu} \\ \Delta \text{Therms} &= (11258 + 6000 + 23438) * 365.25 / 100000 \\ &= 149 \text{ therms} \end{aligned}$$

**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<sup>103</sup>

### DEEMED MEASURE COST

The incremental capital cost for this measure is<sup>104</sup>

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

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

Loadshape C01 - Commercial Electric Cooking

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<sup>103</sup> 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](http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG)

<sup>104</sup> 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](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<sup>105</sup>:

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

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS**

Custom calculation below, otherwise use deemed values depending on HFHC size<sup>106</sup>

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

$$\Delta kWh = HFHC_{Baseline} kWh - HFHC_{ENERGYSTAR} kWh$$

Where:

$$HFHC_{Baseline} kWh = Power_{Baseline} * HOURS_{day} * Days / 1000$$

Power<sub>Baseline</sub> = Custom, otherwise

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

HOURS<sub>day</sub> = Average Daily Operation

<sup>105</sup> Minnesota 2012 Technical Reference Manual, [Electric Food Service\\_v03.2.xls](http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech),

<http://mn.gov/commerce/energy/topics/conservation/Design-Resources/Deemed-Savings.jspech>

<sup>106</sup> 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](http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG)

= custom or if unknown, use 15 hours

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:

$$\begin{aligned} \Delta\text{kWh} &= (\text{PowerBaseline} * \text{HOURSday} * \text{Days}) / 1000 - (\text{PowerENERGYSTAR} * \text{HOURSday} * \text{Days}) / 1000 \\ &= (2500 * 15 * 365.25) / 1000 - (800 * 15 * 365.25) / 1000 \\ &= 9,314 \text{ kWh} \end{aligned}$$

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

$$\Delta\text{kW} = \Delta\text{kWh} / \text{Hours} * \text{CF}$$

Where: Hours = Hoursday \* Days

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

$$\begin{aligned} &= 9,314 \text{ kWh} / (15 * 365.25) * .36 \\ &= 0.61 \text{ kW} \end{aligned}$$

**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<sup>107</sup>.

### DEEMED MEASURE COST

The incremental capital cost for this measure is provided below.<sup>108</sup>

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

### DEEMED O&M COST ADJUSTMENTS

N/A

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<sup>107</sup>DEER 2008

<sup>108</sup>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%20Electric%20Measure%20Workpapers%2011-08-05.DOC>>.

**LOADSHAPE**

Loadshape C23 - Commercial Refrigeration

**COINCIDENCE FACTOR**

The Summer Peak Coincidence Factor is assumed to equal 0.937

**Algorithm**

**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS**

$$\Delta \text{kWh} = [(\text{kWh}_{\text{base}} - \text{kWh}_{\text{ee}}) / 100] * (\text{DC} * \text{H}) * 365.25$$

Where:

$\text{kWh}_{\text{base}}$  = 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.

$\text{kWh}_{\text{ee}}$  = 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	kWhbase109	kWhee110
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.

<sup>109</sup>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>>.

<sup>110</sup>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](http://www.energystar.gov/ia/partners/product_specs/program_reqs/ice_machine_prog_req.pdf)>

DC = Duty Cycle of the ice machine

$$= 0.57^{111}$$

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

$$\begin{aligned} \Delta \text{kWh} &= [(6.4 - 5.8) / 100] * (0.57 * 450) * 365.25 \\ &= 562 \text{ kWh} \end{aligned}$$

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

$$\Delta \text{kW} = \Delta \text{kWh} / (\text{HOURS} * \text{DC}) * \text{CF}$$

Where:

HOURS = annual operating hours

$$= 8766^{112}$$

CF = 0.937

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

$$\begin{aligned} \Delta \text{kW} &= 562 / (8766 * 0.57) * 0.937 \\ &= 0.105 \text{ kW} \end{aligned}$$

<sup>111</sup>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](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.

<sup>112</sup>Unit is assumed to be connected to power 24 hours per day, 365.25 days per year.

**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<sup>113</sup> 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.

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

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

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<sup>113</sup>AHRI Certification Directory, Accessed on 7/7/10.  
<<http://www.ahridirectory.org/ahridirectory/pages/home.aspx>>

### 4.2.11 High Efficiency Pre-Rinse Spray Valve

**DESCRIPTION**

Pre-rinse 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
<p>The baseline equipment is assumed to be 1.6 gallons per minute. The Energy Policy Act (EPAAct) 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<sup>114</sup>.</p>	<p>The baseline equipment is assumed to be an existing pre-rinse spray valve with a flow rate of 1.9 gallons per minute.<sup>115</sup> 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 (EPAAct) 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</p>

**DEEMED LIFETIME OF EFFICIENT EQUIPMENT**

The expected measure life is assumed to be 5 years<sup>116</sup>

<sup>115</sup> 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)

<sup>116</sup>Reference 2010 Ohio Technical Reference Manual, Act on Energy Business Program Technical Reference

**DEEMED MEASURE COST**

The cost of this measure is assumed to be \$100<sup>117</sup>

**DEEMED O&M COST ADJUSTMENTS**

N/A

**LOADSHAPE**

Loadshape C01 - Commercial Electric Cooking

**COINCIDENCE FACTOR**

N/A

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**Algorithm**

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**CALCULATION OF ENERGY SAVINGS**

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

$$\Delta kWh = \Delta Gallons \times 8.33 \times 1 \times (T_{out} - T_{in}) \times (1/EFF \text{ electric}) / 3,413 \times FLAG$$

Where:

- $\Delta Gallons$  = 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
- $T_{out}$  = Water Heater Outlet Water Temperature  
= custom, otherwise assume  $T_{in} + 70^\circ \text{ F}$  temperature rise from  $T_{in}$ <sup>118</sup>
- $T_{in}$  = Inlet Water Temperature  
= custom, otherwise assume 54.1 degree F<sup>119</sup>
- EFF = Efficiency of electric water heater supplying hot water to pre-rinse spray

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Manual Rev05, and Federal Energy Management Program (2004), "How to Buy a Low-Flow Pre-Rinse Spray Valve." **117**Costs range from \$60 Chicagoland (Integrus for North Shore & People's Gas) to \$150 referenced by Nicor's Resource Solutions Group Workpaper WPRSGCCODHW102 "Pre-Rinse Spray Valve." Act on Energy references \$100.

<sup>118</sup>If unknown, assume a 70 degree temperature rise from  $T_{in}$  per Food Service Technology Center calculator assumptions to account for variations in mixing and water heater efficiencies

<sup>119</sup>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.

valve

=custom, otherwise assume 97%<sup>120</sup>

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 :

$$\begin{aligned} \Delta\text{kWh} &= 30,326 \times 8.33 \times 1 \times ((70+54.1) - 54.1) \times (1/.97) / 3,413 \times 1 \\ &= 5,341\text{kWh} \end{aligned}$$

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:

$$\begin{aligned} \Delta\text{kWh} &= 47,175 \times 8.33 \times 1 \times ((70+ 54.1) - 54.1) \times (1/.97) / 3,413 \times 1 \\ &= 8309 \text{ kWh} \end{aligned}$$

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

N/A

**NATURAL GAS ENERGY SAVINGS**

$$\Delta\text{Therms} = \Delta\text{Gallons} \times 8.33 \times 1 \times (\text{Tout} - \text{Tin}) \times (1/\text{EFF}) / 100,000 \text{ Btu}$$

Where (new variables only):

EFF = Efficiency of gas water heater supplying hot water to pre-rinse spray valve  
 = custom, otherwise assume 75%<sup>121</sup>

<sup>120</sup>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.

<sup>121</sup> IECC 2012, Table C404.2, Minimum Performance of Water-Heating Equipment

**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:

$$\begin{aligned} \Delta\text{Therms} &= 30,326 \times 8.33 \times 1 \times ((70+54.1) - 54.1) \times (1/.75)/100,000 \times 1.0 \\ &= 236 \text{ Therms} \end{aligned}$$

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:

$$\begin{aligned} \Delta\text{Therms} &= 47,175 \times 8.33 \times 1 \times ((70+54.1) - 54.1) \times (1/.75)/100,000 \times (1-0) \\ &= 368 \text{ Therms} \end{aligned}$$

**WATER IMPACT CALCULATION<sup>122</sup>**

$$\Delta\text{Gallons} = (\text{FLObase} - \text{FLOeff})\text{gal/min} \times 60 \text{ min/hr} \times \text{HOURSday} \times \text{DAYYear}$$

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

Time of Sale	Retrofit, Direct Install
1.6 gal/min <sup>123</sup>	1.9 gal/min <sup>124</sup>

FLOeff = Efficient case flow in gallons per minute or custom

Time of Sale	Retrofit, Direct Install
1.06 gal/min <sup>125</sup>	1.06 gal/min <sup>126</sup>

<sup>122</sup>In order to calculate energy savings, water savings must first be calculated

<sup>123</sup>The baseline equipment is assumed to be 1.6 gallons per minute. The Energy Policy Act (EPA) 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](http://www1.eere.energy.gov/femp/pdfs/spec_prerinsesprayvavles.pdf).

<sup>124</sup>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)

<sup>125</sup>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.

<sup>126</sup>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

HOURS<sub>day</sub> = Hours per day that the pre-rinse spray valve is used at the site, custom, otherwise<sup>127</sup>:

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

DAYS<sub>year</sub> = 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

$$= (1.6 - 1.06) * 60 * 3 * 312$$

$$= 30,326 \text{ gal/yr}$$

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 equals

$$= (1.9 - 1.06) * 60 * 3 * 312$$

$$= 47,175 \text{ gal/yr}$$

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

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

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the data. The average of the nozzles listed on the FSTC website is 1.06.

<sup>127</sup> 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<sup>128</sup>

### DEEMED MEASURE COST

The incremental capital cost for this measure is \$2200<sup>129</sup>

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

N/A

### COINCIDENCE FACTOR

N/A

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### Algorithm

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### CALCULATION OF SAVINGS

### ELECTRIC ENERGY SAVINGS

N/A

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<sup>128</sup>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

<sup>129</sup>Ibid.

**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.<sup>130</sup>

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-FSE-IRCB-V01-120601**

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<sup>130</sup> 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.

## 4.2.13 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<sup>131</sup>

### DEEMED MEASURE COST

The incremental capital cost for this measure is \$2700<sup>132</sup>

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

N/A

### COINCIDENCE FACTOR

N/A

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### Algorithm

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### CALCULATION OF SAVINGS

### ELECTRIC ENERGY SAVINGS

N/A

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<sup>131</sup> 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

<sup>132</sup> Ibid.

**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<sup>133</sup>

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-FSE-IROV-V01-120601**

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<sup>133</sup>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<sup>134</sup>

### DEEMED MEASURE COST

The incremental capital cost for this measure is \$1000<sup>135</sup>

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

N/A

### COINCIDENCE FACTOR

N/A

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### Algorithm

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### CALCULATION OF SAVINGS

### ELECTRIC ENERGY SAVINGS

N/A

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<sup>134</sup>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

<sup>135</sup>Ibid.

**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<sup>136</sup>

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

**DEEMED O&M COST ADJUSTMENT CALCULATION**

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

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<sup>136</sup> 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<sup>137</sup>

### DEEMED MEASURE COST

The incremental capital cost for this measure is \$5900<sup>138</sup>

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

N/A

### COINCIDENCE FACTOR

N/A

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### Algorithm

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### CALCULATION OF SAVINGS

### ELECTRIC ENERGY SAVINGS

N/A

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<sup>137</sup> 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

<sup>138</sup> Ibid.

**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<sup>139</sup>.

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

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

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<sup>139</sup> 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.<sup>140</sup>

### DEEMED MEASURE COST

The incremental capital cost for this measure is<sup>141</sup>

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

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

Loadshape C23 - Commercial Ventilation

### COINCIDENCE FACTOR

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

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<sup>140</sup> PG&E Workpaper: Commercial Kitchen Demand Ventilation Controls-Electric, 2004 - 2005

<sup>141</sup> 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**

N/A

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-FSE-VENT-V01-120601**

## 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 pasta 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<sup>142</sup>.

### DEEMED MEASURE COST

The incremental capital cost for this measure is \$2400<sup>143</sup>.

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

N/A

### COINCIDENCE FACTOR

N/A

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### Algorithm

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### CALCULATION OF SAVINGS

### ELECTRIC ENERGY SAVINGS

N/A

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<sup>142</sup>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

<sup>143</sup>Ibid.

**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<sup>144</sup>.

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

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

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<sup>144</sup>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.

## 4.2.18 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  $\geq 50\%$  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.<sup>145</sup>

### DEEMED MEASURE COST

The incremental capital cost for this measure is \$8646.<sup>146</sup>

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

N/A

### COINCIDENCE FACTOR

N/A

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### Algorithm

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### CALCULATION OF SAVINGS

### ELECTRIC ENERGY SAVINGS

N/A

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<sup>145</sup>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

<sup>146</sup>Ibid.

**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<sup>147</sup>

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

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

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<sup>147</sup>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

## 4.3 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 Btuh 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 <sup>148</sup> : 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 Btuh 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.

<sup>148</sup> 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 <sup>149</sup>	The expected measure life is assumed to be 15 years <sup>150</sup>	The expected measure life is assumed to be 5 years <sup>151</sup> .

**DEEMED MEASURE COST**

Gas, High Efficiency	Gas, Standard	Electric								
The incremental capital cost for this measure is \$209 <sup>152</sup>	The deemed measure cost is assumed to be \$400 <sup>153</sup>	The incremental capital cost for this measure is assumed to be <sup>154</sup> <table border="1" data-bbox="945 583 1370 711"> <thead> <tr> <th>Tank Size</th> <th>Incremental Cost</th> </tr> </thead> <tbody> <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> </tbody> </table>	Tank Size	Incremental Cost	50 gallons	\$1050	80 gallons	\$1050	100 gallons	\$1950
Tank Size	Incremental Cost									
50 gallons	\$1050									
80 gallons	\$1050									
100 gallons	\$1950									

**DEEMED O&M COST ADJUSTMENTS**

N/A

**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

<sup>149</sup> Nicor Gas Energy Efficiency Plan 2011-2014. Revised Plan Filed Pursuant to Order Docket 10-0562, May 27, 2011

<sup>150</sup> Gas Storage Water Heater 0.67. Work Paper WPRSGNGDHW106. Resource Solutions Group. December 2010

<sup>151</sup> Ibid.

<sup>154</sup> Ibid.

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS**<sup>155</sup>

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	1780.85
80 gallons	4962.69
100 gallons	8273.63

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**<sup>156</sup>

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

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<sup>155</sup> Ibid.

<sup>156</sup> Ibid.

**NATURAL GAS ENERGY SAVINGS**

Gas, High Efficiency	Gas, Standard																																
The annual natural gas energy savings from this measure is a deemed value equaling 251 <sup>157</sup>	Gas savings depend on building type and are based on measure case energy factor of 0.67 and a heating capacity of 75 MBtuh. These values are averages of qualifying units. Savings values are derived from 2008 DEER Miser, which provides MBtuh gas savings per MBtuh capacity. Savings presented here are per water heater. <sup>158</sup>																																
	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="background-color: #cccccc;">Building Type</th> <th style="background-color: #cccccc;">Energy Savings (therms/unit)</th> </tr> </thead> <tbody> <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 – &gt; 60,000 sq-ft</td><td>164</td></tr> <tr><td>Office – &lt; 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> </tbody> </table>	Building Type	Energy Savings (therms/unit)	Assembly	185	Education – Primary/Secondary	124	Education – Post Secondary	178	Grocery	191	Health/Medical - Hospital	297	Lodging - Hotel	228	Manufacturing - Light Industrial	140	Office – > 60,000 sq-ft	164	Office – < 60,000 sq-ft	56	Restaurant - FastFood	109	Restaurant – Sit Down	166	Retail	105	Storage	150	Multi-Family	119	Other	148
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	Office – < 60,000 sq-ft	56																															
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	Restaurant – Sit Down	166																															
Retail	105																																
Storage	150																																
Multi-Family	119																																
Other	148																																

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-HW\_-STWH-V01-120601**

<sup>157</sup> 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

<sup>158</sup> 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.

### DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 9 years.<sup>159</sup>

### DEEMED MEASURE COST

The incremental cost for this measure is \$8<sup>160</sup> or program actual

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

Loadshape C02 - Commercial Electric DHW

### COINCIDENCE FACTOR

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

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<sup>159</sup> Table C-6, Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007.

"[http://neep.org/uploads/EMV%20Forum/EMV%20Studies/measure\\_life\\_GDS%5B1%5D.pdf](http://neep.org/uploads/EMV%20Forum/EMV%20Studies/measure_life_GDS%5B1%5D.pdf)"

<sup>160</sup> 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**<sup>161</sup>.

$$\Delta kWh = \%ElectricDHW * ((GPM\_base - GPM\_low)/GPM\_base) * Usage * EPG\_electric * ISR$$

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”  
 = 1.2<sup>162</sup> or custom based on metering studies<sup>163</sup>

**GPM\_low** = Average flow rate, in gallons per minute, of the low-flow faucet aerator “as-used”  
 = 0.94<sup>164</sup> or custom based on metering studies<sup>165</sup>

**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,

<sup>161</sup> 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.

<sup>162</sup> Representative baseline 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. 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.

<sup>163</sup> 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.

<sup>164</sup> 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.

<sup>165</sup> 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.

if not use the following defaults (or substitute custom information in to the calculation):

Building Type	Gallons hot water per unit per day <sup>166</sup> (A)	Unit	Estimated % hot water from Faucets <sup>167</sup> (B)	Multiplier <sup>168</sup> (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	6,563
Sit-Down Rest	2.4	meal/day	50%	36	meals per faucet	365	10,800
Retail	2	employee	100%	5	employees per faucet	365	2,500
Grocery	2	employee	100%	5	employees per faucet	365	2,500
Warehouse	2	employee	100%	5	employees per faucet	250	2,500
Elementary School	0.6	person	50%	50	students per faucet	200	3,750
Jr High/High School	1.8	person	50%	50	students per faucet	200	11,250
Health	90	patient	25%	2	Patients per faucet	365	11,250
Motel	20	room	25%	1	faucet per room	365	1,250
Hotel	14	room	25%	1	faucet per room	365	875
Other	1	employee	100%	20	employees per faucet	250	5,000

EPG<sub>electric</sub> = Energy per gallon of mixed water used by faucet (electric water heater)

$$= (8.33 * 1.0 * (\text{WaterTemp} - \text{SupplyTemp})) / (\text{RE}_{\text{electric}} * 3412)$$

$$= (8.33 * 1.0 * (90 - 54.1)) / (0.98 * 3412)$$

$$= 0.0894 \text{ kWh/gal}$$

8.33 = Specific weight of water (lbs/gallon)

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

WaterTemp = Assumed temperature of mixed water

$$= 90\text{F}^{169}$$

<sup>166</sup> Table 2-45 Chapter 49, Service Water Heating, 2007 ASHRAE Handbook, HVAC Applications.

<sup>167</sup> 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](http://www.pacinst.org/reports/urban_usage/appendix_e.pdf)

<sup>168</sup> 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.

<sup>169</sup> Temperature cited from SBW Consulting, Evaluation for the Bonneville Power Authority, 1994, [http://www.bpa.gov/energy/n/reports/evaluation/residential/faucet\\_aerator.cfm](http://www.bpa.gov/energy/n/reports/evaluation/residential/faucet_aerator.cfm). This is a variable that would benefit from further evaluation.

- SupplyTemp = Assumed temperature of water entering building  
 = 54.1F<sup>170</sup>
- RE\_electric = Recovery efficiency of electric water heater  
 = 98%<sup>171</sup>
- 3412 = Converts Btu to kWh (Btu/kWh)
- ISR = In service rate of faucet aerators dependant on install method as listed in table below<sup>172</sup>

Selection	ISR
Direct Install - Deemed	0.95

**EXAMPLE**

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

$$\Delta kWh = 1 * ((1.2 - 0.94)/0.94) * 11,250 * 0.0894 * 0.95$$

$$= 207 \text{ kWh}$$

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

$$\Delta kWh = 1 * ((1.2 - 0.94)/0.94) * 3,750 * 0.0894 * 0.95$$

$$= 69 \text{ kWh}$$

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

$$\Delta kW = (\Delta kWh / \text{Hours}) * CF$$

Where:

- $\Delta kWh$  = calculated value above on a per faucet basis
- Hours = Annual electric DHW recovery hours for faucet use  
 = (Usage \* 0.545<sup>173</sup>)/GPH

<sup>170</sup> US DOE Building America Program. Building America Analysis Spreadsheet. For Chicago, IL [http://www1.eere.energy.gov/buildings/building\\_america/analysis\\_spreadsheets.html](http://www1.eere.energy.gov/buildings/building_america/analysis_spreadsheets.html).

<sup>171</sup> Electric water heater have recovery efficiency of 98%: <http://www.ahrinet.org/ARI/util/showdoc.aspx?doc=576>

<sup>172</sup> 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

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

Building Type	Annual Recovery Hours
Small Office	19
Large Office	84
Fast Food Rest	49
Sit-Down Rest	81
Retail	19
Grocery	19
Warehouse	19
Elementary School	28
Jr High/High School	84
Health	84
Motel	9
Hotel	7
Other	37

Where :

GPH = Gallons per hour recovery of electric water heater calculated for 65.9F temp rise (120-54.1), 98% recovery efficiency, and typical 12kW electric resistance storage tank.

= 73

CF = Coincidence Factor for electric load reduction

= Dependent on building type<sup>174</sup>

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

<sup>173</sup> 54.5% is the proportion of hot 120F water mixed with 54.1F supply water to give 90F mixed faucet water.

<sup>174</sup> 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.

Motel	0.0006
Hotel	0.0004
Other	0.0128

**EXAMPLE**

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

$$\begin{aligned} \Delta kW &= 207/84 * 0.0064 \\ &= 0.016 \text{ kW} \end{aligned}$$

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

$$\begin{aligned} \Delta kW &= 69/28 * 0.0096 \\ &= 0.024 \text{ kW} \end{aligned}$$

**FOSSIL FUEL IMPACT DESCRIPTIONS AND CALCULATION**

$$\Delta \text{Therms} = \% \text{FossilDHW} * ((\text{GPM}_{\text{base}} - \text{GPM}_{\text{low}}) / \text{GPM}_{\text{base}}) * \text{Usage} * \text{EPG}_{\text{gas}} * \text{ISR}$$

Where:

$\% \text{FossilDHW}$  = proportion of water heating supplied by fossil fuel heating

DHW fuel	$\% \text{Fossil\_DHW}$
Electric	0%
Fossil Fuel	100%

$\text{EPG}_{\text{gas}}$  = Energy per gallon of mixed water used by faucet (gas water heater)

$$= (8.33 * 1.0 * (\text{WaterTemp} - \text{SupplyTemp})) / (\text{RE}_{\text{gas}} * 100,000)$$

$$= 0.00446 \text{ Therm/gal}$$

Where:

$\text{RE}_{\text{gas}}$  = Recovery efficiency of gas water heater

$$= 67\%^{175}$$

<sup>175</sup> 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.

