$\Delta kWh = BHP / \eta_{motor} \times HOURS \times ESF$

Where:

BHP = The brake horsepower of the motor. To be collected with the application.

η_{motor} = Efficiency of the motor that is driven by the VFD. To be collected with the application.

HOURS = The hours of operation for the motor. Default hours shown in table below.

Application	HOURS[516]
Hot water pump	6000
Chilled Water pump	1,852
Fans	3,985

ESF = Energy Savings Factor. See table in reference section.

For example, a VFD on a 5 BHP chilled water pump with 95% efficiency would see energy savings of:

$\Delta kWh = (5 / 0.95 * 1,852 * 0.432)$
$= 4,211$ kWh

Summer Coincident Peak Demand Savings

$\Delta kW = BHP / \eta_{motor} \times DSF$

Where:

DSF = Demand Savings Factor. See table in reference section

For example, a VFD on a 5 BHP chilled water pump with 95% efficiency would see peak demand savings of:

$\Delta kW = (5 / 0.95 * 0.299)$
$= 1.57$ kW

Baseline Adjustment
There are no expected code changes in the future.

Fossil Fuel Impact Descriptions and Calculation
There are no expected fossil fuel impacts for this measure.

Deemed O&M Cost Adjustment Calculation
There are no expected O&M savings associated with this measure.

Reference Tables

HVAC Fan VFD Savings Factors[517]

Baseline	ESF	DSF
Constant Volume	0.535	0.348
Air foil / backward inlet	0.354	0.26
Air foil inlet guide vanes	0.227	0.13
Forward curved	0.179	0.136
Forward curved inlet guide vanes	0.092	0.03

[516] CL&P and UI Program Savings Documentation for 2008 Program Year. Average of hours across all building types.
[517] Ibid.

HVAC Pump VFD Savings Factors[518]

System	ESF	DSF
Chilled water pump	0.432	0.299
Hot water pump	0.482	0

Ohio VFD Cost Analysis

HP	Altivar 61 (3-phase, 208-240 VAC, 50/60 Hz)	Altivar 61 (3-phase, 400-480 VAC, 50/60 Hz)	AC Adjustable-Frequency Drive (3-phase, 200-230 VAC, 60/50 Hz)	AC Adjustable-Frequency Drive (3-phase, 380-460 VAC, 60/50 Hz)	AF-300 P11 (3-phase, 200-230 VAC, 60/50 Hz)	AF-300 P11 (3-phase, 380-480 VAC, 60/50 Hz)	Altivar 31 (3-phase, 208-240 VAC, 50/60 Hz)	Altivar 31 (3-phase, 400-460 VAC, 50/60 Hz)	Average VFD Cost	Labor Hours	Labor Cost	Total Installed Cost*
5		1021	621	1022	1067	1369	637	675	$ 916	10	$ 413.62	$ 1,330
7.5		1146	1081	1297	1186	1521	1024.5	843.5	$ 1,128	11.94	$ 493.87	$ 1,622
10		1392	1342	1685	1484	1898	993	1032	$ 1,404	11.94	$ 493.87	$ 1,898
15	1647	1530	1649	2125	1800	2310		1359	$ 1,774	17.978	$ 743.61	$ 2,518
20	2067	1901	2205	2849	2407	3080		1687	$ 2,315	17.978	$ 743.61	$ 3,059
25	2410	2288	2668	3490	3038	3870			$ 2,961	23.881	$ 987.77	$ 3,948

Source: Grainger 2008 Catalog pp.286-289
* Jump in price at 15 stems from the RSMeans assumption that VFDs of this size and greater will require 2 electricians for installation

Source: RSMeans Mechanical Cost Data 2008

Labor Rate	45.55	$/hr
Ohio Average City		
Location Factor	90.8	
Columbus	89.2	
Marion	85.3	
Toledo	101	
Zanesville	84.5	
Steubenville	93.5	
Lorain	95.4	
Cleveland	104.2	
Akron	96.2	
Youngstown	91.8	
Hamilton	87	
Cincinnati	89	
Dayton	88.1	
Springfield	88.2	
Chillicothe	94.2	
Athens	77.6	
Lima	87.7	
Average	90.8	

Analyis prepared by M. Socks, Optimal Energy Inc.
Jul-10

Version Date & Revision History

Draft: Portfolio #
Effective date: Date TRM will become effective
End date: Date TRM will cease to be effective (or TBD)

518 Ibid.

Cool Roof (Retrofit – New Equipment)

Official Measure Code (Measure Number: X-X-X-X (Efficient Products, Lighting End Use)

Description
This section covers installation of "cool roof" roofing materials in commercial buildings. The cool roof is assumed to have a solar absorptance of 0.3[519] compared to a standard roof with solar absorptance of 0.8[520]. Energy and demand saving are realized through reductions in the building cooling loads. The approach utilizes DOE-2.2 simulations on a series of commercial prototypical building models. Energy and demand impacts are normalized per thousand square feet of roof space.