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

Other variables as defined above.

**EXAMPLE**

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

$$\begin{aligned} \Delta\text{Therms} &= 1 * ((1.2 - 0.94)/0.94) * 11,250 * 0.00446 * 0.95 \\ &= 13.2 \text{ Therms} \end{aligned}$$

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

$$\begin{aligned} \Delta\text{Therms} &= 1 * ((1.2 - 0.94)/0.94) * 3,750 * 0.00446 * 0.95 \\ &= 4.4 \text{ Therms} \end{aligned}$$

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

$$\Delta\text{gallons} = ((\text{GPM}_{\text{base}} - \text{GPM}_{\text{low}})/\text{GPM}_{\text{base}}) * \text{Usage} * \text{ISR}$$

Variables as defined above

**EXAMPLE**

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

$$\begin{aligned} \Delta\text{gallons} &= ((1.2 - 0.94)/0.94) * 11,250 * 0.95 \\ &= 2956 \text{ gallons} \end{aligned}$$

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

$$\begin{aligned} \Delta\text{gallons} &= ((1.2 - 0.94)/0.94) * 3,750 * 0.95 \\ &= 985 \text{ gallons} \end{aligned}$$

**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-HW\_-LFFA-V03-130601**

### 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.<sup>176</sup>

#### DEEMED MEASURE COST

The incremental cost for this measure is \$12<sup>177</sup> or program actual.

#### DEEMED O&M COST ADJUSTMENTS

N/A

#### LOADSHAPE

Loadshape CO2 - Commercial Electric DHW

#### COINCIDENCE FACTOR

The coincidence factor for this measure is assumed to be 2.78%<sup>178</sup>.

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<sup>176</sup> 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](http://neep.org/uploads/EMV%20Forum/EMV%20Studies/measure_life_GDS%5B1%5D.pdf)"

<sup>177</sup> Direct-install price per showerhead assumes cost of showerhead (Market research average of \$7 and assess and install time of \$5 (20min @ \$15/hr)

<sup>178</sup> 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

**Algorithm**

**CALCULATION OF SAVINGS**<sup>179</sup>

**ELECTRIC ENERGY SAVINGS**

Note these savings are per showerhead fixture

$\Delta kWh =$

$$\%ElectricDHW * ((GPM\_base * L\_base - GPM\_low * L\_low) * NSPD * 365.25) * EPG\_electric * ISR$$

Where:

**%ElectricDHW** = proportion of water heating supplied by electric resistance heating  
 = 1 if electric DHW, 0 if fuel DHW, if unknown assume 16%<sup>180</sup>

**GPM\_base** = Flow rate of the baseline showerhead  
 = 2.67 for Direct-install programs<sup>181</sup>

**GPM\_low** = As-used flow rate of the low-flow showerhead, which may, as a result of measurements of program evaluations deviate from rated flows, see table below:

Rated Flow
2.0 GPM
1.75 GPM
1.5 GPM
Custom or Actual <sup>182</sup>

**L\_base** = Shower length in minutes with baseline showerhead  
 = 8.20 min<sup>183</sup>

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

<sup>179</sup>Based on excel spreadsheet 120911.xls ...on SharePoint

<sup>180</sup> Table HC8.9. Water Heating in U.S. Homes in Midwest Region, Divisions, and States, 2009 (RECS)

<sup>181</sup> Based on measured data from Ameren IL EM&V of Direct-Install program. Program targets showers that are rated 2.5 GPM or above.

<sup>182</sup> 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.

L <sub>low</sub>	= Shower length in minutes with low-flow showerhead = 8.20 min <sup>184</sup>
365.25	= Days per year, on average.
NSPD	= Estimated number of showers taken per day for one showerhead
EPG <sub>electric</sub>	= Energy per gallon of hot water supplied by electric = $(8.33 * 1.0 * (\text{ShowerTemp} - \text{SupplyTemp})) / (\text{RE}_{\text{electric}} * 3412)$ = $(8.33 * 1.0 * (105 - 54.1)) / (0.98 * 3412)$ = 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 = 105F <sup>185</sup>
SupplyTemp	= Assumed temperature of water entering house = 54.1F <sup>186</sup>
RE <sub>electric</sub>	= Recovery efficiency of electric water heater = 98% <sup>187</sup>
3412	= Converts Btu to kWh (btu/kWh)

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<sup>183</sup> Representative value from sources 1, 2, 3, 4, 5, and 6 (See Source Table at end of measure section)

<sup>184</sup> Set equal to L<sub>base</sub>.

<sup>185</sup> 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](http://www.bpa.gov/energy/n/reports/evaluation/residential/faucet_aerator.cfm)

<sup>186</sup> US DOE Building America Program. Building America Analysis Spreadsheet. For Chicago, IL [http://www1.eere.energy.gov/buildings/building\\_america/analysis\\_spreadsheets.html](http://www1.eere.energy.gov/buildings/building_america/analysis_spreadsheets.html).

<sup>187</sup> Electric water heater have recovery efficiency of 98%: <http://www.ahrinet.org/ARI/util/showdoc.aspx?doc=576>

ISR = In service rate of showerhead

= Dependant on program delivery method as listed in table below

Selection	ISR <sup>188</sup>
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:

$$\begin{aligned} \Delta kWh &= 1 * ((2.67*8.20) - (1.5*8.20)) * 3*365.25 * 0.127 * 0.98 \\ &= 1308.4 kWh \end{aligned}$$

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

$$\Delta kW = \Delta kWh / \text{Hours} * CF$$

Where:

$\Delta kWh$  = calculated value above

Hours = Annual electric DHW recovery hours for showerhead use

$$= ((GPM\_base * L\_base) * NSPD * 365.25) * 0.773^{189} / GPH$$

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

$$= 0.0278^{190}$$

<sup>188</sup> 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.

<sup>189</sup> 77.3% is the proportion of hot 120F water mixed with 54.1F supply water to give 105F shower water.

<sup>190</sup> Calculated as follows: Assume 11% showers take place during peak hours (based on:

**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:

$$\Delta kW = (1308.4 / 674.1) * 0.0278$$

**FOSSIL FUEL IMPACT DESCRIPTIONS AND CALCULATION**

$$\Delta \text{Therms} = \% \text{FossilDHW} * ((\text{GPM}_{\text{base}} * L_{\text{base}} - \text{GPM}_{\text{low}} * L_{\text{low}}) * \text{NSPD} * 365.25) * \text{EPG}_{\text{gas}} * \text{ISR}$$

Where:

$\% \text{FossilDHW}$  = proportion of water heating supplied by fossil fuel heating

DHW fuel	$\% \text{Fossil\_DHW}$
Electric	0%
Fossil Fuel	100%
Unknown	84% <sup>191</sup>

$\text{EPG}_{\text{gas}}$  = Energy per gallon of Hot water supplied by gas

$$= (8.33 * 1.0 * (\text{ShowerTemp} - \text{SupplyTemp})) / (\text{RE}_{\text{gas}} * 100,000)$$

$$= 0.0063 \text{ Therm/gal}$$

Where:

$\text{RE}_{\text{gas}}$  = Recovery efficiency of gas water heater

$$= 67\%<sup>192</sup>$$

<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  $7.23 / 260 = 0.0278$

<sup>191</sup> 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

<sup>192</sup> 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

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:

$$\begin{aligned} \Delta\text{Therms} &= 1.0 * ((2.67 * 8.2) - (1.5 * 8.2)) * 3 * 365.25 * 0.0063 * 0.98 \\ &= 64.9 \text{ therms} \end{aligned}$$

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

$$\Delta\text{gallons} = ((\text{GPM}_{\text{base}} * L_{\text{base}} - \text{GPM}_{\text{low}} * L_{\text{low}}) * \text{NSPD} * 365.25 * \text{ISR})$$

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:

$$\Delta\text{gallons} = ((2.67 * 8.20) - (1.5 * 8.20)) * 3 * 365.25 * 0.98$$

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

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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-V02-120601**

#### 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<sup>193</sup>

##### **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.<sup>194</sup>

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<sup>193</sup> 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

<sup>194</sup> 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
<b>Average</b>	<b>\$2.00</b>	<b>\$2.04</b>

**DEEMED O&M COST ADJUSTMENTS**

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

**LOADSHAPE**

N/A

**COINCIDENCE FACTOR**

N/A

**NET TO GROSS RATIO**

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**Algorithm**

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**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.<sup>195</sup>

$$\Delta\text{Therms} = \text{SavingFactor} \times \text{Size of Pool}$$

Where

Savings factor = dependant on pool location and listed in table below<sup>196</sup>

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<sup>195</sup> Full method and supporting information found in reference document: IL TRM - Business Pool Covers WorkPaper.docx

<sup>196</sup> Business Pool Covers.xlsx

Location	Therm / sq-ft
Chicago - indoor	2.61
Chicago - outdoor	1.01

Size of Pool = custom input

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

$\Delta$ Therms = WaterSavingFactor x Size of Pool

Where

WaterSavingFactor = Water savings for this measure dependant on pool location and listed in table below.<sup>197</sup>

Location	Annual Savings Gal / sq-ft
Chicago - indoor	15.28
Chicago - 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**

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<sup>197</sup> 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 <sup>198</sup> .	The expected measure life is assumed to be 20 years <sup>199</sup>

**DEEMED MEASURE COST**

The incremental capital cost for an electric tankless heater this measure is assumed to be<sup>200</sup>

<sup>198</sup> 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](http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12820)

<sup>199</sup> Ibid.

<sup>200</sup> 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 <sup>201</sup>
Time of Sale or New Construction	\$2,526 <sup>202</sup>

**DEEMED O&M COST ADJUSTMENTS**

\$100<sup>203</sup>

**LOADSHAPE**

Loadshape C02 - Commercial Electric DHW

**COINCIDENCE FACTOR**

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

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<sup>201</sup> Based on AOE historical average installation data of 42 tankless gas hot water heaters

<sup>202</sup> <http://www.mncee.org/getattachment/7b8982e9-4d95-4bc9-8e64-f89033617f37/>, Low contractor estimate used to reflect less labor required in new construction of venting.

<sup>203</sup> 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, Rinnai, 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<sup>204</sup>**

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	2,991.98
10.0	7,904.82
15.0	12,878.51

**SUMMER COINCIDENT PEAK DEMAND SAVINGS<sup>205</sup>**

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 ENERGY SAVINGS**

$$\Delta\text{Therms} = \left[ \frac{W_{\text{gal}} \times 8.33 \times 1 \times (T_{\text{out}} - T_{\text{in}}) \times \left[ \frac{1}{\text{Eff base}} - \frac{1}{\text{Eff ee}} \right]}{100,000} \right] + \left[ \frac{(SL \times 8,766)}{\text{Eff base}} \right] / 100,000 \text{ Btu/Therms}$$

Where:

- Wgal = Annual water use for equipment in gallons  
= custom, otherwise assume 21,915 gallons<sup>206</sup>
- 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

<sup>204</sup> Act on Energy Technical Reference Manual, Table 9.6.2-3

<sup>205</sup> Ibid.

<sup>206</sup> 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.

= custom, otherwise assume 130 degree F<sup>207</sup>

Tin = Inlet Water Temperature

= custom, otherwise assume 54.1 degree F<sup>208</sup>

Eff base = Rated efficiency of baseline water heater expressed as Energy Factor (EF) or Thermal Efficiency (Et); see table below<sup>209</sup>

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

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

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 Thermal 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<sup>210</sup>

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<sup>211</sup>

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

<sup>207</sup> Based on 2010 Ohio Technical Reference Manual and NAHB Research Center, (2002) Performance Comparison of Residential hot Water Systems. Prepared for National Renewable Energy Laboratory, Golden, Colorado.

<sup>208</sup> 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.

<sup>209</sup> IECC 2012, Table C404.2, Minimum Performance of Water-Heating Equipment

<sup>210</sup> 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.

<sup>211</sup> Stand-by loss is provided 2012 International Energy Conservation Code (IECC2012), Table C404.2, Minimum Performance of Water-Heating Equipment

	Volume))
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Where:

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

Input Value = nameplate Btu/hr rating of water heater

**EXAMPLE**

For example, a 75,000 Btu/h 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:

$$\Delta\text{Therms} = \frac{[(21,915 \times 8.33 \times 1 \times (130 - 54.1) \times [(1/.8) - (1/.84)]/100,000] + [(1008.3 \times 8,766)/.8]}{100,000}$$

$$= 115 \text{ Therms}$$

**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<sup>212</sup>

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<sup>212</sup> 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 <sup>a, b</sup>	TEST PROCEDURE
Water heaters, electric	≤ 12 kW	Resistance	0.97 - 0.00132 V, EF	DOE 10 CFR Part 430
	> 12 kW	Resistance	1.73 V/ 155 SL, Btu/h	ANSI Z21.10.3
	≤ 24 amps and ≤ 260 volts	Heat pump	0.93 - 0.00132 V, EF	DOE 10 CFR Part 430
Storage water heaters, gas	≤ 75,000 Btu/h	≥ 20 gal	0.67 - 0.0019 V, EF	DOE 10 CFR Part 430
	> 75,000 Btu/h and ≤ 155,000 Btu/h	< 4,000 Btu/h/gal	80% E <sub>r</sub> (Q/800 + 110/√V) SL, Btu/h	ANSI Z21.10.3
	> 155,000 Btu/h	< 4,000 Btu/h/gal	80% E <sub>r</sub> (Q/800 + 110/√V) SL, Btu/h	
Instantaneous water heaters, gas	> 60,000 Btu/h and < 200,000 Btu/h <sup>c</sup>	≥ 4,000 (Btu/h)/gal and < 2 gal	0.62 - 0.0019 V, EF	DOE 10 CFR Part 430
	≥ 200,000 Btu/h	≥ 4,000 Btu/h/gal and < 10 gal	80% E <sub>r</sub>	ANSI Z21.10.3
	≥ 200,000 Btu/h	≥ 4,000 Btu/h/gal and ≥ 10 gal	80% E <sub>r</sub> (Q/800 + 110/√V) SL, Btu/h	
Storage water heaters, oil	≤ 105,000 Btu/h	≥ 20 gal	0.59 - 0.0019 V, EF	DOE 10 CFR Part 430
	≥ 105,000 Btu/h	< 4,000 Btu/h/gal	78% E <sub>r</sub> (Q/800 + 110/√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 - 0.0019 V, EF	DOE 10 CFR Part 430
	> 210,000 Btu/h	≥ 4,000 Btu/h/gal and < 10 gal	80% E <sub>r</sub>	ANSI Z21.10.3
	> 210,000 Btu/h	≥ 4,000 Btu/h/gal and ≥ 10 gal	78% E <sub>r</sub> (Q/800 + 110/√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 <sub>r</sub>	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 <sub>r</sub> (Q/800 + 110/√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 <sub>r</sub> (Q/800 + 110/√V) SL, Btu/h	
Pool heaters, gas and oil	All	—	78% E <sub>r</sub>	ASHRAE 146
Heat pump pool heaters	All	—	4.0 COP	AHRI 1160
Unfired storage tanks	All	—	Minimum insulation requirement R-12.5 (h · ft <sup>2</sup> · °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<sub>r</sub>) 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

## 4.4 HVAC End Use

### 4.4.1 Air Conditioner Tune-up

#### DESCRIPTION

An air conditioning system that is operating as designed saves energy and provides adequate cooling and comfort to the conditioned space

#### DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to be a unitary or split system air conditioner least 3 tons and preapproved by program. The measure requires that a certified technician performs the following items:

- Check refrigerant charge
- Identify and repair leaks if refrigerant charge is low
- Measure and record refrigerant pressures
- Measure and record temperature drop at indoor coil
- Clean condensate drain line
- Clean outdoor coil and straighten fins
- Clean and straighten indoor and outdoor fan blades
- Clean indoor coil with spray-on cleaner and straighten fins
- Repair damaged insulation – suction line
- Change air filter
- Measure and record blower amp draw
- Measure and record compressor integrity (MOhm)
- Measure and record condenser fan motor amp draw

A copy of contractor invoices that detail the work performed to identify tune-up items, as well as additional labor and parts to improve/repair air conditioner performance must be submitted to the program

#### DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline condition is assumed to be an AC system that that does not have a standing maintenance contract or a tune up within in the past 36 months.

#### DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 3 years.<sup>213</sup>

#### DEEMED MEASURE COST

The incremental capital cost for this measure is \$35<sup>214</sup> per ton.

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<sup>213</sup>Act on Energy Commercial Technical Reference Manual No. 2010-4

<sup>214</sup>Ibid.

**DEEMED O&M COST ADJUSTMENTS**

N/A

**LOADSHAPE**

Loadshape C03 - Commercial Cooling

**COINCIDENCE FACTOR**

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

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS**

The measure has a deemed savings which applies to all building types and air conditioning unit size and equals an average value of 878 kWh a year.<sup>215</sup>

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

The measure has a deemed savings which applies to all building types and air conditioning unit size and equals an average value 0.39 kW a year.<sup>216</sup>

**NATURAL GAS ENERGY SAVINGS**

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

**DEEMED O&M COST ADJUSTMENT CALCULATION**

**MEASURE CODE: CI-HVC-ACTU-V01-120601**

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<sup>215</sup> Ibid.

<sup>216</sup> Act on Energy Commercial Technical Reference Manual No. 2010-4. These deemed values should be compared to PY evaluation and revised as necessary.

## 4.4.2 Space Heating Boiler Tune-up<sup>217</sup>

### DESCRIPTION

This measure is for a non-residential boiler that provides space heating. The tune-up will improve boiler efficiency by cleaning and/or inspecting burners, combustion chamber, and burner nozzles. Adjust air flow and reduce excessive stack temperatures, adjust burner and gas input. Check venting, safety controls, and adequacy of combustion air intake. Combustion efficiency should be measured before and after tune-up using an electronic flue gas analyzer.

### DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure the facility must, as applicable, complete the tune-up requirements<sup>218</sup> listed below, by approved technician:

- Measure combustion efficiency using an electronic flue gas analyzer
- Adjust airflow and reduce excessive stack temperatures
- Adjust burner and gas input, manual or motorized draft control
- Check for proper venting
- Complete visual inspection of system piping and insulation
- Check safety controls
- Check adequacy of combustion air intake
- Clean fireside surfaces.
- Inspect all refractory. Patch and wash coat as required.
- Inspect gaskets on front and rear doors and replace as necessary.
- Seal and close front and rear doors properly.
- Clean low and auxiliary low water cut-off controls, then re-install using new gaskets.
- Clean plugs in control piping.
- Remove all hand hole and man hole plates. Flush boiler with water to remove loose scale and sediment.
- Replace all hand hole and man hole plates with new gaskets.
- Open feedwater tank manway, inspect and clean as required. Replace manway plate with new gasket.
- Clean burner and burner pilot.
- Check pilot electrode and adjust or replace.
- Clean air damper and blower assembly.
- Clean motor starter contacts and check operation.
- Make necessary adjustments to burner for proper combustion.
- Perform all flame safeguard and safety trip checks.
- Check all hand hole plates and man hole plates for leaks at normal operating temperatures and pressures.
- Troubleshoot any boiler system problems as requested by on-site personnel

### DEFINITION OF BASELINE EQUIPMENT

The baseline condition of this measure is a boiler that has not had a tune-up within the past 36 months

### DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The life of this measure is 3 years<sup>219</sup>

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<sup>217</sup>High Impact Measure

<sup>218</sup>Act on Energy Commercial Technical Reference Manual No. 2010-4, 9.2.2 Gas Boiler Tune-up

<sup>219</sup>Act on Energy Commercial Technical Reference Manual No. 2010-4, 9.2.2 Gas Boiler Tune-up

**DEEMED MEASURE COST**

The cost of this measure is \$0.83/MBtuh<sup>220</sup> per tune-up

**DEEMED O&M COST ADJUSTMENTS**

N/A

**LOADSHAPE**

N/A

**COINCIDENCE FACTOR**

N/A

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**Algorithm**

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**CALCULATION OF ENERGY SAVINGS**

**ELECTRIC ENERGY SAVINGS**

N/A

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

N/A

**NATURAL GAS ENERGY SAVINGS**

$$\Delta\text{therms} = \text{Ngi} * \text{SF} * \text{EFLH} / (\text{Effpre} * 100)$$

Where:

Ngi = Boiler gas input size (kBTU/hr)

= custom

SF = Savings factor

Note: Savings factor is the percentage reduction in gas consumption as a result of the tune-up

= 1.6%<sup>221</sup> or custom

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<sup>220</sup>Work Paper – Tune up for Boilers serving Space Heating and Process Load by Resource Solutions Group, January 2012

<sup>221</sup>Work Paper WPRRSGNGRO301 Resource Solutions Group "Boiler Tune-Up" which cites Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0, PA Consulting, KEMA, March 22, 2010

EFLH = Equivalent Full Load Hours for heating<sup>222</sup>

Building Type	EFLH				
	Zone 1 (Rockford)	Zone 2 (Chicago)	Zone 3 (Springfield)	Zone 4 (Belleville/)	Zone 5 (Marion)
Office - High Rise	2,746	2,768	2,656	2,155	2,420
Office - Mid Rise	996	879	824	519	544
Office - Low Rise	797	666	647	343	329
Convenience	696	550	585	272	297
Healthcare Clinic	1,118	1,036	1,029	694	737
Manufacturing Facility	1,116	1,123	904	771	857
Lodging Hotel/Motel	2,098	2,050	1,780	1,365	1,666
High School	969	807	999	569	674
Hospital	2,031	1,929	1,863	1,497	1,800
Elementary	970	840	927	524	637
Religious Facility	1,830	1,657	1,730	1,276	1,484
Restaurant	1,496	1,379	1,291	872	1,185
Retail - Strip Mall	1,266	1,147	1,151	732	863
Retail - Department Store	1,065	927	900	578	646
College/University	373	404	376	187	187
Warehouse	416	443	427	226	232
Unknown	1,249	1,163	1,130	786	910

Effpre = Boiler Combustion Efficiency Before Tune-Up

<sup>222</sup>Equivalent full load hours for heating were developed using eQuest models for various building types averaged across each climate zones for Illinois for the following building types: office, healthcare/clinic, manufacturing, lodging, high school, hospital, elementary school, religious/assembly, restaurant, retail, college and warehouse. eQuest models werer those developed for IL lighting interactive effects.