Definition of Efficient Equipment
The efficient condition is a roof with a solar absorptance of 0.30.

Definition of Baseline Equipment
The baseline condition is a roof with a solar absorptance of 0.80

Deemed Calculation for this Measure

Annual kWh Savings = $SF / 1000 * \Delta kWh_{kSF}$

Summer Coincident Peak kW Savings = $SF / 1000 * \Delta kW_{kSF} \times 0.74$

Annual MMBtu Increase = $SF / 1000 * \Delta MMBtu_{kSF}$

Deemed Lifetime of Efficient Equipment
The expected lifetime of the measure is 15 years[521].

Deemed Measure Cost
The full installed cost for retrofit applications is $8,454.67 per one thousand square feet (kSF)[522].

Deemed O&M Cost Adjustments
There are no expected O&M cost adjustments for this measure.

Coincidence Factor
The coincidence factor is 0.74[523].

REFERENCE SECTION

Calculation of Savings

Energy Savings

$$\Delta kWh = SF / 1000 * \Delta kWh_{kSF}$$

[519] Maximum value to meet Cool Roof standards under California's Title 24
[520] Itron. 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study. December 2005.
[521] 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, "Effective/Remaining Useful Life Values", California Public Utilities Commission, December 16, 2008
[522] 2005 Database for Energy-Efficiency Resources (DEER), Version 2005.2.01, "Technology and Measure Cost Data", California Public Utilities Commission, October 26, 2005
[523] Coincidence factor supplied by Duke Energy for the commercial HVAC end-use. Pending verification based on information from the utilities.

Where:

SF = The square footage of the roof. To be collected with the incentive form.

ΔkWh_{kSF} = unit energy savings per 100 square feet of roof. See lookup table below.

For example, an assembly building in Dayton with 1,000 square feet of roof:

ΔkWh = 1,000 / 1,000 * 184
= 192 kWh

Summer Coincident Peak Demand Savings

ΔkW = SF / 1000 * ΔkW_{kSF} x CF

Where:

ΔkW_{kSF} = unit demand savings per 1,000 square foot of roof area. This can be found in the table below.

CF = The summer coincident peak factor, or 0.74.

For example, an assembly building in Dayton with 1,000 square feet of roof:

ΔkW = 1,000 / 1,000 * 0.165 * 0.74
= 0.122 kW

Baseline Adjustment

There are no expected future code changes to affect this measure.

Fossil Fuel Impact Descriptions and Calculation

$\Delta MMBtu$ = SF / 1000 * $\Delta MMBtu_{kSF}$

Where:

$\Delta MMBtu_{kSF}$ = unit gas savings per 1000 square feet of roof space. See lookup table below.

For example, an assembly building in Dayton with 1,000 square feet of roof:

$\Delta MMBtu$ = 1,000 / 1,000 * -1.54
= -1.54 MMBtu

Deemed O&M Cost Adjustment Calculation

There are no expected O&M costs or savings associated with this measure.

Reference Tables

Cool Roof[524]

Building Type	City	ΔkWh_{kSF}	ΔkWh_{kSF}	$\Delta MMBtu_{kSF}$
Assembly	Akron	150	0.091	-1.54
	Cincinnati	199	0.141	-1.47
	Cleveland	153	0.044	-1.56
	Columbus	176	0.050	-1.87

[524] Unit energy, demand, and gas savings data is based on a series of prototypical small commercial building simulation runs. 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.

Building Type	City	ΔkWh_{kSF}	ΔkWh_{kSF}	$\Delta MMBtu_{kSF}$
	Dayton	184	0.165	-1.54
	Mansfield	143	0.029	-1.59
	Toledo	155	0.021	-1.62
Big Box Retail	Akron	149	0.098	-1.06
	Cincinnati	184	0.124	-0.99
	Cleveland	147	0.093	-1.08
	Columbus	173	0.120	-1.21
	Dayton	174	0.112	-1.01
	Mansfield	145	0.112	-1.11
	Toledo	159	0.099	-1.12
Fast Food Restaurant	Akron	141	0.100	-2.10
	Cincinnati	183	0.050	-2.40
	Cleveland	137	0.050	-2.55
	Columbus	164	0.000	-2.35
	Dayton	163	0.100	-2.25
	Mansfield	136	0.100	-2.20
	Toledo	140	0.050	-2.70
Full-Service Restaurant	Akron	191	0.175	-1.75
	Cincinnati	145	0.150	-1.85
	Cleveland	145	0.075	-1.85
	Columbus	171	0.125	-1.93
	Dayton	171	0.175	-1.85
	Mansfield	136	0.125	-1.88
	Toledo	158	0.150	-1.93
Light Industrial	Akron	95	0.116	-1.69
	Cincinnati	126	0.083	-1.78
	Cleveland	99	0.078	-1.69
	Columbus	106	0.085	-1.91
	Dayton	108	0.101	-1.83
	Mansfield	84	0.146	-1.74
	Toledo	105	0.105	-1.73
Primary School	Akron	206	0.500	-2.86
	Cincinnati	322	0.668	-3.00
	Cleveland	230	0.502	-2.96
	Columbus	241	0.570	-3.30
	Dayton	284	0.508	-3.00
	Mansfield	189	0.324	-3.09
	Toledo	237	0.456	-3.01
Small Office	Akron	148	0.080	-0.98
	Cincinnati	190	0.100	-0.94
	Cleveland	148	0.060	-1.02
	Columbus	175	0.080	-1.06
	Dayton	173	0.020	-0.98
	Mansfield	143	0.080	-1.06
	Toledo	166	0.080	-1.00
Small Retail	Akron	173	0.141	-1.50
	Cincinnati	173	0.141	-1.50

Building Type	City	ΔkWh_{kST}	ΔkWh_{kST}	$\Delta MMBtu_{kST}$
	Cleveland	169	0.078	-1.53
	Columbus	190	0.109	-1.77
	Dayton	194	0.156	-1.64
	Mansfield	154	0.094	-1.67
	Toledo	178	0.109	-1.69

Version Date & Revision History

Draft: Portfolio #

Effective date: Date TRM will become effective

End date: Date TRM will cease to be effective (or TBD)

Commercial Window Film (Retrofit – New Equipment)

Official Measure Code (Measure Number: X-X-X-X (Efficient Products, HVAC End Use)

Description
This section covers installation of reflective window film in commercial buildings. The baseline condition is assumed to be double pane clear glass with a solar heat gain coefficient (SHGC) of 0.73 and U-value of 0.72 Btu/hr-SF-deg F. The window film is assumed to provide a SHGC of 0.40 or less. Energy and demand savings are realized through reductions in the building cooling loads. The approach utilizes DOE-2.2 simulations on a series of commercial prototypical building models. The commercial simulation models are adapted from the California Database for Energy Efficiency Resources (DEER), with changes to reflect Ohio climate and building practices. Energy and demand impacts are normalized per 100 square feet of window.

Definition of Efficient Equipment
The efficient condition is double pane clear glass windows with a standard window film. The standard window film will lower the SHGC to 0.40.

Definition of Baseline Equipment
The baseline condition is double pane clear glass windows without any window film, with a U-value of 0.72, and a SHGC of 0.73.

Deemed Calculation for this Measure

$$\text{Annual kWh Savings} = SF / 100 * \Delta kWh_{100SF}$$

$$\text{Summer Coincident Peak kW Savings} = SF / 100 * \Delta kW_{100SF} * 0.74$$

$$\text{Annual MMBtu Increase} = SF / 100 * \Delta MMBtu_{100SF}$$

Deemed Lifetime of Efficient Equipment
The expected lifetime of the measure is 10 years[525].

Deemed Measure Cost
This is a retrofit only measure. Actual installed cost should be use, but for analysis purposes, the full installed cost including labor is assumed as $267 per 100 square feet of window[526].

Deemed O&M Cost Adjustments
There are no expected O&M savings associated with this measure

Coincidence Factor
The summer peak coincidence factor for this measure is 74%[527].

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[525] 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, "Effective/Remaining Useful Life Values", California Public Utilities Commission, December 16, 2008
[526] 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, "Cost Values and Summary Documentation", California Public Utilities Commission, December 16, 2008
[527] Coincidence factor supplied by Duke Energy for the commercial HVAC end-use. Pending verification based on information from the utilities.