= 80%<sup>223</sup> or custom

**EXAMPLE**

For example, a 1050 kBtu boiler in Chicago at a high rise office:

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

N/A

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

Measure Code: CI-HVC-BLRT-V02-130601

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<sup>223</sup>Work Paper WPRRSGNGRO301 Resource Solutions Group "Boiler Tune-Up" which cites Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0, PA Consulting, KEMA, March 22, 2010

### 4.4.3 Process Boiler Tune-up<sup>224</sup>

#### DESCRIPTION

This measure is for a non-residential boiler for process loads. For space heating, see measure 5.2.1. The tune-up will improve boiler efficiency by cleaning and/or inspecting burners, combustion chamber, and burner nozzles. Adjust air flow and reduce excessive stack temperatures, adjust burner and gas input. Check venting, safety controls, and adequacy of combustion air intake. Combustion efficiency should be measured before and after tune-up using an electronic flue gas analyzer.

#### DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure the facility must, as applicable, complete the tune-up requirements<sup>225</sup> by approved technician, as specified below:

- Measure combustion efficiency using an electronic flue gas analyzer
- Adjust airflow and reduce excessive stack temperatures
- Adjust burner and gas input, manual or motorized draft control
- Check for proper venting
- Complete visual inspection of system piping and insulation
- Check safety controls
- Check adequacy of combustion air intake
- Clean fireside surfaces
- Inspect all refractory. Patch and wash coat as required.
- Inspect gaskets on front and rear doors and replace as necessary.
- Seal and close front and rear doors properly.
- Clean low and auxiliary low water cut-off controls, then re-install using new gaskets.
- Clean plugs in control piping.
- Remove all hand hole and man hole plates. Flush boiler with water to remove loose scale and sediment.
- Replace all hand hole and man hole plates with new gaskets.
- Open feedwater tank manway, inspect and clean as required. Replace manway plate with new gasket.
- Clean burner and burner pilot.
- Check pilot electrode and adjust or replace.
- Clean air damper and blower assembly.
- Clean motor starter contacts and check operation.
- Make necessary adjustments to burner for proper combustion.
- Perform all flame safeguard and safety trip checks.
- Check all hand hole plates and man hole plates for leaks at normal operating temperatures and pressures.
- Troubleshoot any boiler system problems as requested by on-site personnel

#### DEFINITION OF BASELINE EQUIPMENT

The baseline condition of this measure is a boiler that has not had a tune-up within the past 36 months

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<sup>224</sup>High Impact Measure

<sup>225</sup>Act on Energy Commercial Technical Reference Manual No. 2010-4, 9.2.2 Gas Boiler Tune-up

**DEEMED LIFETIME OF EFFICIENT EQUIPMENT**

The life of this measure is 3 years<sup>226</sup>

**DEEMED MEASURE COST**

The cost of this measure is \$0.83/MBtuh<sup>227</sup> per tune-up

**DEEMED O&M COST ADJUSTMENTS**

N/A

**LOADSHAPE**

N/A

**COINCIDENCE FACTOR**

N/A

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**Algorithm**

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**CALCULATION OF ENERGY SAVINGS**

**ELECTRIC ENERGY SAVINGS**

N/A

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

N/A

**NATURAL GAS ENERGY SAVINGS**

$$\Delta\text{therms} = ((N_{gi} * 8766 * UF) / 100) * (1 - (\text{Eff}_{pre} / \text{Eff}_{measured}))$$

Where:

$N_{gi}$  = Boiler gas input size (kBTU/hr)

= custom

UF = Utilization Factor

= 41.9%<sup>228</sup> or custom

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<sup>226</sup> Act on Energy Commercial Technical Reference Manual No. 2010-4, 9.2.2 Gas Boiler Tune-up

<sup>227</sup> Work Paper – Tune up for Boilers serving Space Heating and Process Load by Resource Solutions Group, January 2012

$Eff_{pre}$  = Boiler Combustion Efficiency Before Tune-Up  
= 80%<sup>229</sup> or custom

$Eff_{measured}$  = Boiler Combustion Efficiency After Tune-Up  
= 81.3%<sup>230</sup> or custom

**EXAMPLE**

For example, a 1050 kBtu boiler:

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

N/A

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

Measure Code: CI-HVC-PBTU-V02-130601

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<sup>228</sup>Work Paper – Tune up for Boilers serving Space Heating and Process Load by Resource Solutions Group, January 2012

<sup>229</sup>Work Paper – Tune up for Boilers serving Space Heating and Process Load by Resource Solutions Group, January 2012, which cites Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0, PA Consulting, KEMA, March 22, 2010

<sup>230</sup>Work Paper – Tune up for Boilers serving Space Heating and Process Load by Resource Solutions Group, January 2012, which cites Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0, PA Consulting, KEMA, March 22, 2010

#### 4.4.4 Boiler Lockout/Reset Controls

**DESCRIPTION**

This measure relates to improving combustion efficiency by adding controls to non-residential building heating boilers to vary the boiler entering water temperature relative to heating load as a function of the outdoor air temperature to save energy. Energy is saved by increasing the temperature difference between the water temperature entering the boiler in the boiler's heat exchanger and the boiler's burner flame temperature. The flame temperature remains the same while the water temperature leaving the boiler decreases with the decrease in heating load due to an increase in outside air temperature. A lockout temperature is also set to prevent the boiler from turning on when it is above a certain temperature outdoors.

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**

Natural gas customer adding boiler reset controls capable of resetting the boiler supply water temperature in an inverse linear fashion with outdoor air temperature. Boiler lockout temperatures should be set to 55 F at this time as well, to turn the boiler off when the temperature goes above a certain setpoint.

**DEFINITION OF BASELINE EQUIPMENT**

Existing boiler without boiler reset controls, any size with constant hot water flow.

**DEEMED LIFETIME OF EFFICIENT EQUIPMENT**

THE LIFE OF THIS MEASURE IS 20 YEARS<sup>231</sup>

**DEEMED MEASURE COST**

The cost of this measure is \$612<sup>232</sup>

**DEEMED O&M COST ADJUSTMENTS**

N/A

**LOADSHAPE**

N/A

**COINCIDENCE FACTOR**

N/A

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<sup>231</sup> Resource Solutions Group references the Brooklyn Union Gas Company, High Efficiency Heating and Water and Controls, Gas Energy Efficiency Program Implementation Plan.

<sup>232</sup> Nexant. Questar DSM Market Characterization Report. August 9, 2006.

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS**

N/A

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

N/A

**NATURAL GAS ENERGY SAVINGS**

$$\text{Therm Savings} = \text{Binput} * \text{SF} * \text{EFLH} / (\text{Effpre} * 100)$$

Where:

Binput = Boiler Input Capacity (kBTU)

= custom

SF = Savings factor

= 8%<sup>233</sup> or custom

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<sup>233</sup>Savings factor is the estimate of annual gas consumption that is saved due to adding boiler reset controls. The Resource Solutions Group uses a boiler tuneup savings value derived from Xcel Energy "DSM Biennial Plan- Technical Assumptions," Colorado. Focus on Energy uses 8%, citing multiple sources. Vermont Energy Investment Corporation's boiler reset savings estimates for custom projects further indicate 8% savings estimate is better reflection of actual expected savings.

EFLH = Equivalent Full Load Hours for heating<sup>234</sup> (hr)

Building Type	EFLH				
	Zone 1 (Rockford)	Zone 2 (Chicago)	Zone 3 (Springfield)	Zone 4 (Belleville/)	Zone 5 (Marion)
Office - High Rise	2,746	2,768	2,656	2,155	2,420
Office - Mid Rise	996	879	824	519	544
Office - Low Rise	797	666	647	343	329
Convenience	696	550	585	272	297
Healthcare Clinic	1,118	1,036	1,029	694	737
Manufacturing Facility	1,116	1,123	904	771	857
Lodging Hotel/Motel	2,098	2,050	1,780	1,365	1,666
High School	969	807	999	569	674
Hospital	2,031	1,929	1,863	1,497	1,800
Elementary	970	840	927	524	637
Religious Facility	1,830	1,657	1,730	1,276	1,484
Restaurant	1,496	1,379	1,291	872	1,185
Retail - Strip Mall	1,266	1,147	1,151	732	863
Retail - Department Store	1,065	927	900	578	646
College/University	373	404	376	187	187
Warehouse	416	443	427	226	232
Unknown	1,249	1,163	1,130	786	910

Effpre = Boiler Efficiency or custom

= 80%<sup>235</sup> or custom

**EXAMPLE**

For example, a 800 kBtu boiler at a restaurant in Rockford, IL

$$\Delta\text{Therms} = 800 * 0.08 * 1,496 / (0.80 * 100)$$

$$= 1197 \text{ Therms}$$

<sup>234</sup>Equivalent full load hours for heating were developed using eQuest models for various building types averaged across each climate zones for Illinois for the following building types: office, healthcare/clinic, manufacturing, lodging, high school, hospital, elementary school, religious/assembly, restaurant, retail, college and warehouse. eQuest models were those developed for IL lighting interactive effects.

<sup>235</sup>Work Paper WPRRSGNGRO301 Resource Solutions Group "Boiler Tune-Up" which cites Focus on Energy Evaluation Business Programs: Deemed Savings Manual V1.0, PA Consulting, KEMA, March 22, 2010

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-HVC-BLRC-V01-120601**

## 4.4.5 Condensing Unit Heaters

### DESCRIPTION

This measure applies to a gas fired condensing unit heater installed in a commercial application.

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

### DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to be a condensing unit heater up to 300 MBH with a Thermal Efficiency > 90% and the heater must be vented, and condensate drained per manufacturer specifications. The unit must be replacing existing natural gas equipment.

### DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline condition is assumed to be a non-condensing natural gas unit heater at end of life.

### DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 12 years<sup>236</sup>

### DEEMED MEASURE COST

The incremental capital cost for a unit heater is \$676<sup>237</sup>

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

N/A

### COINCIDENCE FACTOR

N/A

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<sup>236</sup> DEER 2008

<sup>237</sup> 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

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**Algorithm**

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**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 266 Therms.

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-HVC-CUHT-V01-120601**

### 4.4.6 Electric Chiller

**DESCRIPTION**

This measure relates to the installation of a new electric chiller meeting the efficiency standards presented below. This measure could relate to the replacement of an existing unit at the end of its useful life, or the installation of a new system in an existing building (i.e. time of sale). Only single-chiller applications should be assessed with this methodology. The characterization is not suited for multiple chillers projects or chillers equipped with variable speed drives (VSDs).

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

**DEFINITION OF EFFICIENT EQUIPMENT**

In order for this characterization to apply, the efficient equipment is assumed to exceed the efficiency requirements of the 2009 International Energy Conservation Code, Table 503.2.3(7)

**DEFINITION OF BASELINE EQUIPMENT**

In order for this characterization to apply, the baseline equipment is assumed to meet the efficiency requirements of the 2009 International Energy Conservation Code, Table 503.2.3(7).

**DEEMED LIFETIME OF EFFICIENT EQUIPMENT**

The expected measure life is assumed to be 20 years<sup>238</sup>.

**DEEMED MEASURE COST**

The incremental capital cost for this measure is provided below.

Equipment Type	Size Category	Incremental Cost (\$/ton) <sup>239</sup>
Air cooled, electrically operated	All capacities	\$127/ton <sup>240</sup>
Water cooled, electrically operated, positive displacement (reciprocating)	All capacities	\$22/ton
Water cooled, electrically operated, positive displacement (rotary screw and scroll)	< 150 tons	\$128/ton
	>= 150 tons and < 300 tons	\$70/ton
	>= 300 tons	\$48/ton

<sup>238</sup>2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, "Effective/Remaining Useful Life Values", California Public Utilities Commission, December 16, 2008 ([http://deeresources.com/deer0911planning/downloads/EUL\\_Summary\\_10-1-08.xls](http://deeresources.com/deer0911planning/downloads/EUL_Summary_10-1-08.xls))

<sup>239</sup>2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, "Cost Values and Summary Documentation", California Public Utilities Commission, December 16, 2008 ([http://deeresources.com/deer0911planning/downloads/DEER2008\\_Costs\\_ValuesAndDocumentation\\_080530Rev1.zip](http://deeresources.com/deer0911planning/downloads/DEER2008_Costs_ValuesAndDocumentation_080530Rev1.zip))

<sup>240</sup>Calculated as the simple average of screw and reciprocating air-cooled chiller incremental costs from DEER2008. This assumes that baseline shift from IECC 2006 to IECC 2009 carries the same incremental costs. Values should be verified during evaluation

**DEEMED O&M COST ADJUSTMENTS**

N/A

**LOADSHAPE**

Loadshape C03 - Commercial Cooling

**COINCIDENCE FACTOR**

The summer peak coincidence factor for cooling is provided in two different ways below. The first is used to estimate peak savings during the utility peak hour and is most indicative of actual peak benefits, and the second represents the *average* savings over the defined summer peak period, and is presented so that savings can be bid into PJM’s Forward Capacity Market. Both values provided are based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren.

$$\begin{aligned} CF_{SSP} &= \text{Summer System Peak Coincidence Factor for Commercial cooling (during system peak hour)} \\ &= 91.3\%^{241} \end{aligned}$$

$$\begin{aligned} CF_{PJM} &= \text{PJM Summer Peak Coincidence Factor for Commercial cooling (average during peak period)} \\ &= 47.8\%^{242} \end{aligned}$$

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS**

$$\Delta kWH = \text{TONS} * ((12/\text{IPLVbase}) - (12/\text{IPLVee})) * \text{EFLH}$$

Where:

TONS = chiller nominal cooling capacity in tons (note: 1 ton = 12,000 Btu/h)  
 = Actual installed

12 = conversion factor to express Integrated Part Load Value (IPLV) EER in terms of kW per ton

IPLVbase = efficiency of baseline equipment expressed as Integrated Part Load Value EER. Dependent on chiller type. See Baseline Efficiency Values by Chiller Type and Capacity in the Reference Tables section.

IPLVee<sup>243</sup> = efficiency of high efficiency equipment expressed as Integrated Part Load Value EER<sup>244</sup>

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<sup>241</sup>Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The AC load during the utility’s peak hour is divided by the maximum AC load during the year.

<sup>242</sup>Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The average AC load over the PJM peak period (1-5pm, M-F, June through August) is divided by the maximum AC load during the year

= Actual installed

EFLH = equivalent full load hours dependent on location as below:

System Type <sup>245</sup>	EFLH by Zone <sup>246</sup>				
	1 (Rockford)	2 (Chicago)	3 (Springfield)	4 (Belleville)	5 (Marion)
CV reheat, no economizer	2,723	4,206	3,341	3,872	2,734
CV reheat, economizer	870	1,343	1,067	1,237	873
VAV reheat, economizer	803	1,241	985	1,142	806

For example, a 100 ton air cooled, with condenser, electrically operated chiller with 3 IPLV, 3 COP of in Rockford with and economizer and CV reheat would save:

$$\begin{aligned} \Delta \text{kWh} &= 100 * ((12/12.5) - (12/14)) * 870 \\ &= 8949 \text{ kWh} \end{aligned}$$

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

$$\Delta \text{kW}_{\text{SSP}} = \text{TONS} * ((12/\text{PEbase}) - (12/\text{PEee})) * \text{CF}_{\text{SSP}}$$

$$\Delta \text{kW}_{\text{PJM}} = \text{TONS} * ((12/\text{PEbase}) - (12/\text{PEee})) * \text{CF}_{\text{PJM}}$$

Where:

PEbase = Peak efficiency of baseline equipment expressed as Full Load EER

PEee = Peak efficiency of high efficiency equipment expressed as Full Load EER

= Actual installed

CF<sub>SSP</sub> = Summer System Peak Coincidence Factor for Commercial cooling (during system peak hour)

= 91.3%

CF<sub>PJM</sub> = PJM Summer Peak Coincidence Factor for Commercial cooling (average during peak period)

<sup>243</sup>Integrated Part Load Value is a seasonal average efficiency rating calculated in accordance with ARI Standard 550/590. It may be calculated using any measure of efficiency (EER, kW/ton, COP), but for consistency with IECC 2006, it is expressed in terms of COP here.

<sup>244</sup>Can determine IPLV from standard testing or looking at engineering specs for design conditions. Standard data is available from AHRnetl.org. <http://www.ahrnet.org/>

<sup>245</sup>CV= Constant Volume, VAV=Variable Air Volume

<sup>246</sup>Cooling EFLHs have been modified from the "Technical Reference Manual (TRM) for Ohio and adjusted by CDD for IL locations. These appear reasonable, but are recommended for further study.

= 47.8%

For example, a 100 ton air cooled, with condenser, electrically operated chiller with 3 IPLV, 3 COP of in Rockford with and economizer and CV reheat would save:

$$\begin{aligned}\Delta kW_{SSP} &= 100 * ((12/9.562) - (12/10.0)) * .913 \\ &= 5.0 \text{ kW}\end{aligned}$$

**NATURAL GAS ENERGY SAVINGS**

N/A

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**REFERENCE TABLES**

Baseline Efficiency Values by Chiller Type and Capacity<sup>247</sup>

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247 International Energy Conservation Code (IECC)2009

TABLE 503.2.3(7)  
WATER CHILLING PACKAGES, EFFICIENCY REQUIREMENTS\*

EQUIPMENT TYPE	SIZE CATEGORY	UNITS	BEFORE 1/1/2010		AS OF 1/1/2010 <sup>e</sup>				TEST PROCEDURE <sup>b</sup>
			FULL LOAD	IPLV	PATH A		PATH B		
					FULL LOAD	IPLV	FULL LOAD	IPLV	
Air-cooled chillers	< 150 tons	EER	≥ 9.562	≥ 10.416	≥ 9.562	≥ 12.500	NA <sup>d</sup>	NA <sup>d</sup>	AHRI 550/590
	≥ 150 tons	EER			≥ 9.562	≥ 12.750	NA <sup>d</sup>	NA <sup>d</sup>	
Air cooled without condenser, electrical operated	All capacities	EER	≥ 10.586	≥ 11.782	Air-cooled chillers without condensers must be rated with matching condensers and comply with the air-cooled chiller efficiency requirements				
Water cooled, electrically operated, reciprocating	All capacities	kW/ton	≤ 0.837	≤ 0.696	Reciprocating units must comply with water cooled positive displacement efficiency requirements				
Water cooled, electrically operated, positive displacement	< 75 tons	kW/ton	≤ 0.790	≤ 0.676	≤ 0.780	≤ 0.630	≤ 0.800	≤ 0.600	
	≥ 75 tons and < 150 tons	kW/ton			≤ 0.775	≤ 0.615	≤ 0.790	≤ 0.586	
	≥ 150 tons and < 300 tons	kW/ton	≤ 0.717	≤ 0.627	≤ 0.680	≤ 0.580	≤ 0.718	≤ 0.540	
	≥ 300 tons	kW/ton	≤ 0.639	≤ 0.571	≤ 0.620	≤ 0.540	≤ 0.639	≤ 0.490	
Water cooled, electrically operated, centrifugal	< 150 tons	kW/ton	≤ 0.703	≤ 0.669	≤ 0.634	≤ 0.596	≤ 0.639	≤ 0.450	
	≥ 150 tons and < 300 tons	kW/ton	≤ 0.634	≤ 0.596					
	≥ 300 tons and < 600 tons	kW/ton	≤ 0.576	≤ 0.549	≤ 0.576	≤ 0.549	≤ 0.600	≤ 0.400	
	≥ 600 tons	kW/ton	≤ 0.576	≤ 0.549	≤ 0.570	≤ 0.539	≤ 0.590	≤ 0.400	
Air cooled, absorption single effect	All capacities	COP	≥ 0.600	NR <sup>e</sup>	≥ 0.600	NR <sup>e</sup>	NA <sup>d</sup>	NA <sup>d</sup>	AHRI 560
Water-cooled, absorption single effect	All capacities	COP	≥ 0.700	NR <sup>e</sup>	≥ 0.700	NR <sup>e</sup>	NA <sup>d</sup>	NA <sup>d</sup>	
Absorption double effect, indirect-fired	All capacities	COP	≥ 1.000	≥ 1.050	≥ 1.000	≥ 1.050	NA <sup>d</sup>	NA <sup>d</sup>	
Absorption double effect, direct fired	All capacities	COP	≥ 1.000	≥ 1.000	≥ 1.000	≥ 1.000	NA <sup>d</sup>	NA <sup>d</sup>	

For SI: 1 ton = 3517 W, 1 British thermal unit per hour = 0.2931 W

- a. The chiller equipment requirements do not apply for chillers used in low-temperature applications where the design leaving fluid temperature is < 40°F.
- b. Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
- c. Compliance with this standard can be obtained by meeting the minimum requirements of Path A or B. However, both the full load and IPLV must be met to fulfill the requirements of Path A or B.
- d. NA means that this requirement is not applicable and cannot be used for compliance.
- e. NR means that there are no minimum requirements for this category.

MEASURE CODE: CI-HVC-CHIL-V01-120601

4.4.7 ENERGY STAR and CEE Tier 1 Room Air Conditioner

DESCRIPTION

This measure relates to the purchase and installation of a room air conditioning unit that meets either the ENERGY STAR or CEE TIER 1 minimum qualifying efficiency specifications, in place of a baseline unit meeting minimum Federal Standard efficiency ratings presented below.<sup>248</sup>

Product Class (Btu/H)	Federal Standard EER, with louvered sides	Federal Standard EER, without louvered sides	ENERGY STAR EER, with louvered sides	ENERGY STAR EER, without louvered sides	CEE TIER 1 EER
< 8,000	9.7	9	10.7	9.9	11.2
8,000 to 13,999	9.8	8.5	10.8	9.4	11.3
14,000 to 19,999	9.7	8.5	10.7	9.4	11.2
>= 20,000	8.5	8.5	9.4	9.4	9.8

Casement	Federal Standard (EER)	ENERGY STAR (EER)
Casement-only	8.7	9.6
Casement-slider	9.5	10.5

Reverse Cycle - Product Class (Btu/H)	Federal Standard EER, with louvered sides	Federal Standard EER, without louvered sides	ENERGY STAR EER, with louvered sides	ENERGY STAR EER, without louvered sides
< 14,000	N/A	8.5	N/A	9.4
>= 14,000	N/A	8	N/A	8.8
< 20,000	9	N/A	9.9	N/A
>= 20,000	8.5	N/A	9.4	N/A

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.

<sup>248</sup>[http://www.energystar.gov/index.cfm?c=roomac.pr\\_crit\\_room\\_ac](http://www.energystar.gov/index.cfm?c=roomac.pr_crit_room_ac) and [http://www.cee1.org/resid/seha/rm-ac/rm-ac\\_specs.pdf](http://www.cee1.org/resid/seha/rm-ac/rm-ac_specs.pdf)

Side louvers that extend from a room air conditioner model in order to position the unit in a window. A model without louvered sides is placed in a built-in wall sleeve and are commonly referred to as "through-the-wall" or "built-in" models.

Casement-only refers to a room air conditioner designed for mounting in a casement window of a specific size. Casement-slider refers to a room air conditioner with an encased assembly designed for mounting in a sliding or casement window of a specific size.

Reverse cycle refers to the heating function found in certain room air conditioner models.

[http://www.energystar.gov/ia/partners/product\\_specs/program\\_reqs/room\\_air\\_conditioners\\_prog\\_req.pdf](http://www.energystar.gov/ia/partners/product_specs/program_reqs/room_air_conditioners_prog_req.pdf)

**DEFINITION OF EFFICIENT EQUIPMENT**

To qualify for this measure the new room air conditioning unit must meet the ENERGY STAR efficiency standards presented above.

**DEFINITION OF BASELINE EQUIPMENT**

The baseline assumption is a new room air conditioning unit that meets the current minimum federal efficiency standards presented above.

**DEEMED LIFETIME OF EFFICIENT EQUIPMENT**

The measure life is assumed to be 9 years.<sup>249</sup>

**DEEMED MEASURE COST**

The incremental cost for this measure is assumed to be \$40 for an ENERGY STAR unit and \$80 for a CEE TIER 1 unit.<sup>250</sup>

**DEEMED O&M COST ADJUSTMENTS**

N/A

**LOADSHAPE**

Loadshape C03 - Commercial Cooling

**COINCIDENCE FACTOR**

The summer peak coincidence factor for cooling is provided in two different ways below. The first is used to estimate peak savings during the utility peak hour and is most indicative of actual peak benefits, and the second represents the *average* savings over the defined summer peak period, and is presented so that savings can be bid into PJM's Forward Capacity Market. Both values provided are based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren.

$$\begin{aligned} CF_{SSP} &= \text{Summer System Peak Coincidence Factor for Commercial cooling (during system peak hour)} \\ &= 91.3\% \text{ }^{251} \end{aligned}$$

$$\begin{aligned} CF_{PJM} &= \text{PJM Summer Peak Coincidence Factor for Commercial cooling (average during peak period)} \\ &= 47.8\% \text{ }^{252} \end{aligned}$$

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<sup>249</sup> Energy Star Room Air Conditioner Savings Calculator,  
[http://www.energystar.gov/index.cfm?fuseaction=find\\_a\\_product.showProductGroup&pgw\\_code=AC](http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=AC)  
[http://neep.org/uploads/EMV%20Forum/EMV%20Studies/measure\\_life\\_GDS%5B1%5D.pdf](http://neep.org/uploads/EMV%20Forum/EMV%20Studies/measure_life_GDS%5B1%5D.pdf)

<sup>250</sup> Based on field study conducted by Efficiency Vermont

<sup>251</sup> Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The AC load during the utility's peak hour is divided by the maximum AC load during the year.

<sup>252</sup> Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The average AC load over the PJM peak period (1-5pm, M-F, June through August) is divided by the maximum AC load during

**Algorithm**

**CALCULATION OF SAVINGS**

**ENERGY SAVINGS**

$$\Delta kWh = (FLH_{RoomAC} * Btu/H * (1/EERbase - 1/EERee))/1000$$

Where:

FLH<sub>RoomAC</sub> = Full Load Hours of room air conditioning unit  
 = dependent on location:<sup>253</sup>

Zone	FLH <sub>RoomAC</sub>
1 (Rockford)	253
2-(Chicago)	254
3 (Springfield)	310
4-(Belleville)	391
5-(Marion)	254

Btu/H = Size of unit  
 = Actual. If unknown assume 8500 BTU/hour<sup>254</sup>

EERbase = Efficiency of baseline unit  
 = As provided in tables above

EERee = Efficiency of ENERGY STAR or CEE Tier 1 unit  
 = Actual. If unknown assume minimum qualifying standard as provided in tables above

For example for an 8,500 BTU/H capacity ENERGY STAR unit, with louvered sides, in Rockford:

$$\Delta kWh_{ENERGY STAR} = (253 * 8500 * (1/9.8 - 1/10.8)) / 1000$$

= 20.3 kWh

the year

<sup>253</sup> Full load hours for room AC is significantly lower than for central AC. The average ratio of FLH for Room AC (provided in RLW Report: Final Report Coincidence Factor Study Residential Room Air Conditioners, June 23, 2008: [http://www.puc.nh.gov/Electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/117\\_RLW\\_CF%20Res%20RAC.pdf](http://www.puc.nh.gov/Electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/117_RLW_CF%20Res%20RAC.pdf)) to FLH for Central Cooling for the same location (provided by AHRI: [http://www.energystar.gov/ia/business/bulk\\_purchasing/bpsavings\\_calc/Calc\\_CAC.xls](http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls)) is 31%. This ratio has been applied to the FLH from the unitary and split system air conditioning measure.

<sup>254</sup> Based on maximum capacity average from the RLW Report: Final Report Coincidence Factor Study Residential Room Air Conditioners, June 23, 2008

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

$$\Delta kW = \text{Btu/H} * ((1/\text{EER}_{\text{base}} - 1/\text{EER}_{\text{ee}}))/1000 * \text{CF}$$

Where:

$\text{CF}_{\text{SSP}}$  = Summer System Peak Coincidence Factor for Commercial cooling (during system peak hour)  
= 91.3%<sup>255</sup>

$\text{CF}_{\text{PJM}}$  = PJM Summer Peak Coincidence Factor for Commercial cooling (average during peak period)  
= 47.8%<sup>256</sup>

Other variable as defined above

For example for an 8,500 BTU/H capacity ENERGY STAR unit, with louvered sides, in Rockford during system peak

$$\begin{aligned} \Delta kW_{\text{ENERGY STAR}} &= (8500 * (1/9.8 - 1/10.8)) / 1000 * 0.913 \\ &= 0.073 \text{ kW} \end{aligned}$$

**FOSSIL FUEL SAVINGS**

N/A

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-HVC-ESRA-V01-120601**

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<sup>255</sup>Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The AC load during the utility's peak hour is divided by the maximum AC load during the year.

<sup>256</sup>Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The average AC load over the PJM peak period (1-5pm, M-F, June through August) is divided by the maximum AC load during the year

## 4.4.8 Guest Room Energy Management (PTAC & PTHP)

### DESCRIPTION

This measure applied to the installation of a temperature setback and lighting control system for individual guest rooms. The savings are achieved based on Guest Room Energy Management's (GREM's) ability to automatically adjust the guest room's set temperatures and control the HVAC unit for various occupancy modes.

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

### DEFINITION OF EFFICIENT EQUIPMENT

Guest room temperature set point must be controlled by automatic occupancy detectors or keycard that indicates the occupancy status of the room. During unoccupied periods the default setting for controlled units differs by at least 5 degrees from the operating set point. Theoretically, the control system may also be tied into other electric loads, such as lighting and plug loads to shut them off when occupancy is not sensed. This measure bases savings on improved HVAC controls. If system is connected to lighting and plug loads, additional savings would be realized. The incentive is per guestroom controlled, rather than per sensor, for multi-room suites. Replacement or upgrades of existing occupancy-based controls are not eligible for an incentive.

### DEFINITION OF BASELINE EQUIPMENT

Manual Heating/Cooling Temperature Setpoint and Fan On/Off/Auto Thermostat

### DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The measure life for GREM is 15 years<sup>257</sup>.

### DEEMED MEASURE COST

\$260/unit

The IMC documented for this measure is \$260 per room HVAC controller, which is the cost difference between a non-programmable thermostat and a GREM<sup>258</sup>.

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

Loadshape C03 - Commercial Cooling

### COINCIDENCE FACTOR<sup>259</sup>

The coincidence factor for this measure is 0.67

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<sup>257</sup> DEER 2008 value for energy management systems

<sup>258</sup> This value was extracted from Smart Ideas projects in PY1 and PY2.

<sup>259</sup> KEMA

**Algorithm**

**CALCULATION OF SAVINGS**

Below are the annual kWh savings per installed EMS for different sizes and types of HVAC units. The savings are achieved based on GREM’s ability to automatically adjust the guest room’s set temperatures and control the HVAC unit to maintain set temperatures for various occupancy modes. These values are from the Michigan savings database using Michigan’s 574 annual CDD and 6,676 annual HDD, which are conservative when compared to 857 CDD and 6,418 HDD in Zon2 1 (Chicago).

**ELECTRIC ENERGY SAVINGS**

**Measure Savings for GREM**

Cooling Type	Cooling kWh		Heating (kWh & Therms)		Total kWh	
	3/4 ton	1 ton	3/4 ton	1 ton	3/4 ton	1 ton
PTAC	208	287	1,234 kWh	1,645 kWh	1,441	1,932
PTHP	181	263	721 kWh	988 kWh	902	1,251
FCU with Gas Heat/Elec Cool	407	542	53 Therms	70 Therms	407	542

On average, the annual kWh saving for a 0.75 ton and 1 ton HVAC unit with electric cooling and electric heating is 1,117 kWh per room. For non-electric heating, it is assumed the savings are approximately one third at 334 kWh per room. The average between 0.75 and 1 tons is used for a conservative estimate. However, it is assumed that most PTAC units in hotel rooms are sized to 1 ton.

**Measure Savings Analysis**

Savings estimate shall be verified using an eQuest model. The Michigan work paper assumes a 30% savings with the GREM. The model outputs will be validated by actual monitored projects, as they become available. Once the model is calibrated, its outputs will be used to update the work paper. The inputs for simulating average occupancy and setback temperatures are as follows (90% occupancy rate is assumed):

**Base case:** 72°F all the time

**Proposed case:**

Cooling Type	Cooling, °F		Heating, °F	
	Occupied Rooms	Unoccupied Rooms	Occupied Rooms	Unoccupied Rooms
6pm-11pm	72	85	72	65
11pm- 7am	78	85	65	65
7am- 9am	72	85	72	65
9am- 6pm	78	85	65	65

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

The coincident kW impacts for this measure have not been sufficiently studied or modeled to provide a confident estimate. In the meantime the following kW impacts are estimated for systems that control cooling operation.

kW Savings per ton = (12/HVAC EER) x average on peak uncontrolled load factor of 50% (estimated from anecdotal observations by KEMA for NV Energy) x estimated cycling reduction of 30% (estimated by KEMA from empirical observations and logging from manufacturers for NV Energy)

$$kW = (12/8.344) \times 0.5 \times 0.3 = 1.25 \text{ kW per ton or room}$$

where,

HVAC EER = is based on a 1 ton unit at code baseline efficiency of PTAC,

$$\text{defined as } EER = 10.9 - (0.213 \times 12000 \text{ btu/hr}/1000) = 8.344$$

In addition, a coincident factor for cooling needs to be included to consider that not all room PTAC units are operating at the same. It is estimated as 0.67 (Ref: Pennsylvania Technical Resource Manual (12/23/09 version) for HVAC Measures, Table 6.17 p 55) This factor will be used pending further study.

$$\text{Coincident kW Savings} = 1.25 \times 0.67 = 0.84 \text{ kW per unit-ton or per room}$$

**NATURAL GAS ENERGY SAVINGS**

Heating	Heating (Therms)	
	3/4 ton	1 ton
FCU with Gas Heat/Elec Cool	53 Therms	70 Therms

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-HVC-GREM-V01-120601**

## 4.4.9 Heat Pump Systems

### DESCRIPTION

This measure applies to the installation of high-efficiency air cooled, water source, ground water source, and ground source heat pump systems. This measure could apply to replacing an existing unit at the end of its useful life, or installation of a new unit in a new or existing building

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

### DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to be a high-efficiency air cooled, water source, ground water source, or ground source heat pump system that exceeds the energy efficiency requirements of the International Energy Conservation Code (IECC) 2006, Table 503.2.3(2).

### DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline equipment is assumed to be a standard-efficiency air cooled, water source, ground water source, or ground source heat pump system that meets the energy efficiency requirements of the International Energy Conservation Code (IECC) 2006, Table 503.2.3(2). The rating conditions for the baseline and efficient equipment efficiencies must be equivalent

### DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 15 years.<sup>260</sup>

### DEEMED MEASURE COST

For analysis purposes, the incremental capital cost for this measure is assumed as \$100 per ton for air-cooled units.<sup>261</sup> The incremental cost for all other equipment types should be determined on a site-specific basis

### DEEMED O&M COST ADJUSTMENTS

N/A

### LOADSHAPE

Loadshape C05 - Commercial Electric Heating and Cooling

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<sup>260</sup> Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, Inc., June 2007.

<sup>261</sup> Based on a review of TRM incremental cost assumptions from Vermont, Wisconsin, and California.

**COINCIDENCE FACTOR**

The summer peak coincidence factor for cooling is provided in two different ways below. The first is used to estimate peak savings during the utility peak hour and is most indicative of actual peak benefits, and the second represents the *average* savings over the defined summer peak period, and is presented so that savings can be bid into PJM’s Forward Capacity Market. Both values provided are based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren.

$$CF_{SSP} = \text{Summer System Peak Coincidence Factor for Commercial cooling (during system peak hour)}$$

$$= 91.3\%^{262}$$

$$CF_{PJM} = \text{PJM Summer Peak Coincidence Factor for Commercial cooling (average during peak period)}$$

$$= 47.8\%^{263}$$

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS**

For units with cooling capacities less than 65 kBtu/h:

$$\Delta kWh = \text{Annual kWh Savings}_{cool} + \text{Annual kWh Savings}_{heat}$$

$$\text{Annual kWh Savings}_{cool} = (kBtu/h_{cool}) * [(1/SEERbase) - (1/SEERee)] * EFLH_{cool}$$

$$\text{Annual kWh Savings}_{heat} = (kBtu/h_{cool}) * [(1/HSPFbase) - (1/HSPFee)] * EFLH_{heat}$$

For units with cooling capacities equal to or greater than 65 kBtu/h:

$$\Delta kWh = \text{Annual kWh Savings}_{cool} + \text{Annual kWh Savings}_{heat}$$

$$\text{Annual kWh Savings}_{cool} = (kBtu/h_{cool}) * [(1/EERbase) - (1/EERee)] * EFLH_{cool}$$

$$\text{Annual kWh Savings}_{heat} = (kBtu/h_{heat})/3.412 * [(1/COPbase) - (1/COPee)] * EFLH_{heat}$$

Where:

- kBtu/h<sub>cool</sub> = capacity of the cooling equipment in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/h).
- = Actual installed
- SEERbase = Seasonal Energy Efficiency Ratio of the baseline equipment; see table below for values.  
<sup>264</sup>

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<sup>262</sup> Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The AC load during the utility’s peak hour is divided by the maximum AC load during the year.

<sup>263</sup> Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The average AC load over the PJM peak period (1-5pm, M-F, June through August) is divided by the maximum AC load during the year

<sup>264</sup> International Energy Conservation Code (IECC) 2009

**TABLE 503.2.3(2)  
UNITARY AIR CONDITIONERS AND CONDENSING UNITS, ELECTRICALLY OPERATED, MINIMUM EFFICIENCY REQUIREMENTS**

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY <sup>b</sup>	TEST PROCEDURE <sup>a</sup>
Air cooled, (Cooling mode)	< 65,000 Btu/h <sup>d</sup>	Split system	13.0 SEER	AHRI 210/240
		Single package	13.0 SEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split system and single package	10.1 EER <sup>c</sup> (before Jan 1, 2010) 11.0 EER <sup>c</sup> (as of Jan 1, 2010)	AHRI 340/360
		Split system and single package	9.3 EER <sup>c</sup> (before Jan 1, 2010) 10.6 EER <sup>c</sup> (as of Jan 1, 2010)	
≥ 135,000 Btu/h and < 240,000 Btu/h	Split system and single package	9.0 EER <sup>c</sup> 9.2 IPLV <sup>e</sup> (before Jan 1, 2010) 9.5 EER <sup>c</sup> 9.2 IPLV <sup>e</sup> (as of Jan 1, 2010)	AHRI 340/360	
	Split system and single package	9.0 EER <sup>c</sup> 9.2 IPLV <sup>e</sup> (before Jan 1, 2010) 9.5 EER <sup>c</sup> 9.2 IPLV <sup>e</sup> (as of Jan 1, 2010)		
Through-the-Wall (Air cooled, cooling mode)	< 30,000 Btu/h <sup>d</sup>	Split system	10.9 SEER (before Jan 23, 2010) 12.0 SEER (as of Jan 23, 2010)	AHRI 210/240
		Single package	10.6 SEER (before Jan 23, 2010) 12.0 SEER (as of Jan 23, 2010)	
Water Source (Cooling mode)	< 17,000 Btu/h	86°F entering water	11.2 EER	AHRI/ASHRAE 13256-1
	≥ 17,000 Btu/h and < 135,000 Btu/h	86°F entering water	12.0 EER	AHRI/ASHRAE 13256-1
Groundwater Source (Cooling mode)	< 135,000 Btu/h	59°F entering water	16.2 EER	AHRI/ASHRAE 13256-1
Ground source (Cooling mode)	< 135,000 Btu/h	77°F entering water	13.4 EER	AHRI/ASHRAE 13256-1
Air cooled (Heating mode)	< 65,000 Btu/h <sup>d</sup> (Cooling capacity)	Split system	7.7 HSPF	AHRI 210/240
		Single package	7.7 HSPF	
	≥ 65,000 Btu/h and < 135,000 Btu/h (Cooling capacity)	47°F db/43°F wb Outdoor air	3.2 COP (before Jan 1, 2010) 3.3 COP (as of Jan 1, 2010)	AHRI 210/240
≥ 135,000 Btu/h (Cooling capacity)	47°F db/43°F wb Outdoor air	3.1 COP (before Jan 1, 2010) 3.2 COP (as of Jan 1, 2010)	AHRI 340/360	

TABLE 503.2.3(2)—continued  
 UNITARY AIR CONDITIONERS AND CONDENSING UNITS, ELECTRICALLY OPERATED, MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY <sup>b</sup>	TEST PROCEDURE <sup>a</sup>
Through-the-wall (Air cooled, heating mode)	< 30,000 Btu/h	Split System	7.1 HSPE (before Jan 23, 2010) 7.4 HSPF (as of Jan 23, 2010)	AHRI 210/240
		Single package	7.0 HSPF (before Jan 23, 2010) 7.4 HSPF (as of Jan 23, 2010)	
Water source (Heating mode)	< 135,000 Btu/h (Cooling capacity)	68°F entering water	4.2 COP	AHRI/ASHRAE 13256-1
Groundwater source (Heating mode)	< 135,000 Btu/h (Cooling capacity)	50°F entering water	3.6 COP	AHRI/ASHRAE 13256-1
Ground source (Heating mode)	< 135,000 Btu/h (Cooling capacity)	32°F entering water	3.1 COP	AHRI/ASHRAE 13256-1

For SI: °C = (°F - 32)/1.8, 1 British thermal unit per hour = 0.2931 W.

db = dry-bulb temperature, °F; wb = wet-bulb temperature, °F.

a. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

b. IPLVs and Part load rating conditions are only applicable to equipment with capacity modulation.

c. Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

d. Single-phase air-cooled heat pumps < 65,000 Btu/h are regulated by the National Appliance Energy Conservation Act of 1987 (NAECA). SEER and HSPF values are those set by NAECA.

SEER<sub>ee</sub> = Seasonal Energy Efficiency Ratio of the energy efficient equipment.

= Actual installed

EFLH<sub>cool</sub> = cooling mode equivalent full load hours; see table below for default values:

Zone	Equivalent Full Load Hours Cooling (EFLH) <sup>265</sup>	Equivalent Full Load heating Cooling (EFLH)
1 (Rockford)	816	1153
2 (Chicago)	819	1069
3 (Springfield)	1001	885
4 (Belleville)	1261	621
5 (Marion)	819	623

HSPF<sub>base</sub> = Heating Seasonal Performance Factor of the baseline equipment; see table above for values.

HSPF<sub>ee</sub> = Heating Seasonal Performance Factor of the energy efficient equipment.

= Actual installed

<sup>265</sup> Heating and cooling EFLH data based on a series of prototypical small commercial building simulation runs for the Ohio TRM. Values shown are weighted averages across fast food restaurant, full service restaurant, assembly, big box retail, small retail, small office, light industrial and school building models. The prototypes are based on the California DEER study prototypes, modified for local construction practices. Simulations were run using TMY3 weather data for each of the cities listed. Building prototypes used in the energy modeling are described in Appendix A - Prototypical Building Energy Simulation Model Development. The Ohio values were adjusted base on CCD and HDD for IL locations. Further study recommended for IL specific building types.

- EFLH<sub>heat</sub> = heating mode equivalent full load hours; see table above for default values.
- EERbase = Energy Efficiency Ratio of the baseline equipment; see the table above for values. Since IECC 2006 does not provide EER requirements for air-cooled heat pumps < 65 kBtu/h, assume the following conversion from SEER to EER: EER≈SEER/1.1.
- EERee = Energy Efficiency Ratio of the energy efficient equipment. For air-cooled air conditioners < 65 kBtu/h, if the actual EERee is unknown, assume the following conversion from SEER to EER: EER≈SEER/1.1.
- = Actual installed
- kBtu/h<sub>heat</sub> = capacity of the heating equipment in kBtu per hour.
- = Actual installed
- 3.412 = Btu per Wh.
- COPbase = coefficient of performance of the baseline equipment; see table above for values.
- COPee = coefficient of performance of the energy efficient equipment.
- = Actual installed

$$\text{Annual kWh Savings}_{\text{cool}} = (\text{kBtu}/\text{h}_{\text{cool}}) * [(1/\text{SEER}_{\text{base}}) - (1/\text{SEER}_{\text{ee}})] * \text{EFLH}_{\text{cool}}$$

$$\text{Annual kWh Savings}_{\text{heat}} = (\text{kBtu}/\text{h}_{\text{heat}}) * [(1/\text{HSPF}_{\text{base}}) - (1/\text{HSPF}_{\text{ee}})] * \text{EFLH}_{\text{heat}}$$

For example a 5 ton cooling unit with 60 kbtu heating with an efficient EER of 14 and an efficient HSPF of 9 saves

$$= [(60) * [(1/13) - (1/14)] * 816] + [(60)/3.412 * [(1/7.7) - (1/9)] * 1153]$$

$$= 649 \text{ kWh}$$

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

$$\Delta \text{kW} = (\text{kBtu}/\text{h}_{\text{cool}}) * [(1/\text{EER}_{\text{base}}) - (1/\text{EER}_{\text{ee}})] * \text{CF}$$

Where CF value is chosen between:

CF<sub>SSP</sub> = Summer System Peak Coincidence Factor for Commercial cooling (during system peak hour)

$$= 91.3\%^{266}$$

CF<sub>PJM</sub> = PJM Summer Peak Coincidence Factor for Commercial cooling (average during peak period)

<sup>266</sup>Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The AC load during the utility's peak hour is divided by the maximum AC load during the year.

$$= 47.8\%^{267}$$

For example a 5 ton cooling unit with 60 kbtu heating with an efficient EER of 14 and an efficient HSPF of 9 saves

$$\begin{aligned}\Delta kW &= [(60) * [(1/13) - (1/14)]] *.913 \\ &= 0.3\end{aligned}$$

**NATURAL GAS ENERGY SAVINGS**

N/A

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-HVC-HPSY-V01-120601**

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<sup>267</sup>Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The average AC load over the PJM peak period (1-5pm, M-F, June through August) is divided by the maximum AC load during the year

#### 4.4.10 High Efficiency Boiler<sup>268</sup>

**DESCRIPTION**

To qualify for this measure the installed equipment must be replacement of an existing boiler at the end of its service life, in a commercial or multifamily space with a high efficiency, gas-fired steam or hot water boiler. High efficiency boilers achieve gas savings through the utilization of a sealed combustion chamber and multiple heat exchangers that remove a significant portion of the waste heat from flue gasses. Because multiple heat exchangers are used to remove waste heat from the escaping flue gasses, some of the flue gasses condense and must be drained.