REFERENCE SECTION

Calculation of Savings

Energy Savings

$\Delta kWh = SF / 100 * \Delta kWh_{100SF}$

Where:

SF = glazing surface area of installed window film, not including frame (square feet)

ΔkWh_{100SF} = unit energy savings per 100 square feet of window film. See lookup table below.

Summer Coincident Peak Demand Savings

$\Delta kW = SF / 100 * \Delta kW_{100SF} * CF$

Where:

ΔkW_{100SF} = unit demand savings per 100 square feet of window film. See lookup table below.

CF = summer coincident peak factor
= 0.74

Baseline Adjustment
Since this is a retrofit measure that only applies to existing buildings with clear, double pane windows, future code adjustments should not affect projected savings.

Fossil Fuel Impact Descriptions and Calculation
$\Delta MMBtu = SF / 100 * \Delta MMBtu_{100SF}$

Where:

$\Delta MMBtu_{100SF}$ = unit heating energy savings per 100 square feet of window film. See lookup table above.

Deemed O&M Cost Adjustment Calculation
There are no expected O&M savings or costs associated with this measure.

Reference Tables

Table 10: Window Film[528]

Building Type	City	ΔkWh_{100SF}	ΔkW_{100SF}	$\Delta MMBtu_{100SF}$
Assembly	Akron	309	0.16	-4.4
	Cincinnati	404	0.14	-4.0
	Cleveland	347	0.15	-4.2
	Columbus	316	0.05	-5.1
	Dayton	349	0.16	-4.7

[528] Unit energy, demand, and gas savings data is based on a series of prototypical small commercial building simulation runs. 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.

Building Type	City	ΔkWh_{100SF}	ΔkW_{100SF}	$\Delta MMBtu_{100SF}$
	Mansfield	292	0.05	-4.8
	Toledo	285	0.04	-5.4
Big Box Retail	Akron	298	0.19	-3.2
	Cincinnati	350	0.15	-3.3
	Cleveland	310	0.16	-3.2
	Columbus	304	0.12	-3.6
	Dayton	333	0.18	-3.5
	Mansfield	287	0.17	-4.1
	Toledo	303	0.14	-3.8
Fast Food Restaurant	Akron	240	0.19	-5.2
	Cincinnati	292	0.14	-5.4
	Cleveland	254	0.14	-5.1
	Columbus	259	0.07	-5.1
	Dayton	272	0.15	-5.2
	Mansfield	235	0.17	-5.7
	Toledo	237	0.12	-6.0
Full Service Restaurant	Akron	220	0.19	-7.5
	Cincinnati	281	0.17	-7.1
	Cleveland	236	0.19	-6.9
	Columbus	255	0.17	-6.6
	Dayton	264	0.19	-7.2
	Mansfield	222	0.19	-7.3
	Toledo	227	0.19	-7.9
Light Industrial	Akron	197	0.20	-4.1
	Cincinnati	225	0.14	-4.6
	Cleveland	222	0.07	-3.9
	Columbus	160	0.14	-4.6
	Dayton	230	0.14	-4.1
	Mansfield	172	0.23	-4.4
	Toledo	181	0.14	-4.4
Primary School	Akron	345	0.18	-7.2
	Cincinnati	452	0.20	-7.8
	Cleveland	399	0.17	-7.2
	Columbus	352	0.17	-7.6
	Dayton	416	0.20	-7.7
	Mansfield	329	0.06	-8.0
	Toledo	357	0.15	-7.8
Small Office	Akron	245	0.14	-2.7
	Cincinnati	304	0.14	-2.5
	Cleveland	258	0.12	-2.7
	Columbus	271	0.12	-2.6
	Dayton	282	0.09	-2.7
	Mansfield	247	0.13	-3.0
	Toledo	264	0.13	-3.0
Small Retail	Akron	259	0.17	-4.6
	Cincinnati	311	0.15	-4.5
	Cleveland	269	0.15	-4.6

Building Type	City	ΔkWh_{100SF}	ΔkW_{100SF}	$\Delta MMBtu_{100SF}$
	Columbus	277	0.14	-4.6
	Dayton	286	0.18	-4.9
	Mansfield	252	0.18	-5.1
	Toledo	262	0.16	-5.3

Version Date & Revision History
Draft: Portfolio #
Effective date: Date TRM will become effective
End date: TBD

Roof Insulation (Retrofit – New Equipment)

Official Measure Code (Measure Number: X-X-X-X (Efficient Products, Lighting End Use)

Description
This section covers improvements to the roof insulation in commercial buildings. Roof insulation R-value is assumed to increase to R-18 from the baseline level assumed for each building type. Energy and demand saving are realized through reductions in the building heating and cooling loads. The approach utilizes DOE-2.2 simulations on a series of commercial prototypical building models. The commercial simulation models are adapted from the California Database for Energy Efficiency Resources (DEER) study, with changes to reflect Ohio climate and building practices. Energy and demand impacts are normalized per thousand square feet of installed insulation.