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**

To qualify for this measure the installed equipment must be a boiler used 80% or more for space heating, not process, and boiler AFUE, TE (thermal efficiency), or Ec (combustion efficiency) rating must be rated greater than or equal to 85% for hot water boilers and 81% for steam boilers.

**DEFINITION OF BASELINE EQUIPMENT**

Dependent on when the unit is installed and whether the unit is hot water or steam. The baseline efficiency source is the Energy Independence and Security Act of 2007 with technical amendments from Federal Register, volume 73, Number 145, Monday, July 28, 2008 for boilers <300,000 Btu/h and is Final Rule, Federal Register, volume 74, Number 139, Wednesday, July 22, 2009 for boiler ≥300,000 Btu/h.

Hot water boiler baseline:

Year	Efficiency
Hot Water <300,000 Btu/h < June 1, 2013 <sup>269</sup>	80% AFUE
Hot Water <300,000 Btu/h ≥ June 1, 2013	82% AFUE
Hot Water ≥300,000 & ≤2,500,000 Btu/h	80% TE
Hot Water >2,500,000 Btu/h	82% Ec

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<sup>268</sup> High Impact Measure

<sup>269</sup> The Federal baseline for boilers <300,000 btu/hr changes from 80% to 82% in September 2012. To prevent a change in baseline mid-program, the increase in efficiency is delayed until June 2013 when a new program year starts.

Steam boiler baseline:

Year	Efficiency
Steam <300,000 Btu/h < June 1, 2013 <sup>270</sup>	75% AFUE
Steam <300,000 Btu/h ≥ June 1, 2013	80% AFUE
Steam - all except natural draft ≥300,000 & ≤2,500,000 Btu/h	79% TE
Steam - natural draft ≥300,000 & ≤2,500,000 Btu/h	77% TE
Steam - all except natural draft >2,500,000 Btu/h	79% TE
Steam - natural draft >2,500,000 Btu/h	77% TE

**DEEMED LIFETIME OF EFFICIENT EQUIPMENT**

The expected measure life is assumed to be 20 years<sup>271</sup>

**DEEMED MEASURE COST**

The incremental capital cost for this measure depends on efficiency as listed below<sup>272</sup>

Measure Tier	Incr. Cost, per unit
ENERGY STAR® Minimum	\$1,470
AFUE 90%	\$2,400
AFUE 95%	\$3,370
AFUE ≥ 96%	\$4,340
Boilers > 300,000 Btu/h with TE (thermal efficiency) rating	Custom

**DEEMED O&M COST ADJUSTMENTS**

N/A

**LOADSHAPE**

N/A

<sup>270</sup> Ibid.

<sup>271</sup> The Technical support documents for federal residential appliance standards: [http://www1.eere.energy.gov/buildings/appliance\\_standards/residential/pdfs/fb\\_fr\\_tsd/appendix\\_e.pdf](http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/fb_fr_tsd/appendix_e.pdf) Note that this value is below the 20 years used by CA's DEER and the range of 20-40 year estimate made by the Consortium for Energy Efficiency in 2010

<sup>272</sup> Average of low and high incremental cost based on Nicor Gas program data for non-condensing and condensing boilers. Nicor Gas Energy Efficiency Plan 2011 - 2014, May 27, 2011 \$1,470 for ≤ 300,000 Btu/hr for non-condensing hydronic boilers >85% AFUE & \$3,365 for condensing boilers > 90% AFUE. The exception is \$4,340 for AFUE ≥ 96% AFUE which was obtained from extrapolation above the size range that Nicor Gas Energy Efficiency Plan provided for incremental cost.

**COINCIDENCE FACTOR**

N/A

**Algorithm**

**CALCULATION OF ENERGY SAVINGS**

**ELECTRIC ENERGY SAVINGS**

N/A

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

N/A

**NATURAL GAS ENERGY SAVINGS**

$$\Delta \text{Therms} = \text{EFLH} * \text{Capacity} * (1/\text{EfficiencyRating}(\text{base})) - (1/\text{EfficiencyRating}(\text{actual})) / 100,000$$

Where:

$$\text{EFH} = \text{Equivalent Full Load Hours for heating}^{273} \text{ (hr)}$$

Building Type	EFLH				
	Zone 1 (Rockford)	Zone 2 (Chicago)	Zone 3 (Springfield)	Zone 4 (Belleville/)	Zone 5 (Marion)
Office - High Rise	2,746	2,768	2,656	2,155	2,420
Office - Mid Rise	996	879	824	519	544
Office - Low Rise	797	666	647	343	329
Convenience	696	550	585	272	297
Healthcare Clinic	1,118	1,036	1,029	694	737
Manufacturing Facility	1,116	1,123	904	771	857
Lodging Hotel/ Motel/ Multifamily	2,098	2,050	1,780	1,365	1,666
High School	969	807	999	569	674
Hospital	2,031	1,929	1,863	1,497	1,800
Elementary	970	840	927	524	637
Religious Facility	1,830	1,657	1,730	1,276	1,484
Restaurant	1,496	1,379	1,291	872	1,185
Retail - Strip Mall	1,266	1,147	1,151	732	863
Retail - Department Store	1,065	927	900	578	646
College/University	373	404	376	187	187
Warehouse	416	443	427	226	232
Unknown	1,249	1,163	1,130	786	910

<sup>273</sup> Equivalent full load hours for heating were developed using eQuest models for various building types averaged across each climate zones for Illinois for the following building types: office, healthcare/clinic, manufacturing, lodging, high school, hospital, elementary school, religious/assembly, restaurant, retail, college and warehouse. eQuest models were those developed for IL lighting interactive effects.

Capacity = Nominal Heating Capacity Boiler Size (btuh)

= custom Boiler input capacity in Btu/hr

EfficiencyRating(base) = Baseline Boiler Efficiency Rating, dependant on year and boiler type. Baseline efficiency values by boiler type and capacity are found in the Definition of Baseline Equipment Section

EfficiencyRating(actual) = Efficient Boiler Efficiency Rating use actual value

Measure Type	Actual AFUE
ENERGY STAR® Minimum	85%
AFUE 90%	90%
AFUE 95%	95%
AFUE ≥ 96%	≥ 96%
Custom	Value to one significant digit i.e. 95.7%

**EXAMPLE**

For example, a 150,000 btu/hr water boiler meeting AFUE 90% in Rockford at a high rise office building , in the year 2012

$$\Delta\text{Therms} = 2,746 * 150,000 * (1/.80 - 1/.90) / 100,000 \text{ Btu/Therm}$$

$$= 572 \text{ Therms}$$

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-HVC-BOIL-V03-130601**

#### 4.4.11 High Efficiency Furnace<sup>274</sup>

##### DESCRIPTION

This measure covers the installation of a high efficiency gas furnace in lieu of a standard efficiency gas furnace in a commercial or industrial space. High efficiency gas furnaces achieve savings through the utilization of a sealed, super insulated combustion chamber, more efficient burners, and multiple heat exchangers that remove a significant portion of the waste heat from the flue gasses. Because multiple heat exchangers are used to remove waste heat from the escaping flue gasses, most of the flue gasses condense and must be drained. Furnaces equipped with ECM fan motors can save additional electric energy

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

Time of sale:

- a. The installation of a new high efficiency, gas-fired condensing furnace in a commercial location. This could relate to the replacement of an existing unit at the end of its useful life, or the installation of a new system.

Early replacement:

- a. The early removal of an existing functioning AFUE 75% or less furnace from service, prior to its natural end of life, and replacement with a new high efficiency unit. Savings are calculated between existing unit and efficient unit consumption during the remaining life of the existing unit, and between new baseline unit and efficient unit consumption for the remainder of the measure life. At time of writing, the DOE had rescinded the next Federal Standard change for furnaces, however it is likely that a new standard will be in effect after the assumed remaining useful life of the existing unit. For the purposes of this measure- the new baseline is assumed to be 90%.
- b. The assumption of the existing unit efficiency in the Early Replacement section of this TRM is based upon the average efficiency of units that were classified in Ameren's PY3-PY4 as functioning and AFUE  $\leq 75\%$ . Therefore it is only appropriate to use these Early Replacement assumptions where those conditions are met. The TAC defined "functioning" as the unit is fully operational – providing sufficient space conditioning (i.e. heat exchanger, compressors, pumps work effectively) and/or the cost of repair is under 20% of the new baseline replacement cost. Therefore in order to apply early replacement assumptions the programs should apply the following eligibility criteria: AFUE  $\leq 75\%$  and cost of any repairs  $< \$528$ .

##### DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure the installed equipment must be a furnace with input energy less than 225,000 BTU/h rated natural gas fired furnace with an Annual Fuel Utilization Efficiency (AFUE) rating and fan electrical efficiency exceeding the program requirements:

##### DEFINITION OF BASELINE EQUIPMENT

Time of Sale: Although the current Federal Standard for gas furnaces is an AFUE rating of 78%, based upon review of available product in the AHRI database, the baseline efficiency for this characterization is assumed to be 80%.

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<sup>274</sup> High Impact Measure

The baseline will be adjusted when the Federal Standard is updated.

Early replacement: The baseline for this measure is the efficiency of the existing equipment for the assumed remaining useful life of the unit and a new baseline unit for the remainder of the measure life. As discussed above we estimate that the new baseline unit that could be purchased in the year the existing unit would have needed replacing is 90%

**DEFINITION OF MEASURE LIFE**

The expected measure life is assumed to be 16.5 years<sup>275</sup>

Remaining life of existing equipment is assumed to be 5.5 years<sup>276</sup>.

**DEEMED MEASURE COST**

Time of Sale: The incremental capital cost for this measure depends on efficiency as listed below<sup>277</sup>:

AFUE	Installation Cost	Incremental Install Cost
80%	\$2011	n/a
90%	\$2641	\$630
91%	\$2727	\$716
92%	\$2813	\$802
93%	\$3049	\$1,038
94%	\$3286	\$1,275
95%	\$3522	\$1,511
96%	\$3758	\$1,747

Early Replacement: The full installation cost is provided in the table above. The assumed deferred cost (after 5.5 years) of replacing existing equipment with a new baseline unit is assumed to be \$2641. This cost should be discounted to present value using the utilities discount rate.

**DEEMED O&M COST ADJUSTMENTS**

N/A

**LOADSHAPE**

N/A

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<sup>275</sup> Average of 15-18 year lifetime estimate made by the Consortium for Energy Efficiency in 2010.

<sup>276</sup> Assumed to be one third of effective useful life

<sup>277</sup> Based on data from Appendix E of the Appliance Standards Technical Support Documents including equipment cost and installation labor

([http://www1.eere.energy.gov/buildings/appliance\\_standards/residential/pdfs/fb\\_fr\\_tsd/appendix\\_e.pdf](http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/fb_fr_tsd/appendix_e.pdf)).

Where efficiency ratings are not provided, the values are interpolated from those that are.

**COINCIDENCE FACTOR**

N/A

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS**

$$\Delta kWh = \text{Heating Savings} + \text{Cooling Savings} + \text{Shoulder Season Savings}$$

Where:

$$\begin{aligned} \text{Heating Savings} &= \text{Brushless DC motor or Electronically commutated motor (ECM)} \\ &= 418 \text{ kWh}^{278} \end{aligned}$$

$$\begin{aligned} \text{Cooling Savings} &= \text{Brushless DC motor or electronically commutated motor (ECM)} \\ \text{savings during cooling season} & \end{aligned}$$

$$\text{If air conditioning} = 263 \text{ kWh}$$

$$\text{If no air conditioning} = 175 \text{ kWh}$$

$$\text{If unknown (weighted average)} = 241 \text{ kWh}^{279}$$

$$\begin{aligned} \text{Shoulder Season Savings} &= \text{Brushless DC motor or electronically commutated motor (ECM)} \\ \text{savings during shoulder seasons} & \end{aligned}$$

$$= 51 \text{ kWh}$$

**EXAMPLE**

For example, a blower motor in an office building where air conditioning presence is unknown:

$$\begin{aligned} \Delta kWh &= \text{Heating Savings} + \text{Cooling Savings} + \text{Shoulder Season Savings} \\ &= 418 + 251 + 51 \\ &= 721 \text{ kWh} \end{aligned}$$

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

For units that have evaporator coils and condensing units and are cooling in the summer in addition to heating in the winter the summer coincident peak demand savings should be calculated. If the unit is not equipment with

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<sup>278</sup>To estimate heating, cooling and shoulder season savings for Illinois, VEIC adapted results from a 2009 Focus on Energy study of BPM blower motor savings in Wisconsin. This study included effects of behavior change based on the efficiency of new motor greatly increasing the amount of people that run the fan continuously. The savings from the Wisconsin study were adjusted to account for different run hour assumptions (average values used) for Illinois. See: FOE to IL Blower Savings.xlsx.

<sup>279</sup>The weighted average value is based on assumption that 75% of buildings installing BPM furnace blower motors have Central AC.

coils or condensing units, the summer peak demand savings will not apply.

$$\Delta kW = (\Delta kWh/HOURYear) * CF$$

Where:

HOURYear = Actual hours per year if known, otherwise use hours from Table below for building type.

Building Type	Pumps and fans (h/yr)
College/University	4216
Grocery	5840
Heavy Industry	3585
Hotel/Motel	6872
Light Industry	2465
Medical	6871
Office	1766
Restaurant	4654
Retail/Service	3438
School(K-12)	2203
Warehouse	3222
Average=Miscellaneous	4103

CF =Summer Peak Coincidence Factor for measure is provided below for different building types<sup>280</sup>:

Location	CF
Restaurant	0.80
Office	0.66
School (K-12)	0.22
College/University	0.56
Medical	0.75

**EXAMPLE**

For example, a blower motor in an office building where air conditioning presence is unknown:

$$\Delta kW = (721 kWh/1766) * 0.66 = 0.27 kW$$

**NATURAL GAS ENERGY SAVINGS**

Time of Sale:

<sup>280</sup>Based on DEER 2008 values

$$\Delta\text{Therms} = \text{EFLH} * \text{Capacity} * (1/\text{AFUE}(\text{base}) - 1/\text{AFUE}(\text{eff})) / 100,000 \text{ Btu/Therm}$$

Early replacement<sup>281</sup>:

$\Delta\text{Therms}$  for remaining life of existing unit (1st 5.5 years):

$$\Delta\text{Therms} = \text{EFLH} * \text{Capacity} * (1/\text{AFUE}(\text{exist}) - 1/\text{AFUE}(\text{eff})) / 100,000 \text{ Btu/Therm}$$

$\Delta\text{Therms}$  for remaining measure life (next 11 years):

$$\Delta\text{Therms} = \text{EFLH} * \text{Capacity} * (1/\text{AFUE}(\text{base}) - 1/\text{AFUE}(\text{eff})) / 100,000 \text{ Btu/Therm}$$

Where:

$$\text{EFLH} = \text{Equivalent Full Load Hours for heating}^{282} \text{ (hr)}$$

Building Type	EFLH				
	Zone 1 (Rockford)	Zone 2 (Chicago)	Zone 3 (Springfield)	Zone 4 (Belleville/ St. Louis)	Zone 5 (Marion)
Office - High Rise	2,746	2,768	2,656	2,155	2,420
Office - Mid Rise	996	879	824	519	544
Office - Low Rise	797	666	647	343	329
Convenience	696	550	585	272	297
Healthcare Clinic	1,118	1,036	1,029	694	737
Manufacturing Facility	1,116	1,123	904	771	857
Lodging Hotel/Motel	2,098	2,050	1,780	1,365	1,666
High School	969	807	999	569	674
Hospital	2,031	1,929	1,863	1,497	1,800
Elementary	970	840	927	524	637
Religious Facility	1,830	1,657	1,730	1,276	1,484
Restaurant	1,496	1,379	1,291	872	1,185
Retail - Strip Mall	1,266	1,147	1,151	732	863
Retail - Department Store	1,065	927	900	578	646
College/University	373	404	376	187	187
Warehouse	416	443	427	226	232
Unknown	1,249	1,163	1,130	786	910

<sup>281</sup> 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).

<sup>282</sup> Equivalent full load hours for heating were developed using eQuest models for various building types averaged across each climate zones for Illinois for the following building types: office, healthcare/clinic, manufacturing, lodging, high school, hospital, elementary school, religious/assembly, restaurant, retail, college and warehouse. eQuest models were those developed for IL lighting interactive effects.

Capacity = Nominal Heating Capacity Furnace Size (btuh)

= custom Furnace input capacity in Btu/hr or if unknown 150,000

AFUE(exist)= Existing Furnace Annual Fuel Utilization Efficiency Rating

= Use actual AFUE rating where it is possible to measure or reasonably estimate.

If unknown, assume 64.4 AFUE% .

AFUE(base) = Baseline Furnace Annual Fuel Utilization Efficiency Rating, dependant on year as listed below:

Dependent on program type as listed below<sup>284</sup>:

Program Year	AFUE(base)
Time of Sale	80%
Early Replacement	90%

AFUE(eff) = Efficient Furnace Annual Fuel Utilization Efficiency Rating.

= Actual. If Unknown, assume 95%<sup>285</sup>

**EXAMPLE**

For example, a 150,000 btu/hr 92% efficient furnace at a low rise office building in Rockford, in the year 2012

$$\begin{aligned} \Delta\text{Therms} &= 797 * 150,000 * (1/80\% - 1/92\%) / 100,000 \text{ Btu/Therm} \\ &= 195 \text{ Therms} \end{aligned}$$

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

<sup>283</sup> Average nameplate efficiencies of all Early Replacement qualifying equipment in Ameren PY3-PY4.

<sup>284</sup> Though the Federal Minimum AFUE is 78%, there were only 50 models listed in the AHRI database at that level. At AFUE 79% the total rises to 308. There are 3,548 active furnace models listed with AFUE ratings between 78 and 80.

<sup>285</sup> Minimum ENERGY STAR efficiency after 2.1.2012.

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-HVC-FRNC-V02-130601**

#### 4.4.12 Infrared Heaters (all sizes), Low Intensity

**DESCRIPTION**

This measure applies to natural gas fired low-intensity infrared heaters with an electric ignition that use non-conditioned air for combustion

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

**DEFINITION OF EFFICIENT EQUIPMENT**

To qualify for this measure the installed equipment must be a natural gas heater with an electric ignition that uses non-conditioned air for combustion

**DEFINITION OF BASELINE EQUIPMENT**

The baseline equipment is a standard natural gas fired heater warm air heater.

**DEEMED LIFETIME OF EFFICIENT EQUIPMENT**

The expected measure life is assumed to be 12 years<sup>286</sup>

**DEEMED MEASURE COST**

The incremental capital cost for this measure is \$1716<sup>287</sup>

**DEEMED O&M COST ADJUSTMENTS**

N/A

**LOADSHAPE**

N/A

**COINCIDENCE FACTOR**

N/A

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS**

N/A

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<sup>286</sup>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

<sup>287</sup>Ibid.

**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 451 Therms<sup>288</sup>

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-HVC-IRHT-V01-120601**

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<sup>288</sup>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.

#### 4.4.13 Package Terminal Air Conditioner (PTAC) and Package Terminal Heat Pump (PTHP)

##### DESCRIPTION

A PTAC is a packaged terminal air conditioner that cools and sometimes provides heat through an electric resistance heater (heat strip). A PTHP is a packaged terminal heat pump. A PTHP uses its compressor year round to heat or cool. In warm weather, it efficiently captures heat from inside your building and pumps it outside for cooling. In cool weather, it captures heat from outdoor air and pumps it into your home, adding heat from electric heat strips as necessary to provide heat.

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

##### DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to be PTACs or PTHPs that exceed baseline efficiencies replacing existing equipment at the end of its useful life.

##### DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline conditions must be met as listed in the reference table.

##### DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 15 years.<sup>289</sup>

##### DEEMED MEASURE COST

The incremental capital cost for this equipment is estimated to be \$84/ton.<sup>290</sup>

##### DEEMED O&M COST ADJUSTMENTS

N/A

##### LOADSHAPE

Loadshape C03 - Commercial Cooling

##### COINCIDENCE FACTOR

The summer peak coincidence factor for cooling is provided in two different ways below. The first is used to estimate peak savings during the utility peak hour and is most indicative of actual peak benefits, and the second represents the *average* savings over the defined summer peak period, and is presented so that savings can be bid into PJM's Forward Capacity Market. Both values provided are based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren.