Definition of Efficient Equipment
The efficient condition is R-18 insulation on the roof.

Definition of Baseline Equipment
The baseline condition by building type is shown in the table below:

Building Type	Baseline R-Value
Assembly	R-12
Big Box Retail	R-13.5
Fast Food	R-13.5
Full Service Restaurant	R-13.5
Light Industrial	R-12
School	R-13.5
Small Office	R-13.5
Small Retail	R-13.5

Deemed Calculation for this Measure

Annual kWh Savings = $SF / 1000 * \Delta kWh_{kSF}$

Summer Coincident Peak kW Savings = $SF / 1000 * \Delta kW_{kSF} * 0.74$

Annual MMBtu Increase = $SF / 1000 * \Delta MMBtu_{kSF}$

Deemed Lifetime of Efficient Equipment
The expected lifetime of the measure is 20 years[529].

Deemed Measure Cost
The full installed cost for retrofit applications is $1.36 per square foot[530].

Deemed O&M Cost Adjustments
There are no expected O&M cost adjustments for this measure.

Coincidence Factor
The coincidence factor is 0.74[531].

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[529] 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, "Effective/Remaining Useful Life Values", California Public Utilities Commission, December 16, 2008.
[530] 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, "Cost Values and Summary Documentation", California Public Utilities Commission, December 16, 2008.
[531] Coincidence factor supplied by Duke Energy for the commercial HVAC end-use. Pending verification based on information from the utilities.

REFERENCE SECTION

Calculation of Savings

Energy Savings

$\Delta kWh = SF / 1000 * \Delta kWh_{kSF}$

Where:

SF = The square footage of the roof. To be collected with the incentive form.

ΔkWh_{kSF} = the kWh savings per thousand square feet of roof area. This depends on the building type and region in Ohio, and can be found in the lookup table below.

Summer Coincident Peak Demand Savings

$\Delta kW = SF / 1000 * \Delta kW_{kSF} * CF$

Where:

ΔkW_{kSF} = the kW savings per thousand square feet of roof area. This depends on the building type and region in Ohio, and can be found in the lookup table below.

CF = The summer coincident peak factor, or 0.74.

Baseline Adjustment

There are no expected future code changes to affect this measure.

Fossil Fuel Impact Descriptions and Calculation

$\Delta MMBtu = SF / 1000 * \Delta MMBtu_{kSF}$

Where:

$\Delta MMBtu_{kSF}$ = unit gas savings per thousand square feet of roof space. See lookup table below.

Deemed O&M Cost Adjustment Calculation

There are no expected O&M costs or savings associated with this measure.

Reference Tables

Roof Insulation[532]

Building Type	City	ΔkWh_{kSF}	ΔKW_{kSF}	$\Delta MMBtu_{kSF}$
Assembly	Akron	28	0.047	3.5
	Cincinnati	34	0.065	2.7
	Cleveland	26	0.021	2.9
	Columbus	36	0.024	3.2
	Dayton	36	0.076	3.5
	Mansfield	31	0.012	3.3
	Toledo	41	0.018	5.0

[532] Unit energy, demand, and gas savings data is based on a series of prototypical small commercial building simulation runs. 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.