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<sup>289</sup> Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, Inc., June 2007

<sup>290</sup> DEER 2008 This assumes that baseline shift from IECC 2006 to IECC 2012 carries the same incremental costs. Values should be verified during evaluation

$CF_{SSP}$  = Summer System Peak Coincidence Factor for Commercial cooling (during system peak hour)  
 = 91.3%<sup>291</sup>

$CF_{PJM}$  = PJM Summer Peak Coincidence Factor for Commercial cooling (average during peak period)  
 = 47.8%<sup>292</sup>

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS**

Electric savings for PTACs and PTHPs should be calculated using the following algorithms

**ENERGY SAVINGS**

$PTAC \Delta kWh^{293}$  = Annual kWh Savings<sub>cool</sub>

$PTHP \Delta kWh$  = Annual kWh Savings<sub>cool</sub> + Annual kWh Savings<sub>heat</sub>

Annual kWh Savings<sub>cool</sub> = (kBtu/h<sub>cool</sub>) \* [(1/EERbase) – (1/EERee)] \* EFLH<sub>cool</sub>

Annual kWh Savings<sub>heat</sub> = (kBtu/h<sub>heat</sub>)/3.412 \* [(1/COPbase) – (1/COpee)] \* EFLH<sub>heat</sub>

Where:

kBtu/h<sub>cool</sub> = capacity of the cooling equipment in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/h).

= Actual installed

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<sup>291</sup>Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The AC load during the utility’s peak hour is divided by the maximum AC load during the year.

<sup>292</sup>Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The average AC load over the PJM peak period (1-5pm, M-F, June through August) is divided by the maximum AC load during the year

<sup>293</sup> There are no heating efficiency improvements for PTACs since although some do provide heating, it is always through electric resistance and therefore the COPbase and COpee would be 1.0.

**TABLE C403.2.3(3)  
MINIMUM EFFICIENCY REQUIREMENTS:  
ELECTRICALLY OPERATED PACKAGED TERMINAL AIR CONDITIONERS,  
PACKAGED TERMINAL HEAT PUMPS, SINGLE-PACKAGE VERTICAL AIR CONDITIONERS,  
SINGLE VERTICAL HEAT PUMPS, ROOM AIR CONDITIONERS AND ROOM AIR-CONDITIONER HEAT PUMPS**

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST PROCEDURE <sup>a</sup>
			Before 10/08/2012	As of 10/08/2012	
PTAC (cooling mode) new construction	All Capacities	95°F db outdoor air	12.5 - (0.213 × Cap/1000) EER	13.8 - (0.300 × Cap/1000) EER	AHRI 310/380
PTAC (cooling mode) replacements <sup>b</sup>	All Capacities	95°F db outdoor air	10.9 - (0.213 × Cap/1000) EER	10.9 - (0.213 × Cap/1000) EER	
PTHP (cooling mode) new construction	All Capacities	95°F db outdoor air	12.3 - (0.213 × Cap/1000) EER	14.0 - (0.300 × Cap/1000) EER	
PTHP (cooling mode) replacements <sup>b</sup>	All Capacities	95°F db outdoor air	10.8 - (0.213 × Cap/1000) EER	10.8 - (0.213 × Cap/1000) EER	
PTHP (heating mode) new construction	All Capacities	—	3.2 - (0.26 × Cap/1000) COP	3.2 - (0.26 × Cap/1000) COP	
PTHP (heating mode) replacements <sup>b</sup>	All Capacities	—	2.9 - (0.26 × Cap/1000) COP	2.9 - (0.26 × Cap/1000) COP	

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

"Cap" = The rated cooling capacity of the project in Btu/h. If the unit's capacity is less than 7000 Btu/h, use 7000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculations.

- Chapter 6 of the referenced standard contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
- Replacement unit shall be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY: NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Replacement efficiencies apply only to units with existing sleeves less than 16 inches (406 mm) in height and less than 42 inches (1067 mm) in width.

EFLH<sub>cool</sub> = cooling mode equivalent full load hours; see table below for default values:

Zone	Equivalent Full Load Hours Cooling (EFLHI) <sup>294</sup>	Equivalent Full Load heating Cooling (EFLH)
1 (Rockford)	816	1153
2 (Chicago)	819	1069
3 (Springfield)	1001	885
4 (Belleville)	1261	621
5 (Marion)	819	623

EFLH<sub>heat</sub> = heating mode equivalent full load hours; see table above for default values.

EER<sub>base</sub> = Energy Efficiency Ratio of the baseline equipment; see the table above for values..

EER<sub>ee</sub> = Energy Efficiency Ratio of the energy efficient equipment. For air-cooled air conditioners < 65 kBtu/h, if the actual EER<sub>ee</sub> is unknown, assume the following

<sup>294</sup> Heating and cooling EFLH data based on a series of prototypical small commercial building simulation runs for the Ohio TRM. Values shown are weighted averages across fast food restaurant, full service restaurant, assembly, big box retail, small retail, small office, light industrial and school building models. The prototypes are based on the California DEER study prototypes, modified for local construction practices. Simulations were run using TMY3 weather data for each of the cities listed. Building prototypes used in the energy modeling are described in Appendix A - Prototypical Building Energy Simulation Model Development. The Ohio values were adjusted base on CCD and HDD for IL locations. Further study recommended for IL specific building types.

- conversion from SEER to EER:  $EER \approx SEER/1.1$ .
- = Actual installed
- $kBtu/h_{heat}$  = capacity of the heating equipment in kBtu per hour.
- = Actual installed
- 3.412 = Btu per Wh.
- COPbase = coefficient of performance of the baseline equipment; see table above for values.
- COPee = coefficient of performance of the energy efficient equipment.
- = Actual installed

For example a 1 ton replacement cooling unit with no heating with an efficient SEER of 12 in Rockford saves

$$= [(12) * [(1/7.7) - (1/12)] * 816$$

$$= 455 \text{ kWh}$$

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

$$\Delta kW = (kBtu/h_{cool}) * [(1/EER_{base}) - (1/EER_{ee})] * CF$$

Depending on situation:

- $CF_{SSP}$  = Summer System Peak Coincidence Factor for Commercial cooling (during system peak hour)
- = 91.3%<sup>295</sup>
- $CF_{PJM}$  = PJM Summer Peak Coincidence Factor for Commercial cooling (average during peak period)
- = 47.8%<sup>296</sup>

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<sup>295</sup>Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The AC load during the utility's peak hour is divided by the maximum AC load during the year.

<sup>296</sup>Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The average AC load over the PJM peak period (1-5pm, M-F, June through August) is divided by the maximum AC load during the year

For example a 1 ton replacement cooling unit with no heating with an efficient EER of 12 in Rockford saves

$$\begin{aligned}\Delta kW &= (12) * [(1/7.7) - (1/12)] * 0.913 \\ &= 0.51\end{aligned}$$

**NATURAL GAS ENERGY SAVINGS**

N/A

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-HVC-PTAC-V03-130601**

## 4.4.14 Pipe Insulation

### DESCRIPTION

This measure provides rebates for installation of  $\geq 1''$  or  $\geq 2''$  fiberglass, foam, calcium silicate or other similar types of insulation to existing bare pipe systems for all non-residential installations.

Default per linear foot savings estimates are provided for the both exposed indoor or above ground outdoor piping distributing fluid in the following system types:

- Hydronic heating systems (with or without outdoor reset controls), including:
  - boiler systems that do not circulate water around a central loop and operate upon demand from a thermostat (“non-recirculation”)
  - systems that recirculate during heating season only (“Recirculation – heating season only”)
  - systems recirculating year round (“Recirculation – year round”)
- Domestic hot water
- Low and high-pressure steam systems
  - non-recirculation
  - recirculation - heating season only
  - recirculation - year round

Process piping can also use the algorithms provided but requires custom entry of hours.

Minimum qualifying pipe diameter is 1”. Indoor piping must have at least 1” of insulation and outdoor piping must have at least 2” of insulation and include an all-weather protective jacket.

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

### DEFINITION OF EFFICIENT EQUIPMENT

The efficient case is installing pipe wrap insulation to a length of pipe. Indoor piping must have at least 1” of insulation and outdoor piping must have at least 2” of insulation and include an all-weather protective jacket. Minimum qualifying pipe diameter is 1”.

### DEFINITION OF BASELINE EQUIPMENT

The base case for savings estimates is a bare pipe. Pipes are required by new construction code to be insulated but are still commonly found uninsulated in older commercial buildings.

### DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The measure life is assumed to be 15 years<sup>297</sup>.

### DEEMED MEASURE COST

The measure costs provided below are based on RS Means<sup>1</sup> pricing reference materials. The following table summarizes the estimated costs for this measure per foot of insulation added and include installation costs:

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<sup>297</sup> Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007.  
[http://neep.org/uploads/EMV%20Forum/EMV%20Studies/measure\\_life\\_GDS%5B1%5D.pdf](http://neep.org/uploads/EMV%20Forum/EMV%20Studies/measure_life_GDS%5B1%5D.pdf)

	INSULATION THICKNESS	
	1 INCH (INDOOR)	2 INCHES (OUTDOOR)
<b>Pipe- RS Means #</b>	220719.10.5170	220719.10.5530
<b>Jacket- RS Means #</b>	220719.10.0156	220719.10.0320
<b>Jacket Type</b>	PVC	Aluminum
<b>Insulation Cost per foot</b>	\$9.40	\$13.90
<b>Jacket Cost per foot</b>	\$4.57	\$7.30
<b>Total Cost per foot</b>	<b>\$13.97</b>	<b>\$21.20</b>

**DEEMED O&M COST ADJUSTMENTS**

N/A

**LOADSHAPE**

N/A

**COINCIDENCE FACTOR**

N/A

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS**

N/A

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

N/A

**NATURAL GAS SAVINGS**

$$\Delta \text{therms per foot} = ((Q_{\text{base}} - Q_{\text{eff}}) * \text{HOURS}) / (100,000 * \eta_{\text{Boiler}})$$

Where:

**HOURS** = annual operating time, in hours  
 = Actual or defaults by piping use and building type below:

Piping Use	Building Type	EFLH				
		Zone 1 (Rockford)	Zone 2 (Chicago)	Zone 3 (Springfield)	Zone 4 (Belleville/)	Zone 5 (Marion)
Space Heating - Non-recirculating <sup>298</sup>	Office - High Rise	2,746	2,768	2,656	2,155	2,420
	Office - Mid Rise	996	879	824	519	544
	Office - Low Rise	797	666	647	343	329
	Convenience	696	550	585	272	297
	Healthcare Clinic	1,118	1,036	1,029	694	737
	Manufacturing Facility	1,116	1,123	904	771	857
	Lodging Hotel/ Motel/ Multifamily	2,098	2,050	1,780	1,365	1,666
	High School	969	807	999	569	674
	Hospital	2,031	1,929	1,863	1,497	1,800
	Elementary	970	840	927	524	637
	Religious Facility	1,830	1,657	1,730	1,276	1,484
	Restaurant	1,496	1,379	1,291	872	1,185
	Retail - Strip Mall	1,266	1,147	1,151	732	863
	Retail - Department Store	1,065	927	900	578	646
	College/University	373	404	376	187	187
	Warehouse	416	443	427	226	232
Unknown	1,249	1,163	1,130	786	910	
Space Heating – recirculation heating season only <sup>299</sup>	All buildings (Hours below 55F)	5,039	4,963	4,495	4,021	4,150
Space Heating – recirculation year round <sup>300</sup>	All buildings (All hours)	8,760	8,760	8,760	8,760	8,760
Domestic Hot Water	Recirculation loop	8,760	8,760	8,760	8,760	8,760
Process	Custom	Custom				

$Q_{base}$  = Heat Loss from Bare Pipe (Btu/hr/ft)  
= See table below

$Q_{eff}$  = Heat Loss from Insulated Pipe (Btu/hr/ft)  
= See table below

100,000 = conversion factor (1 therm = 100,000 Btu)

$\eta_{Boiler}$  = Efficiency of the boiler being used to generate the hot water or steam in the pipe

<sup>298</sup>Equivalent full load hours for heating were developed using eQuest models for various building types averaged across each climate zones for Illinois for the following building types: office, healthcare/clinic, manufacturing, lodging, high school, hospital, elementary school, religious/assembly, restaurant, retail, college and warehouse. eQuest models were those developed for IL lighting interactive effects.

<sup>299</sup> These hours of use represent the number of hours in each climate zone that the outside temperature is below 55 degrees F. This is a consistent assumption of heating set point for commercial buildings. Hourly temperature data is obtained from the National Climactic Data Center (NCDC).

<sup>300</sup> For example reheat systems such as VAV and constant volume systems.

= 81.9% for water boilers<sup>301</sup>

= 80.7% for steam boilers<sup>302</sup>

The heat loss estimates ( $Q_{base}$  and  $Q_{eff}$ ) were developed using the 3E Plus v4.0 software program<sup>303</sup>. The energy savings analysis is based on adding 1-inch (indoor) or 2-inch (outdoor) thick insulation around bare pipe. The thermal conductivity of pipe insulation varies by material and temperature rating; to obtain a typical value, a range of materials allowed for this measure were averaged.

Insulation Type	Conductivity (Btu.in / hr.ft <sup>2</sup> .°F @ 75F)	Max temp (°F)
Polyethylene foam	0.25	200
Flexible polyurethane-based foam	0.27	200
Fiberglass	0.31	250
Melamine foam	0.26	350
Flexible silicon foam	0.40	392
Calcium silicate	0.40	1200
Cellular glass	0.31	400
Average conductivity of all these materials (Btu.in / hr.ft <sup>2</sup> .°F @ 75°F)	0.31	

The pipe fluid temperature assumption used depends upon both the system type and whether there is outdoor reset controls:

System Type	Fluid temperature assumption (degrees F)
Hot Water space heating with outdoor reset - Non recirculation	145
Hot Water space heating without outdoor reset - Non recirculation	170
Hot Water space heating with outdoor reset – Recirculation heating season only	145
Hot Water space heating without outdoor reset – Recirculation heating season only	170
Hot Water space heating with outdoor reset – Recirculation year round	130
Hot Water space heating without outdoor reset – Recirculation year round	170
Domestic Hot Water	125
Low Pressure Steam	225
High Pressure Steam	312

The other inputs used for the analysis are described below showing the savings result for one example – Office – High Rise, in Rockford:

<sup>301</sup> Average efficiencies of units from the California Energy Commission (CEC).

<sup>302</sup> Ibid.

<sup>303</sup> 3E Plus is a heat loss calculation software provided by the NAIMA (North American Insulation Manufacturer Association).

	Indoor Insulation, Hot Water	Indoor Insulation, Low Pressure Steam	Indoor Insulation, High Pressure Steam	Domestic Hot Water	Outdoor Insulation, Hot Water	Outdoor Insulation, Low Pressure Steam	Outdoor Insulation, High Pressure Steam
Insulation thickness (inch)	1	1	1	1	2	2	2
Temperature, Fluid in Pipe (°F)	170 (w/o reset) 145 (w/ reset heat) 130 (w/reset year)	225	312	125	170 (w/o reset) 145 (w/ reset heat) 130 (w/reset year)	225	312
Av. steam pressure (psig)	n/a	10.9	82.8	n/a	n/a	10.9	82.8
Operating Time (hrs/yr)	2,746 (non-recirc) 5,039 (recirc heating season) 8,760 (recirc year round)						
Ambient Temperature (°F) <sup>304</sup>	75	75	75	75	48.6	48.6	48.6
Wind speed (mph) <sup>305</sup>	0	0	0	0	9.4	9.4	9.4
<b>Pipe parameters</b>							
Pipe material	Copper	Steel	Steel	Copper	Copper	Steel	Steel
Pipe size for Heat Loss Calc	2"	2"	2"	2"	2"	2"	2"
Outer Diameter, Pipe, actual	2.38"	2.38"	2.38"	2.38"	2.38"	2.38"	2.38"
Heat Loss, Bare Pipe (from 3EPlus) (Btu/hr.ft)	114 (w/o reset) 78 (w/ reset heat) 58 (w/reset year)	232	432	52	460 (w/o reset) 363 (w/ reset heat) 306 (w/reset year)	710	1101
<b>Insulation parameters</b>							
Outer diameter, insulation	4.38"	4.38"	4.38"	4.38"	4.38"	4.38"	4.38"
Average Heat Loss, Insulation (from 3EPlus) (Btu/hr.ft)	24 (w/o reset) 17 (w/ reset heat) 13 (w/reset year)	40	70	13.25	21 (w/o reset) 16 (w/ reset heat) 13 (w/reset year)	32	52
<b>Annual Energy Savings</b>							
Boiler / Water Heater efficiency	81.9%	80.7%	80.7%	67%	81.9%	80.7%	80.7%
<b>Annual Gas Use, Base Case (therms/yr/ft)</b>	3.8 (w/o reset) 4.8 (w/ reset heat) 6.2 (w/reset year)	7.9 (non recirc) 14.5 (recirc heat) 25.2 (recirc year)	14.7 (non recirc) 27.0 (recirc heat) 46.9 (recirc year)	6.76	15.4 (w/o reset) 22.5 (w/ reset heat) 32.7 (w/reset year)	24.1 (non recirc) 44.3 (recirc heat) 77.0 (recirc year)	37.5 (non recirc) 68.7 (recirc heat) 119.5 (recirc year)
<b>Annual Gas Use, Measure case (therms/yr/ft)</b>	0.8 (w/o reset) 1.1 (w/ reset heat) 1.4 (w/reset year)	1.4 (non recirc) 2.5 (recirc heat) 4.4 (recirc year)	2.4 (non recirc) 4.4 (recirc heat) 7.6 (recirc year)	1.73	0.7 (w/o reset) 1.0 (w/ reset heat) 1.4 (w/reset year)	1.1 (non recirc) 2.0 (recirc heat) 3.4 (recirc year)	1.8 (non recirc) 3.2 (recirc heat) 5.6 (recirc year)
<b>Annual Gas Savings (therms/yr/ft)</b>	3.0 (w/o reset) 3.7 (w/ reset heat) 4.8 (w/reset year)	6.5 (non recirc) 12.0 (recirc heat) 20.8 (recirc year)	12.3 (non recirc) 22.6 (recirc heat) 39.3 (recirc year)	5.0	14.7 (w/o reset) 21.4 (w/ reset heat) 31.3 (w/reset year)	23.1 (non recirc) 42.3 (recirc heat) 73.6 (recirc year)	35.7 (non recirc) 65.5 (recirc heat) 113.9 (recirc year)

<sup>304</sup> DOE Weather Data.

[http://apps1.eere.energy.gov/buildings/energyplus/weatherdata/4\\_north\\_and\\_central\\_america\\_wmo\\_region\\_4/1\\_usa/USA\\_IL\\_Aurora.Muni.AP.744655\\_TMY3.stat](http://apps1.eere.energy.gov/buildings/energyplus/weatherdata/4_north_and_central_america_wmo_region_4/1_usa/USA_IL_Aurora.Muni.AP.744655_TMY3.stat)

<sup>305</sup> Ibid.

Heat = heating season only, year = year round

All variables were the same except for hours of operation in the calculation of the default savings per foot for the various building types and applications as presented in the table below:

**Savings Summary by Building Type and System Type**

Location	System Type	Building Type	Annual therm Savings per linear foot (therm /ft) (2" pipe / 1" insulation for hot water, 2" insulation for steam)				
			Zone 1 (Rockford)	Zone 2 (Chicago)	Zone 3 (Springfield)	Zone 4 (Belleville)	Zone 5 (Marion)
Indoor	Hot Water Space Heating with outdoor reset – non-recirculation	Office - High Rise	2.04	2.05	1.97	1.60	1.79
		Office - Mid Rise	0.74	0.65	0.61	0.38	0.40
		Office - Low Rise	0.59	0.49	0.48	0.25	0.24
		Convenience	0.52	0.41	0.43	0.20	0.22
		Healthcare Clinic	0.83	0.77	0.76	0.51	0.55
		Manufacturing Facility	0.83	0.83	0.67	0.57	0.64
		Lodging Hotel/ Motel/ Multifamily	1.55	1.52	1.32	1.01	1.23
		High School	0.72	0.60	0.74	0.42	0.50
		Hospital	1.51	1.43	1.38	1.11	1.33
		Elementary	0.72	0.62	0.69	0.39	0.47
		Religious Facility	1.36	1.23	1.28	0.95	1.10
		Restaurant	1.11	1.02	0.96	0.65	0.88
		Retail - Strip Mall	0.94	0.85	0.85	0.54	0.64
		Retail - Department Store	0.79	0.69	0.67	0.43	0.48
		College/University	0.28	0.30	0.28	0.14	0.14
		Warehouse	0.31	0.33	0.32	0.17	0.17
		Unknown	0.93	0.86	0.84	0.58	0.67
	Hot Water Space Heating without outdoor reset – non-recirculation	Office - High Rise	3.00	3.03	2.91	2.36	2.65
		Office - Mid Rise	1.09	0.96	0.90	0.57	0.60
		Office - Low Rise	0.87	0.73	0.71	0.38	0.36
		Convenience	0.76	0.60	0.64	0.30	0.32
		Healthcare Clinic	1.22	1.13	1.13	0.76	0.81
		Manufacturing Facility	1.22	1.23	0.99	0.84	0.94
		Lodging Hotel/ Motel/ Multifamily	2.30	2.24	1.95	1.49	1.82
		High School	1.06	0.88	1.09	0.62	0.74
		Hospital	2.22	2.11	2.04	1.64	1.97
		Elementary	1.06	0.92	1.01	0.57	0.70
		Religious Facility	2.00	1.81	1.89	1.40	1.62
		Restaurant	1.64	1.51	1.41	0.95	1.30
		Retail - Strip Mall	1.39	1.25	1.26	0.80	0.94
		Retail - Department Store	1.17	1.01	0.98	0.63	0.71
		College/University	0.41	0.44	0.41	0.20	0.20
	Warehouse	0.46	0.48	0.47	0.25	0.25	
Unknown	1.37	1.27	1.24	0.86	1.00		
Hot Water with outdoor reset - Recirculation heating season only	All buildings (Hours below 55F)	3.73	3.68	3.33	2.98	3.08	

			Annual therm Savings per linear foot (therm /ft) (2" pipe / 1" insulation for hot water, 2" insulation for steam)				
Location	System Type	Building Type	Zone 1 (Rockford)	Zone 2 (Chicago)	Zone 3 (Springfield)	Zone 4 (Belleville)	Zone 5 (Marion)
	Hot Water without outdoor reset- Recirculation heating season only	All buildings (Hours below 55F)	5.51	5.43	4.92	4.40	4.54
	Hot Water with outdoor reset- Recirculation year round	All buildings (All hours)	4.79	4.79	4.79	4.79	4.79
	Hot Water without outdoor reset- Recirculation year round	All buildings (All hours)	9.58	9.58	9.58	9.58	9.58
	Domestic Hot Water	DHW circulation loop	5.02	5.02	5.02	5.02	5.02
	LP Steam – non-recirculation	Office - High Rise	6.53	6.59	6.32	5.13	5.76
		Office - Mid Rise	2.37	2.09	1.96	1.23	1.29
		Office - Low Rise	1.90	1.58	1.54	0.82	0.78
		Convenience	1.66	1.31	1.39	0.65	0.71
		Healthcare Clinic	2.66	2.47	2.45	1.65	1.75
		Manufacturing Facility	2.66	2.67	2.15	1.83	2.04
		Lodging Hotel/ Motel/ Multifamily	4.99	4.88	4.24	3.25	3.96
		High School	2.31	1.92	2.38	1.35	1.60
		Hospital	4.83	4.59	4.43	3.56	4.28
		Elementary	2.31	2.00	2.21	1.25	1.52
		Religious Facility	4.35	3.94	4.12	3.04	3.53
		Restaurant	3.56	3.28	3.07	2.07	2.82
		Retail - Strip Mall	3.01	2.73	2.74	1.74	2.05
		Retail - Department Store	2.53	2.21	2.14	1.38	1.54
		College/University	0.89	0.96	0.89	0.44	0.44
	Warehouse	0.99	1.05	1.02	0.54	0.55	
	Unknown	2.97	2.77	2.69	1.87	2.17	
	LP Steam- Recirculation heating season only	All buildings (Hours below 55F)	11.99	11.81	10.70	9.57	9.88
	LP Steam- Recirculation year round	All buildings (All hours)	20.84	20.84	20.84	20.84	20.84
	HP Steam – non-recirculation	Office - High Rise	12.33	12.42	11.92	9.67	10.86
		Office - Mid Rise	4.47	3.95	3.70	2.33	2.44
		Office - Low Rise	3.58	2.99	2.90	1.54	1.48
		Convenience	3.12	2.47	2.63	1.22	1.33
		Healthcare Clinic	5.02	4.65	4.62	3.12	3.31
		Manufacturing Facility	5.01	5.04	4.06	3.46	3.85
	Lodging Hotel/ Motel/ Multifamily	9.42	9.20	7.99	6.13	7.48	

			Annual therm Savings per linear foot (therm /ft) (2" pipe / 1" insulation for hot water, 2" insulation for steam)				
Location	System Type	Building Type	Zone 1 (Rockford)	Zone 2 (Chicago)	Zone 3 (Springfield)	Zone 4 (Belleville)	Zone 5 (Marion)
		High School	4.35	3.62	4.48	2.55	3.03
		Hospital	9.12	8.66	8.36	6.72	8.08
		Elementary	4.35	3.77	4.16	2.35	2.86
		Religious Facility	8.21	7.44	7.77	5.73	6.66
		Restaurant	6.71	6.19	5.79	3.91	5.32
		Retail - Strip Mall	5.68	5.15	5.17	3.29	3.87
		Retail - Department Store	4.78	4.16	4.04	2.59	2.90
		College/University	1.67	1.81	1.69	0.84	0.84
		Warehouse	1.87	1.99	1.92	1.01	1.04
		Unknown	5.61	5.22	5.07	3.53	4.08
		HP Steam-Recirculation heating season only	All buildings (Hours below 55F)	22.62	22.28	20.18	18.05
HP Steam-Recirculation year round	All buildings (All hours)	39.32	39.32	39.32	39.32	39.32	

			Annual therm Savings per linear foot (therm /ft) (2" pipe / 1" insulation for hot water, 2" insulation for steam)				
Location	System Type	Building Type	Zone 1 (Rockford)	Location	System Type	Building Type	Zone 1 (Rockford)
Outdoor	Hot Water Space Heating with outdoor reset – non-recirculation	Office - High Rise	11.65	11.74	11.27	9.14	10.27
		Office - Mid Rise	4.23	3.73	3.50	2.20	2.31
		Office - Low Rise	3.38	2.83	2.74	1.46	1.40
		Convenience	2.95	2.33	2.48	1.15	1.26
		Healthcare Clinic	4.74	4.40	4.37	2.94	3.13
		Manufacturing Facility	4.73	4.76	3.84	3.27	3.64
		Lodging Hotel/ Motel/ Multifamily	8.90	8.70	7.55	5.79	7.07
		High School	4.11	3.42	4.24	2.41	2.86
		Hospital	8.62	8.18	7.90	6.35	7.64
		Elementary	4.12	3.56	3.93	2.22	2.70
		Religious Facility	7.76	7.03	7.34	5.41	6.30
		Restaurant	6.35	5.85	5.48	3.70	5.03
		Retail - Strip Mall	5.37	4.87	4.88	3.11	3.66
		Retail - Department Store	4.52	3.93	3.82	2.45	2.74
		College/University	1.58	1.71	1.60	0.79	0.79
		Warehouse	1.76	1.88	1.81	0.96	0.98
	Unknown	5.30	4.93	4.79	3.33	3.86	
	Hot Water Space Heating without outdoor reset – non-recirculation	Office - High Rise	14.74	14.86	14.26	11.57	12.99
		Office - Mid Rise	5.35	4.72	4.42	2.79	2.92
		Office - Low Rise	4.28	3.57	3.47	1.84	1.77
Convenience		3.74	2.95	3.14	1.46	1.59	
Healthcare Clinic		6.00	5.56	5.52	3.73	3.96	
Manufacturing Facility	5.99	6.03	4.85	4.14	4.60		

Location	System Type	Building Type	Annual therm Savings per linear foot (therm /ft) (2" pipe / 1" insulation for hot water, 2" insulation for steam)				
			Zone 1 (Rockford)	Location	System Type	Building Type	Zone 1 (Rockford)
		Lodging Hotel/ Motel/ Multifamily	11.26	11.00	9.55	7.33	8.94
		High School	5.20	4.33	5.36	3.05	3.62
		Hospital	10.90	10.35	10.00	8.04	9.66
		Elementary	5.21	4.51	4.98	2.81	3.42
		Religious Facility	9.82	8.89	9.29	6.85	7.97
		Restaurant	8.03	7.40	6.93	4.68	6.36
		Retail - Strip Mall	6.80	6.16	6.18	3.93	4.63
		Retail - Department Store	5.72	4.98	4.83	3.10	3.47
		College/University	2.00	2.17	2.02	1.00	1.00
		Warehouse	2.23	2.38	2.29	1.21	1.25
		Unknown	6.70	6.24	6.07	4.22	4.88
	Hot Water with outdoor reset - Recirculation heating season only	All buildings (Hours below 55F)	21.38	21.06	19.07	17.06	17.61
	Hot Water without outdoor reset- Recirculation heating season only	All buildings (Hours below 55F)	27.05	26.64	24.13	21.58	22.28
	Hot Water with outdoor reset- Recirculation year round	All buildings (All hours)	37.16	37.16	37.16	37.16	37.16
	Hot Water without outdoor reset- Recirculation year round	All buildings (All hours)	47.02	47.02	47.02	47.02	47.02
	LP Steam – non- recirculation	Office - High Rise	23.07	23.25	22.31	18.10	20.33
		Office - Mid Rise	8.37	7.38	6.92	4.36	4.57
		Office - Low Rise	6.70	5.59	5.44	2.88	2.76
		Convenience	5.85	4.62	4.91	2.29	2.50
		Healthcare Clinic	9.39	8.70	8.64	5.83	6.19
		Manufacturing Facility	9.38	9.43	7.59	6.48	7.20
		Lodging Hotel/ Motel/ Multifamily	17.63	17.22	14.95	11.47	14.00
		High School	8.14	6.78	8.39	4.78	5.66
		Hospital	17.06	16.21	15.65	12.58	15.12
		Elementary	8.15	7.06	7.79	4.40	5.35
		Religious Facility	15.37	13.92	14.53	10.72	12.47
		Restaurant	12.57	11.58	10.85	7.33	9.96
		Retail - Strip Mall	10.64	9.64	9.67	6.15	7.25
		Retail - Department Store	8.95	7.79	7.56	4.86	5.43
		College/University	3.13	3.39	3.16	1.57	1.57
	Warehouse	3.49	3.72	3.59	1.90	1.95	
	Unknown	10.49	9.77	9.49	6.60	7.64	
	LP Steam- Recirculation heating season only	All buildings (Hours below 55F)	42.33	41.69	37.76	33.78	34.86

Location	System Type	Building Type	Annual therm Savings per linear foot (therm /ft) (2" pipe / 1" insulation for hot water, 2" insulation for steam)				
			Zone 1 (Rockford)	Location	System Type	Building Type	Zone 1 (Rockford)
	LP Steam- Recirculation year round	All buildings (All hours)	73.59	73.59	73.59	73.59	73.59
	HP Steam – non- recirculation	Office - High Rise	35.71	36.00	34.54	28.02	31.47
		Office - Mid Rise	12.95	11.43	10.72	6.75	7.07
		Office - Low Rise	10.36	8.66	8.41	4.46	4.28
		Convenience	9.05	7.15	7.61	3.54	3.86
		Healthcare Clinic	14.54	13.47	13.38	9.03	9.58
		Manufacturing Facility	14.51	14.60	11.76	10.03	11.14
		Lodging Hotel/ Motel/ Multifamily	27.28	26.66	23.15	17.75	21.67
		High School	12.60	10.49	12.99	7.40	8.76
		Hospital	26.41	25.09	24.23	19.47	23.41
		Elementary	12.61	10.92	12.06	6.81	8.28
		Religious Facility	23.80	21.55	22.50	16.59	19.30
		Restaurant	19.45	17.93	16.79	11.34	15.41
		Retail - Strip Mall	16.46	14.92	14.97	9.52	11.22
		Retail - Department Store	13.85	12.06	11.70	7.52	8.40
		College/University	4.85	5.25	4.89	2.43	2.43
	Warehouse	5.41	5.76	5.55	2.94	3.02	
	Unknown	16.24	15.12	14.69	10.22	11.83	
	HP Steam- Recirculation heating season only	All buildings (Hours below 55F)	65.53	64.54	58.45	52.29	53.97
	HP Steam- Recirculation year round	All buildings (All hours)	113.92	113.92	113.92	113.92	113.92

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-HWE-PINS-V01-130601**

## Illinois Statewide Technical Reference Manual - 4.4.15 Pipe Insulation

### Description

This measure provides rebates for installation of  $\geq 1''$  or  $\geq 2''$  fiberglass, foam, calcium silicate or other similar types of insulation to existing bare pipe systems for all non-residential installations.

Default per linear foot savings estimates are provided for the both exposed indoor or above ground outdoor piping distributing fluid in the following system types:

- Hydronic heating systems (with or without outdoor reset controls), including:
  - boiler systems that do not circulate water around a central loop and operate upon demand from a thermostat (“non-recirculation”)
  - systems that recirculate during heating season only (“Recirculation – heating season only”)
  - systems recirculating year round (“Recirculation – year round”)
- Domestic hot water
- Low and high-pressure steam systems
  - non-recirculation
  - recirculation - heating season only
  - recirculation - year round

Process piping can also use the algorithms provided but requires custom entry of hours.

Minimum qualifying pipe diameter is 1". Indoor piping must have at least 1" of insulation and outdoor piping must have at least 2" of insulation and include an all-weather protective jacket.

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

#### DEFINITION OF EFFICIENT EQUIPMENT

The efficient case is installing pipe wrap insulation to a length of pipe. Indoor piping must have at least 1" of insulation and outdoor piping must have at least 2" of insulation and include an all-weather protective jacket. Minimum qualifying pipe diameter is 1".

## 4.4.15 Single-Package and Split System Unitary Air Conditioners

### DESCRIPTION

This measure promotes the installation of high-efficiency unitary air-, water-, and evaporatively cooled air conditioning equipment, both single-package and split systems. Air conditioning (AC) systems are a major consumer of electricity and systems that exceed baseline efficiencies can save considerable amounts of energy. This measure could apply to the replacing of an existing unit at the end of its useful life or the installation of a new unit in a new or existing building.

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

#### DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to be a high-efficiency air-, water-, or evaporatively cooled air conditioner that exceeds the energy efficiency requirements of the International Energy Conservation Code (IECC) 2009, Table 503.2.3(1).

#### DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline equipment is assumed to be a standard-efficiency air-, water-, or evaporatively cooled air conditioner that meets the energy efficiency requirements of the International

## Illinois Statewide Technical Reference Manual - 4.4.15 Pipe Insulation

### Description

This measure provides rebates for installation of  $\geq 1''$  or  $\geq 2''$  fiberglass, foam, calcium silicate or other similar types of insulation to existing bare pipe systems for all non-residential installations.

Default per linear foot savings estimates are provided for the both exposed indoor or above ground outdoor piping distributing fluid in the following system types:

- Hydronic heating systems (with or without outdoor reset controls), including:
  - boiler systems that do not circulate water around a central loop and operate upon demand from a thermostat (“non-recirculation”)
  - systems that recirculate during heating season only (“Recirculation – heating season only”)
  - systems recirculating year round (“Recirculation – year round”)
- Domestic hot water
- Low and high-pressure steam systems
  - non-recirculation
  - recirculation - heating season only
  - recirculation - year round

Process piping can also use the algorithms provided but requires custom entry of hours.

Minimum qualifying pipe diameter is 1". Indoor piping must have at least 1" of insulation and outdoor piping must have at least 2" of insulation and include an all-weather protective jacket.

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

#### DEFINITION OF EFFICIENT EQUIPMENT

The efficient case is installing pipe wrap insulation to a length of pipe. Indoor piping must have at least 1" of insulation and outdoor piping must have at least 2" of insulation and include an all-weather protective jacket. Minimum qualifying pipe diameter is 1".

Energy Conservation Code (IECC) 2006, Table 503.2.3(1). The rating conditions for the baseline and efficient equipment efficiencies must be equivalent.

#### DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 15 years.<sup>306</sup>

#### DEEMED MEASURE COST

The incremental capital cost for this measure is assumed to be \$100 per ton.<sup>307</sup>

#### DEEMED O&M COST ADJUSTMENTS

N/A

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<sup>306</sup> Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, Inc., June 2007.

<sup>307</sup> Based on a review of TRM incremental cost assumptions from Vermont, Wisconsin, and California. This assumes that baseline shift from IECC 2006 to IECC 2009 carries the same incremental costs. Values should be verified during evaluation

## Illinois Statewide Technical Reference Manual - 4.4.15 Pipe Insulation

### Description

This measure provides rebates for installation of  $\geq 1''$  or  $\geq 2''$  fiberglass, foam, calcium silicate or other similar types of insulation to existing bare pipe systems for all non-residential installations.

Default per linear foot savings estimates are provided for the both exposed indoor or above ground outdoor piping distributing fluid in the following system types:

- Hydronic heating systems (with or without outdoor reset controls), including:
  - boiler systems that do not circulate water around a central loop and operate upon demand from a thermostat (“non-recirculation”)
  - systems that recirculate during heating season only (“Recirculation – heating season only”)
  - systems recirculating year round (“Recirculation – year round”)
- Domestic hot water
- Low and high-pressure steam systems
  - non-recirculation
  - recirculation - heating season only
  - recirculation - year round

Process piping can also use the algorithms provided but requires custom entry of hours.

Minimum qualifying pipe diameter is 1". Indoor piping must have at least 1" of insulation and outdoor piping must have at least 2" of insulation and include an all-weather protective jacket.

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

### DEFINITION OF EFFICIENT EQUIPMENT

The efficient case is installing pipe wrap insulation to a length of pipe. Indoor piping must have at least 1" of insulation and outdoor piping must have at least 2" of insulation and include an all-weather protective jacket. Minimum qualifying pipe diameter is 1".

### LOADSHAPE

Loadshape C03 - Commercial Cooling

### COINCIDENCE FACTOR

The summer peak coincidence factor for cooling is provided in two different ways below. The first is used to estimate peak savings during the utility peak hour and is most indicative of actual peak benefits, and the second represents the *average* savings over the defined summer peak period, and is presented so that savings can be bid into PJM's Forward Capacity Market. Both values provided are based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren.

$$\begin{aligned} CF_{SSP} &= \text{Summer System Peak Coincidence Factor for Commercial cooling (during system peak hour)} \\ &= 91.3\% \end{aligned} \quad ^{308}$$

$$\begin{aligned} CF_{PJM} &= \text{PJM Summer Peak Coincidence Factor for Commercial cooling (average during peak period)} \\ &= 47.8\% \end{aligned} \quad ^{309}$$

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<sup>308</sup>Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The AC load during the utility's peak hour is divided by the maximum AC load during the year.

## Illinois Statewide Technical Reference Manual - 4.4.15 Pipe Insulation

### Description

This measure provides rebates for installation of  $\geq 1''$  or  $\geq 2''$  fiberglass, foam, calcium silicate or other similar types of insulation to existing bare pipe systems for all non-residential installations.

Default per linear foot savings estimates are provided for the both exposed indoor or above ground outdoor piping distributing fluid in the following system types:

- Hydronic heating systems (with or without outdoor reset controls), including:
  - boiler systems that do not circulate water around a central loop and operate upon demand from a thermostat (“non-recirculation”)
  - systems that recirculate during heating season only (“Recirculation – heating season only”)
  - systems recirculating year round (“Recirculation – year round”)
- Domestic hot water
- Low and high-pressure steam systems
  - non-recirculation
  - recirculation - heating season only
  - recirculation - year round

Process piping can also use the algorithms provided but requires custom entry of hours.

Minimum qualifying pipe diameter is 1". Indoor piping must have at least 1" of insulation and outdoor piping must have at least 2" of insulation and include an all-weather protective jacket.

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

#### DEFINITION OF EFFICIENT EQUIPMENT

The efficient case is installing pipe wrap insulation to a length of pipe. Indoor piping must have at least 1" of insulation and outdoor piping must have at least 2" of insulation and include an all-weather protective jacket. Minimum qualifying pipe diameter is 1".

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### Algorithm

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#### CALCULATION OF SAVINGS

#### ELECTRIC ENERGY SAVINGS

For units with cooling capacities less than 65 kBtu/h:

$$\Delta\text{kWH} = (\text{kBtu/h}) * [(1/\text{SEER}_{\text{base}}) - (1/\text{SEER}_{\text{ee}})] * \text{EFLH}$$

For units with cooling capacities equal to or greater than 65 kBtu/h:

$$\Delta\text{kWH} = (\text{kBtu/h}) * [(1/\text{EER}_{\text{base}}) - (1/\text{EER}_{\text{ee}})] * \text{EFLH}$$

Where:

kBtu/h = capacity of the cooling equipment actually installed in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/h).

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<sup>309</sup>Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The average AC load over the PJM peak period (1-5pm, M-F, June through August) is divided by the maximum AC load during the year

## Illinois Statewide Technical Reference Manual - 4.4.15 Pipe Insulation

### Description

This measure provides rebates for installation of  $\geq 1''$  or  $\geq 2''$  fiberglass, foam, calcium silicate or other similar types of insulation to existing bare pipe systems for all non-residential installations.

Default per linear foot savings estimates are provided for the both exposed indoor or above ground outdoor piping distributing fluid in the following system types:

- Hydronic heating systems (with or without outdoor reset controls), including:
  - boiler systems that do not circulate water around a central loop and operate upon demand from a thermostat (“non-recirculation”)
  - systems that recirculate during heating season only (“Recirculation – heating season only”)
  - systems recirculating year round (“Recirculation – year round”)
- Domestic hot water
- Low and high-pressure steam systems
  - non-recirculation
  - recirculation - heating season only
  - recirculation - year round

Process piping can also use the algorithms provided but requires custom entry of hours.

Minimum qualifying pipe diameter is 1". Indoor piping must have at least 1" of insulation and outdoor piping must have at least 2" of insulation and include an all-weather protective jacket.

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

#### DEFINITION OF EFFICIENT EQUIPMENT

The efficient case is installing pipe wrap insulation to a length of pipe. Indoor piping must have at least 1" of insulation and outdoor piping must have at least 2" of insulation and include an all-weather protective jacket. Minimum qualifying pipe diameter is 1".

SEERbase = Seasonal Energy Efficiency Ratio of the baseline equipment; see table below for default values<sup>310</sup>::

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<sup>310</sup> International Energy Conservation Code (IECC) 2009

Illinois Statewide Technical Reference Manual - 4.4.15 Pipe Insulation

Description

This measure provides rebates for installation of ≥1” or ≥2” fiberglass, foam, calcium silicate or other similar types of insulation to existing bare pipe systems for all non-residential installations.

Default per linear foot savings estimates are provided for the both exposed indoor or above ground outdoor piping distributing fluid in the following system types:

- Hydronic heating systems (with or without outdoor reset controls), including:
  - boiler systems that do not circulate water around a central loop and operate upon demand from a thermostat (“non-recirculation”)
  - systems that recirculate during heating season only (“Recirculation – heating season only”)
  - systems recirculating year round (“Recirculation – year round”)
- Domestic hot water
- Low and high-pressure steam systems
  - non-recirculation
  - recirculation - heating season only
  - recirculation - year round

Process piping can also use the algorithms provided but requires custom entry of hours.

Minimum qualifying pipe diameter is 1”. Indoor piping must have at least 1” of insulation and outdoor piping must have at least 2” of insulation and include an all-weather protective jacket.

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

**DEFINITION OF EFFICIENT EQUIPMENT**

The efficient case is installing pipe wrap insulation to a length of pipe. Indoor piping must have at least 1” of insulation and outdoor piping must have at least 2” of insulation and include an all-weather protective jacket. Minimum qualifying pipe diameter is 1”.

TABLE 503.2.3(1)  
UNITARY AIR CONDITIONERS AND CONDENSING UNITS, ELECTRICALLY OPERATED, MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY <sup>b</sup>	TEST PROCEDURE <sup>a</sup>
Air conditioners, Air cooled	< 65,000 Btu/hr <sup>d</sup>	Split system	13.0 SEER	AHRI 210/240
		Single package	13.0 SEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split system and single package	10.3 EER <sup>c</sup> (before Jan 1, 2010)	AHRI 340/360
			11.2 EER <sup>c</sup> (as of Jan 1, 2010)	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Split system and single package	9.7 EER <sup>c</sup> (before Jan 1, 2010)	AHRI 340/360
11.0 EER <sup>c</sup> (as of Jan 1, 2010)				
≥ 240,000 Btu/h and < 760,000 Btu/h	Split system and single package	9.5 EER <sup>c</sup> 9.7 IPLV <sup>c</sup> (before Jan 1, 2010)	AHRI 340/360	
≥ 760,000 Btu/h	Split system and single package	10.0 EER <sup>c</sup> 9.7 IPLV <sup>a</sup> (as of Jan 1, 2010)		
Through-the-wall, Air cooled	< 30,000 Btu/hr <sup>d</sup>	Split system	10.9 SEER (before Jan 23, 2010)	AHRI 210/240
		Single package	12.0 SEER (as of Jan 23, 2010)	
	< 65,000 Btu/h	Split system and	10.6 SEER (before Jan 23, 2010)	
			12.0 SEER (as of Jan 23, 2010)	
		Split system and	12.1 EER	

Illinois Statewide Technical Reference Manual - 4.4.15 Pipe Insulation

Description

This measure provides rebates for installation of ≥1” or ≥2” fiberglass, foam, calcium silicate or other similar types of insulation to existing bare pipe systems for all non-residential installations.