Building Type	City	ΔkWh_{kSF}	ΔKW_{kSF}	$\Delta MMBtu_{kSF}$
Big Box Retail	Akron	-6	0.025	2.5
	Cincinnati	-5	0.039	1.9
	Cleveland	-4	0.028	2.5
	Columbus	-1	0.034	2.6
	Dayton	-2	0.032	2.5
	Mansfield	-8	0.030	2.8
	Toledo	2	0.023	3.0
Fast Food Restaurant	Akron	37	0.050	3.6
	Cincinnati	49	0.000	3.1
	Cleveland	43	0.000	3.6
	Columbus	39	0.000	3.3
	Dayton	45	0.050	3.4
	Mansfield	36	0.050	3.7
	Toledo	43	0.000	3.8
Full-Service Restaurant	Akron	74	0.050	5.1
	Cincinnati	77	0.050	4.3
	Cleveland	78	0.025	5.3
	Columbus	63	0.050	4.3
	Dayton	69	0.075	4.4
	Mansfield	71	0.050	5.3
	Toledo	84	0.050	5.6
Light Industrial	Akron	57	0.028	4.3
	Cincinnati	68	0.018	3.6
	Cleveland	64	0.012	4.2
	Columbus	51	0.023	3.6
	Dayton	63	0.028	4.1
	Mansfield	60	0.029	4.5
	Toledo	53	0.021	4.4
Primary School	Akron	115	-0.008	4.4
	Cincinnati	131	0.150	3.9
	Cleveland	117	0.106	4.4
	Columbus	109	0.054	4.0
	Dayton	126	0.034	4.2
	Mansfield	113	0.056	4.7
	Toledo	116	0.108	4.6
Small Office	Akron	21	0.020	2.1
	Cincinnati	26	0.040	1.6
	Cleveland	27	0.020	2.1
	Columbus	21	0.040	1.7
	Dayton	26	0.000	1.9
	Mansfield	20	0.040	2.2
	Toledo	23	0.020	2.1
Small Retail	Akron	51	0.047	3.4
	Cincinnati	52	0.047	2.8
	Cleveland	53	0.031	3.4
	Columbus	43	0.031	2.9
	Dayton	53	0.047	3.2

Building Type	City	ΔkWh_{KSF}	ΔKW_{KSF}	$\Delta MMBtu_{KSF}$
	Mansfield	48	0.047	3.6
	Toledo	52	0.031	3.8

Version Date & Revision History
Draft: Portfolio #
Effective date: Date TRM will become effective
End date: Date TRM will cease to be effective (or TBD)

High Performance Glazing (Retrofit – Early Replacement)

Official Measure Code (Measure Number: X-X-X-X (Efficient Products, Lighting End Use)

Description
This section covers installation of high performance glazing in commercial buildings. The baseline condition is assumed to be double pane clear glass with a solar heat gain coefficient of 0.73 and U-value of 0.72 Btu/hr-SF-deg F. The efficient glazing must have a solar heat gain coefficient of 0.40 or less and U-value of 0.57 Btu/hr-SF-deg F or less. Energy and demand saving are realized through reductions in the building heating and cooling loads. The approach utilizes DOE-2.2 simulations on a series of commercial prototypical building models. The commercial simulation models are adapted from the California Database for Energy Efficiency Resources (DEER) study, with changes to reflect Ohio climate and building practices. Energy and demand impacts are normalized per 100 square feet of window.

Definition of Efficient Equipment
The efficient condition is a window with a U-value of 0.57 and a solar heat gain coefficient of 0.4.

Definition of Baseline Equipment
The baseline condition is a window with a U-value of 0.72 and a solar heat gain coefficient of 0.73.

Deemed Calculation for this Measure

Annual kWh Savings $= SF / 100 * (\Delta kWh_{100SF})$

Summer Coincident Peak kW Savings $= SF / 100 * (\Delta kW_{100SF}) * 0.74$

Annual MMBTU Increase $= SF / 100 * (\Delta MMBtu_{100SF})$

Deemed Lifetime of Efficient Equipment
The expected lifetime of the measure is 20 years[533] .

Deemed Measure Cost
The full installed cost for retrofit applications is $54.82 per square foot of window[534].

Deemed O&M Cost Adjustments
There are no expected O&M cost adjustments for this measure.

Coincidence Factor
The coincidence factor is 0.74[535].

REFERENCE SECTION

Calculation of Savings

[533] 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, "Effective/Remaining Useful Life Values", California Public Utilities Commission, December 16, 2008.
[534] Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, February, 19, 2010. Value derived from Efficiency Vermont project experience and conversations with suppliers.
[535] Coincidence factor supplied by Duke Energy for the commercial HVAC end-use. Pending verification based on information from the utilities.

Energy Savings

$\Delta kWh = SF / 100 * (\Delta kWh_{100SF})$

Where:

SF = glazing surface area of installed window, not including frame (square feet).

ΔkWh_{100SF} = the kWh savings per 100 square feet of window space. See lookup table below.

Summer Coincident Peak Demand Savings

$\Delta kW = SF / 100 * (\Delta kW_{100SF}) * CF$

Where:

ΔkW_{100SF} = the kW savings per 100 square feet of window space. See lookup table below.