Default per linear foot savings estimates are provided for the both exposed indoor or above ground outdoor piping distributing fluid in the following system types:

- Hydronic heating systems (with or without outdoor reset controls), including:
  - boiler systems that do not circulate water around a central loop and operate upon demand from a thermostat (“non-recirculation”)
  - systems that recirculate during heating season only (“Recirculation – heating season only”)
  - systems recirculating year round (“Recirculation – year round”)
- Domestic hot water
- Low and high-pressure steam systems
  - non-recirculation
  - recirculation - heating season only
  - recirculation - year round

Process piping can also use the algorithms provided but requires custom entry of hours.

Minimum qualifying pipe diameter is 1”. Indoor piping must have at least 1” of insulation and outdoor piping must have at least 2” of insulation and include an all-weather protective jacket.

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

**DEFINITION OF EFFICIENT EQUIPMENT**

The efficient case is installing pipe wrap insulation to a length of pipe. Indoor piping must have at least 1” of insulation and outdoor piping must have at least 2” of insulation and include an all-weather protective jacket. Minimum qualifying pipe diameter is 1”.

- SEER<sub>ee</sub> = Seasonal Energy Efficiency Ratio of the energy efficient equipment (actually installed).
- EER<sub>base</sub> = Energy Efficiency Ratio of the baseline equipment; see table above for default values. Since IECC 2006 does not provide EER requirements for air-cooled air conditioners < 65 kBtu/h, assume the following conversion from SEER to EER: EER≈SEER/1.1
- EER<sub>ee</sub> = Energy Efficiency Ratio of the energy efficient equipment. For air-cooled air conditioners < 65 kBtu/h, if the actual EER<sub>ee</sub> is unknown, assume the following conversion from SEER to EER: EER≈SEER/1.1.
- = Actual installed
- EFLH = cooling equivalent full load hours; see table below for default values:

Zone	Equivalent Full Load Hours Cooling (EFLH) <sup>311</sup>
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<sup>311</sup> Heating and cooling EFLH data based on a series of prototypical small commercial building simulation runs for the Ohio TRM. Values shown are weighted averages across fast food restaurant, full service restaurant, assembly, big box retail, small retail, small office, light industrial and school building models. The prototypes are based on the California DEER study prototypes, modified for local construction practices. Simulations were run using TMY3

## Illinois Statewide Technical Reference Manual - 4.4.15 Pipe Insulation

### Description

This measure provides rebates for installation of  $\geq 1''$  or  $\geq 2''$  fiberglass, foam, calcium silicate or other similar types of insulation to existing bare pipe systems for all non-residential installations.

Default per linear foot savings estimates are provided for the both exposed indoor or above ground outdoor piping distributing fluid in the following system types:

- Hydronic heating systems (with or without outdoor reset controls), including:
  - boiler systems that do not circulate water around a central loop and operate upon demand from a thermostat (“non-recirculation”)
  - systems that recirculate during heating season only (“Recirculation – heating season only”)
  - systems recirculating year round (“Recirculation – year round”)
- Domestic hot water
- Low and high-pressure steam systems
  - non-recirculation
  - recirculation - heating season only
  - recirculation - year round

Process piping can also use the algorithms provided but requires custom entry of hours.

Minimum qualifying pipe diameter is 1”. Indoor piping must have at least 1” of insulation and outdoor piping must have at least 2” of insulation and include an all-weather protective jacket.

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

#### DEFINITION OF EFFICIENT EQUIPMENT

The efficient case is installing pipe wrap insulation to a length of pipe. Indoor piping must have at least 1” of insulation and outdoor piping must have at least 2” of insulation and include an all-weather protective jacket. Minimum qualifying pipe diameter is 1”.

1 (Rockford)	816
2 (Chicago)	819
3 (Springfield)	1001
4 (Belleville)	1261
5 (Marion)	819

For example a 5 ton air cooled split system with a SEER of 15 in Rockford would save

$$\begin{aligned}\Delta\text{kWh} &= (60) * [(1/13) - (1/15)] * 816 \\ &= 502 \text{ kWh}\end{aligned}$$

weather data for each of the cities listed. Building prototypes used in the energy modeling are described in Appendix A - Prototypical Building Energy Simulation Model Development. The Ohio values were adjusted base on CCD for IL locations. Further study recommended for IL specific building types.

## Illinois Statewide Technical Reference Manual - 4.4.15 Pipe Insulation

### Description

This measure provides rebates for installation of  $\geq 1''$  or  $\geq 2''$  fiberglass, foam, calcium silicate or other similar types of insulation to existing bare pipe systems for all non-residential installations.

Default per linear foot savings estimates are provided for the both exposed indoor or above ground outdoor piping distributing fluid in the following system types:

- Hydronic heating systems (with or without outdoor reset controls), including:
  - boiler systems that do not circulate water around a central loop and operate upon demand from a thermostat (“non-recirculation”)
  - systems that recirculate during heating season only (“Recirculation – heating season only”)
  - systems recirculating year round (“Recirculation – year round”)
- Domestic hot water
- Low and high-pressure steam systems
  - non-recirculation
  - recirculation - heating season only
  - recirculation - year round

Process piping can also use the algorithms provided but requires custom entry of hours.

Minimum qualifying pipe diameter is 1". Indoor piping must have at least 1" of insulation and outdoor piping must have at least 2" of insulation and include an all-weather protective jacket.

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

### DEFINITION OF EFFICIENT EQUIPMENT

The efficient case is installing pipe wrap insulation to a length of pipe. Indoor piping must have at least 1" of insulation and outdoor piping must have at least 2" of insulation and include an all-weather protective jacket. Minimum qualifying pipe diameter is 1".

### SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW_{SSP} = (\text{kBtu/h} * (1/\text{EER}_{\text{base}} - 1/\text{EER}_{\text{ee}})) * \text{CF}_{SSP}$$

$$\Delta kW_{PJM} = (\text{kBtu/h} * (1/\text{EER}_{\text{base}} - 1/\text{EER}_{\text{ee}})) * \text{CF}_{PJM}$$

Where:

$\text{CF}_{SSP}$  = Summer System Peak Coincidence Factor for Commercial cooling (during system peak hour)

$$= 91.3\%^{312}$$

$\text{CF}_{PJM}$  = PJM Summer Peak Coincidence Factor for Commercial cooling (average during peak period)

$$= 47.8\%^{313}$$

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312 Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The AC load during the utility's peak hour is divided by the maximum AC load during the year.

313 Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The average AC load over the PJM peak period (1-5pm, M-F, June through August) is divided by the maximum AC load during the year

## Illinois Statewide Technical Reference Manual - 4.4.15 Pipe Insulation

### Description

This measure provides rebates for installation of  $\geq 1''$  or  $\geq 2''$  fiberglass, foam, calcium silicate or other similar types of insulation to existing bare pipe systems for all non-residential installations.

Default per linear foot savings estimates are provided for the both exposed indoor or above ground outdoor piping distributing fluid in the following system types:

- Hydronic heating systems (with or without outdoor reset controls), including:
  - boiler systems that do not circulate water around a central loop and operate upon demand from a thermostat (“non-recirculation”)
  - systems that recirculate during heating season only (“Recirculation – heating season only”)
  - systems recirculating year round (“Recirculation – year round”)
- Domestic hot water
- Low and high-pressure steam systems
  - non-recirculation
  - recirculation - heating season only
  - recirculation - year round

Process piping can also use the algorithms provided but requires custom entry of hours.

Minimum qualifying pipe diameter is 1". Indoor piping must have at least 1" of insulation and outdoor piping must have at least 2" of insulation and include an all-weather protective jacket.

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

#### DEFINITION OF EFFICIENT EQUIPMENT

The efficient case is installing pipe wrap insulation to a length of pipe. Indoor piping must have at least 1" of insulation and outdoor piping must have at least 2" of insulation and include an all-weather protective jacket. Minimum qualifying pipe diameter is 1".

For example a 5 ton air cooled split system with a SEER of 15 in Rockford would save

$$\begin{aligned}\Delta kW_{SSP} &= (60) * [(1/13) - (1/15)] * .913 \\ &= 0.562\end{aligned}$$

#### NATURAL GAS ENERGY SAVINGS

N/A

#### WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

MEASURE CODE: CI-HVC-SPUA-V01-120601

#### 4.4.16 Steam Trap Replacement or Repair<sup>314</sup>

##### **DESCRIPTION**

The measure is for the repair or replacement of faulty steam traps that are allowing excess steam to escape and thereby increasing steam generation. The measure is applicable to commercial applications, commercial HVAC (low pressure steam) including multifamily buildings, low pressure industrial applications, medium pressure industrial applications, applications and high pressure industrial applications. Maximum pressure for this measure is 300 psig.

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**

Customers must have leaking traps to qualify for rebates. However, if a commercial customer opts to replace all traps without inspection, rebates and the savings are discounted to take into consideration the fact that some traps are being replaced that have not yet failed.

##### **DEFINITION OF BASELINE EQUIPMENT**

The baseline criterion is a faulty steam trap in need of replacing. No minimum leak rate is required. Any leaking or blow through trap can be repaired or replaced. If a commercial customer chooses to repair or replace all the steam traps at the facility without verification, the savings are adjusted. Savings for commercial full replacement projects are reduced by the percentage of traps found to be leaking on average from the studies listed. If an audit is performed on a commercial site, then the leaking and blowdown can be adjusted.

##### **DEEMED LIFETIME OF EFFICIENT EQUIPMENT**

The life of this measure is 6 years<sup>315</sup>

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<sup>314</sup>High Impact Measure

<sup>315</sup>Source paper is the Resource Solutions Group "Steam Traps Revision #1" dated August 2011. Primary studies used to prepare the source paper include Enbridge Steam Trap Survey, KW Engineering Steam Trap Survey, Enbridge Steam Saver Program 2005, Armstrong Steam Trap Survey, DOE Federal Energy Management Program Steam Trap Performance Assessment, Oak Ridge National Laboratory Steam System Survey Guide, KEMA Evaluation of PG&E's Steam Trap Program, Sept. 2007. Communication with vendors suggested a inverted bucket steam trap life typically in the range of 5 - 7 years, float and thermostatic traps 4- 6 years, float and thermodynamic disc traps of 1 - 3 years. Cost does not include installation.

**DEEMED MEASURE COST**

Steam System	Cost per trap <sup>316</sup> (\$)
Commercial Dry Cleaners	77
Commercial Heating (including Multifamily), low pressure steam	77
Industrial Medium Pressure >15 psig < 30 psig	180
Steam Trap, Industrial Medium Pressure ≥30 <75 psig	223
Steam Trap, Industrial High Pressure ≥75 <125 psig	276
Steam Trap, Industrial High Pressure ≥125 <175 psig	322
Steam Trap, Industrial High Pressure ≥175 <250 psig	370
Steam Trap, Industrial High Pressure ≥250 psig	418
Steam Trap, Industrial Medium Pressure ≥30 <75 psig	223
Steam Trap, Industrial High Pressure ≥75 <125 psig	276
Steam Trap, Industrial High Pressure ≥125 <175 psig	322
Steam Trap, Industrial High Pressure ≥175 <250 psig	370
Steam Trap, Industrial High Pressure ≥250 psig	418

**DEEMED O&M COST ADJUSTMENTS**

N/A

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<sup>316</sup> Ibid.

**LOADSHAPE**

N/A

**COINCIDENCE FACTOR**

N/A

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ENERGY SAVINGS**

$$\Delta_{\text{therm}} = S * (Hv/B) * \text{Hours} * A * L / 100,000$$

Where:

S = Maximu theoretical steam loss per trap

Steam System	Avg Steam Loss <sup>317</sup> (lb/hr/trap)
Commercial Dry Cleaners	38.1
Commercial Heating (including Multifamily)LPS	13.8
Industrial Low Pressure, <15 psig	13.8
Industrial Medium Pressure >15 psig < 30 psig	12.7
Steam Trap, Industrial Medium Pressure ≥30 <75 psig	19
Steam Trap, Industrial High Pressure ≥75 <125 psig	67.9
Steam Trap, Industrial High Pressure ≥125 <175 psig	105.8
Steam Trap, Industrial High Pressure ≥175 <250 psig	143.7
Steam Trap, Industrial High	200.5

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<sup>317</sup>Resource Solutions Group "Steam Traps Revision #1" dated August 2011.

Pressure $\geq$ 250 psig	
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Hv = Heat of vaporization of steam

Steam System	Heat of Vaporization <sup>318</sup> (Btu/lb)
Commercial Dry Cleaners	890
Commercial Heating (including Multifamily) LPS	951
Industrial Low Pressure $\leq$ 15 psig	951
Industrial Medium Pressure $>$ 15 psig $<$ 30 psig	945
Steam Trap, Industrial Medium Pressure $\geq$ 30 $<$ 75 psig	928
Steam Trap, Industrial High Pressure $\geq$ 75 $<$ 125 psig	894
Steam Trap, Industrial High Pressure $\geq$ 125 $<$ 175 psig	868
Steam Trap, Industrial High Pressure $\geq$ 175 $<$ 250 psig	846
Steam Trap, Industrial High Pressure $\geq$ 250 psig	820

B = Boiler efficiency

= custom, if unknown 0.8<sup>319</sup>

<sup>318</sup>Heat of vaporization of steam at the inlet pressure to the steam trap. Implicit assumption that the average boiler nominal pressure where the vaporization occurs, is essentially that same pressure. Reference Resource Solutions Group "Steam Traps Revision #1" dated August 2011.

<sup>319</sup>California Energy Commission Efficiency Data for Steam Boilers as sited in Resource Solutions Group "Steam Traps Revision #1" dated August 2011.

Hours = Annual operating hours of steam plant

Steam System	Hours/Yr <sup>320</sup>	Zone
Commercial Dry Cleaners	2,425	
Industrial Low Pressure ≤15 psig	7,752	
Industrial Medium Pressure >15 psig < 30 psig	7,752	
Steam Trap, Industrial Medium Pressure ≥30 <75 psig	7,752	
Steam Trap, Industrial High Pressure ≥75 <125 psig	7,752	
Steam Trap, Industrial High Pressure ≥125 <175 psig	7,752	
Steam Trap, Industrial High Pressure ≥175 <250 psig	7,752	
Steam Trap, Industrial High Pressure ≥250 psig	7,752	
Industrial Medium Pressure >15 psig < 30 psig	7,752	
Steam Trap, Industrial Medium Pressure ≥30 <75 psig	7,752	
Commercial Heating (including Multifamily)LPS <sup>321</sup>	4,272	1 (Rockford)
	4,029	2 (Chicago O'Hare)
	3,406	3 (Springfield)
	2,515	4 (Belleville)
	2,546	5 (Marion)

A = Adjustment factor

<sup>320</sup> Resource Solutions Group "Steam Traps Revision #1" dated August 2011, which references Enbridge service territory data and kW Engineering study.

<sup>321</sup> Since commercial LPS reflect heating systems, Hours/yr are equivalent to HDD55 zone table

$$= 50\%^{322}$$

This factor is to account for reducing the maximum theoretical steam flow (S) to the average steam flow (the Enbridge factor).

L = Leaking & blow-thru

L is 1.0 when applied to the replacement of an individual leaking trap. If a number of steam traps are replaced and the system has not been audited, the leaking and blow-thru is applied to reflect the assumed percentage of steam traps that were actually leaking and needed replacing. A custom value can be utilized if supported by an evaluation.

Steam System	% <sup>323</sup>
Custom	Custom
Commercial Dry Cleaners	27%
Industrial Low Pressure ≤15 psig	16%
Industrial Medium Pressure >15 psig	16%
Commercial Heating (including Multifamily) LPS	27%

**EXAMPLE**

For example, a commercial dry cleaning facility with the default hours of operation and boiler efficiency;

$$\Delta\text{Therms} = S * (\text{Hv}/\text{B}) * \text{Hours} * A * L$$

$$= 38.1 \text{ lbs/hr/trap} * (890 \text{ Btu/lb} / 80\%) / 100,000 * 2,425 * 50\% * 27\% =$$

$$138.8 \text{ therms per trap}$$

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE:** CI-HVC-STRE-V02-130601

<sup>322</sup>Enbridge adjustment factor used as referenced in Resource Solutions Group "Steam Traps Revision #1" dated August 2011 and DOE Federal Energy Management Program Steam Trap Performance Assessment.

<sup>323</sup>Dry cleaners survey data as referenced in Resource Solutions Group "Steam Traps Revision #1" dated August 2011.

#### 4.4.17 Variable Speed Drives for HVAC

**DESCRIPTION**

This measure is applied to variable speed drives (VSD) which are installed on the following HVAC system applications: chilled water pump, hot water pumps, supply fans, return fans. All other VSD applications require custom analysis by the program administrator. The VSD will modulate the speed of the motor when it does not need to run at full load. Since the power of the motor is proportional to the cube of the speed for these types of applications, significant energy savings will result.

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**

The VSD is applied to a motor which does not have a VSD. The application must have a variable load and installation is to include the necessary controls. Savings are based on application of VSDs to a range of baseline load conditions including no control, inlet guide vanes, outlet guide vanes and throttling valves.

**DEFINITION OF BASELINE EQUIPMENT**

The time of sale baseline is a new motor installed without a VSD or other methods of control. Retrofit baseline is an existing motor operating as is. Retrofit baselines may or may not include guide vanes, throttling valves or other methods of control. This information shall be collected from the customer.

Installations of new equipment with VSDs which are required by IECC 2009 as adopted by the State of Illinois are not eligible for incentives.

**DEEMED LIFETIME OF EFFICIENT EQUIPMENT**

The expected measure life for HVAC application is 15 years;<sup>324</sup> measure life for process is 10 years.<sup>325</sup>

**DEEMED MEASURE COST**

Customer provided costs will be used when available. Default measure costs<sup>326</sup> are noted below for up to 20 hp motors. Custom costs must be gathered from the customer for motor sizes not listed below.

HP	Cost
1 -5 HP	\$ 1,330
7.5 HP	\$ 1,622
10 HP	\$ 1,898
15 HP	\$ 2,518
20 HP	\$ 3,059

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<sup>324</sup>Efficiency Vermont TRM 10/26/11 for HVAC VSD motors

<sup>325</sup>DEER 2008

<sup>326</sup>Ohio TRM 8/6/2010 varies by motor/fan size based on equipment costs from Granger 2008 Catalog pp 286-289, average across available voltages and models. Labor costs from RS Means Data 2008 Ohio average cost adjustment applied.

**DEEMED O&M COST ADJUSTMENTS**

There are no expected O&M savings associated with this measure

**LOADSHAPE**

- Loadshape C39 - VFD - Supply fans <10 HP
- Loadshape C40 - VFD - Return fans <10 HP
- Loadshape C41 - VFD - Exhaust fans <10 HP
- Loadshape C42 - VFD - Boiler feedwater pumps <10 HP
- Loadshape C43 - VFD - Chilled water pumps <10 HP
- Loadshape C44 - VFD Boiler circulation pumps <10 HP
- Loadshape C48 - VFD Boiler draft fans <10 HP
- Loadshape C49 - VFD Cooling Tower Fans <10 HP

**COINCIDENCE FACTOR**

The demand savings factor (DSF) is already based upon coincident savings, and thus there is no additional coincidence factor for this characterization.

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**Algorithm**

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**CALCULATION OF SAVINGS**

**ELECTRIC ENERGY SAVINGS**

$$\Delta kWh = kW_{connected} * Hours * ESF$$

Where:

$kW_{Connected}$  = kW of equipment is calculated using motor efficiency.

(HP \* .746 kw/hp\* load factor)/motor efficiency

Motors are assumed to have a load factor of 80% for calculating KW if actual values cannot be determined<sup>327</sup>. Custom load factor may be applied if known. Actual motor efficiency shall be used to calculate KW. If not known a default value of 93% shall be used.<sup>328</sup>

HP	BHP	Load Factor	kW Connected <sup>329</sup>
5 HP	5	80%	3.23
7.5 HP	7.5	80%	4.84
10 HP	10	80%	6.45
15 HP	15	80%	9.68

<sup>327</sup> Com Ed TRM June 1, 2010

<sup>328</sup> Ohio TRM 8/6/2010 pp207-209, Com Ed Trm June 1, 2010.

<sup>329</sup> Field data from Illinois evaluations, Navigant, 2011.

HP	BHP	Load Factor	kW Connected <sup>329</sup>
20 HP	20	80%	12.90

Hours = Default hours are provided for HVAC applications which vary by HVAC application and building type<sup>330</sup>. When available, actual hours should be used.

Building Type	Pumps and fans
College/University	4216
Grocery	5840
Heavy Industry	3585
Hotel/Motel	6872
Light Industry	2465
Medical	6871
Office	1766
Restaurant	4654
Retail/Service	3438
School(K-12)	2203
Warehouse	3222
Average=Miscellaneous	4103

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<sup>330</sup> Com Ed Trm June 1, 2010 page 139.

ESF = Energy savings factor varies by VFD application.

Application	ESF331
Hot Water Pump	0.482
Chilled Water Pump	0.432
Constant Volume Fan	0.535
Air Foil/inlet Guide Vanes	0.227
Forward Curved Fan, with discharge dampers	0.179
Forward Curved Inlet Guide Vanes	0.092

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

$$\Delta kW = kW_{\text{connected}} * DSF$$

Where:

DSF = Demand Savings Factor varies by VFD application.<sup>332</sup> Values listed below are based on typical peak load for the listed application. When possible the actual Demand Savings Factor should be calculated.

Application	DSF
Hot Water Pump	0
Chilled Water Pump	0.299
Constant Volume Fan	0.348
Air Foil/inlet Guide Vanes	0.13
Forward Curved Fan, with discharge dampers	0.136
Forward Curved Inlet Guide Vanes	0.03
Custom Process	custom

**FOSSIL FUEL IMPACT DESCRIPTIONS AND CALCULATION**

There are no expected fossil fuel impacts for this measure.

**WATER IMPACT DESCRIPTIONS AND CALCULATION**

N/A

<sup>331</sup> CL&P and UI Program Savings Documentation for 2008 Program Year. Average of hours across all building types. <http://www.ctsavesenergy.com/files/Final%202008%20Program%20Savings%20Document.pdf>.

<sup>332</sup> Ibid

**DEEMED O&M COST ADJUSTMENT CALCULATION**

N/A

**MEASURE CODE: CI-HVC-VSDH-V01-120601**