CF = The summer coincident peak factor, or 0.74.

Baseline Adjustment

There are no expected future code changes to affect this measure.

Fossil Fuel Impact Descriptions and Calculation

$\Delta MMBtu = SF / 100 * (\Delta MMBtu_{100SF})$

Where:

$\Delta MMBtu_{100SF}$ = unit gas savings per 100 square feet of window space. See lookup table below.

Deemed O&M Cost Adjustment Calculation

There are no expected O&M costs or savings associated with this measure.

Reference Tables

High Performance Windows[536]

Building Type	City	ΔkWh_{100SF}	ΔkW100SF	$\Delta MMBtu_{100SF}$
Assembly	Akron	269	0.152	-0.28
	Cincinnati	358	0.138	-0.86
	Cleveland	300	0.143	-0.75
	Columbus	278	0.052	-0.63
	Dayton	312	0.157	-0.43
	Mansfield	262	0.052	-0.26
	Toledo	264	0.038	-0.03
Big Box Retail	Akron	267	0.203	-0.35
	Cincinnati	315	0.158	-1.23
	Cleveland	281	0.169	-0.51
	Columbus	278	0.124	-0.91
	Dayton	301	0.180	-1.04
	Mansfield	263	0.180	-0.56

[536] Unit energy, demand, and gas savings data is based on a series of prototypical small commercial building simulation runs. 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.

Building Type	City	ΔkWh_{100SF}	$\Delta \bar{kW}100SF$	$\Delta MMBtu_{100SF}$
	Toledo	276	0.135	-0.59
Fast Food Restaurant	Akron	253	0.189	-0.29
	Cincinnati	301	0.155	-0.84
	Cleveland	269	0.138	-0.31
	Columbus	260	0.069	-0.86
	Dayton	280	0.155	-0.65
	Mansfield	251	0.172	-0.43
	Toledo	253	0.120	-0.79
Full-Service Restaurant	Akron	268	0.193	-0.55
	Cincinnati	313	0.166	-1.30
	Cleveland	281	0.193	-0.47
	Columbus	265	0.166	-1.63
	Dayton	294	0.193	-1.22
	Mansfield	259	0.193	-0.86
	Toledo	273	0.193	-1.02
Light Industrial	Akron	218	0.136	-2.21
	Cincinnati	188	0.203	-1.47
	Cleveland	220	0.068	-1.40
	Columbus	159	0.136	-2.21
	Dayton	236	0.136	-1.47
	Mansfield	186	0.226	-1.56
	Toledo	185	0.136	-1.81
Primary School	Akron	398	0.189	-2.53
	Cincinnati	493	0.204	-3.50
	Cleveland	443	0.181	-2.63
	Columbus	386	0.172	-3.41
	Dayton	456	0.198	-3.35
	Mansfield	384	0.065	-3.10
	Toledo	400	0.157	-3.08
Small Office	Akron	241	0.144	-0.38
	Cincinnati	294	0.144	-0.60
	Cleveland	257	0.122	-0.41
	Columbus	259	0.118	-0.68
	Dayton	273	0.083	-0.52
	Mansfield	241	0.131	-0.52
	Toledo	258	0.127	-0.59
Small Retail	Akron	272	0.177	-0.77
	Cincinnati	315	0.158	-1.32
	Cleveland	283	0.158	-0.75
	Columbus	277	0.149	-1.42
	Dayton	296	0.177	-1.23
	Mansfield	266	0.186	-0.95
	Toledo	274	0.158	-1.28

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Engineered Nozzles (Time of Sale, Retrofit - Early Replacement)

Official Measure Code (Measure Number: X-X-X-X (Program name, End Use)

Description
Engineered nozzles use compressed air to entrain and amplify atmospheric air into a stream, thus increasing pressure with minimal compressed air use. They are able to induce a large airflow entrainment while still using a smaller volume of air than open jets. The velocity of the resulting airflow is reduced, but the mass flow of the air is increased, thus increasing the cooling and drying effect. Energy savings result due to a decrease in compressor work that is required to provide the nozzles with compressed air. Engineered nozzles have the added benefits of noise reduction and improved safety in systems with greater than 30 psig.

Definition of Efficient Equipment
The efficient condition assumes an engineered nozzle is equipped to the end of a pneumatic tool.

Definition of Baseline Equipment
The baseline condition assumes an open copper tube or an air gun with an open end.

Deemed Savings for this Measure

Annual kWh Savings = $0.0145 \times (FLOW_{baseline} - FLOW_{eng}) \times HOURS$

Summer Coincident Peak kW Savings = $0.0109 \times (FLOW_{baseline} - FLOW_{eng})$

Deemed Lifetime of Efficient Equipment
15 years[537]

Deemed Measure Cost
$14[538]

Deemed O&M Cost Adjustments
n/a

Coincidence Factor
0.75[539]

REFERENCE SECTION

Calculation of Savings

Energy Savings

$$\Delta kWh = (FLOW_{baseline} - FLOW_{eng}) \times kW_{scfm} \times \%USE \times HOURS$$

Where:

kW_{scfm} = the average amount of electrical demand needed to produce one cubic foot of air at 100 PSI
= 0.29[540]

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[537] PA Consulting Group (2009). *Business Programs: Measure Life Study*. Prepared for State of Wisconsin Public Service Commission
[538] See "Compressed Air Analysis.xls" for cost details
[539] PG&E 1996, RLW Schools, RLW CF, SDG&E Time of Use Surveys. Based on 4p-5p peak
[540] See "Compressed Air Analysis.xls" for more detail

$FLOW_{baseline}$ = The flow rate of compressed air from an open end (SCFM)
$FLOW_{eng}$ = The flow rate of compressed air from an engineered nozzle (SCFM)
= Depending on size of nozzle:

	Open Flow (SCFM)[541] $FLOW_{baseline}$	Engineered Nozzle (SCFM)[542] $FLOW_{eng}$	ΔSCFM
1/8" Nozzle	21	6	15
1/4" Nozzle	58	11	47

%USE = percent of the compressor total operating hours that the nozzle is in use (5% for 3 seconds of use per minute)
= 0.05[543]

HOURS = annual operating hours of the compressed air system
= If site specific value is unknown, assume vales based on number of facility shifts as below:

No. of Shifts	HOURS	Description
Single Shift(8/5)	1976	7am – 3pm, weekdays, minus holidays and scheduled downtime
2-Shift	3952	7am – 11pm, weekdays, minus holidays and scheduled downtime
3-Shift	5928	24 hours per day, weekdays, minus holidays and scheduled downtime
4-Shift	8320	24 hours per day, 7 days a week minus holidays and scheduled downtime

Summer Coincident Peak Demand Savings

$$\Delta kW = \Delta kWh / HOURS \times CF$$

Where:

ΔkWh = Energy Savings, caculated above
HOURS = Operating Hours, see above
CF = Peak coincidence factor
= 0.75

Fossil Fuel Impact Descriptions and Calculation
n/a

Water Impact Descriptions and Calculation
n/a

Deemed O&M Cost Adjustment Calculation
n/a

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[541] Machinery's Handbook 25th Edition.
[542] Survey of Engineered Nozzle Suppliers
[543] Assumes 50% handheld air guns and 50% stationary air nozzles. Manual air guns tend to be used less than stationary air nozzles, and a conservative estimate of 1 second of blow-off per minute of compressor run time is assumed. Stationary air nozzles are commonly more wasteful as they are often mounted on machine tools and can be manually operated resulting in the possibility of a long term open blow situation. An assumption of 5 seconds of blow-off per minute of compressor run time is used.

Insulated Pellet Dryers (Retrofit)

Official Measure Code (Measure Number: X-X-X-X (Program name, End Use)

Description
Resin pellets used in injection molders and extruders are typically dried using electrically heated and desiccant dried air. Flexible ducts in the 3" to 8" diameter size range circulate the drying air. Air temperatures usually range from 160°F to 200°F. Un-insulated duct heat loss must be replaced by electric resistance heaters. Most facilities have pellet dryers running constantly to maintain pellet dryness at all times.

Definition of Efficient Equipment
The efficient condition is a pellet dryer with insulation on the heat ducts.

Definition of Baseline Equipment
The baseline condition is pellet dryer with un-insulated heat ducts.

Deemed Savings for this Measure

Annual kWh Savings $= L \times (kW_{baseline} - kW_{eff}) \times HOURS$

Summer Coincident Peak kW Savings $= L \times (kW_{baseline} - kW_{eff}) \times CF$

Deemed Lifetime of Efficient Equipment
5 years[544]

Deemed Measure Cost
Incremental costs are based on linear feet and diameter of heating ducts.

Incremental Capital Cost[545]

Diameter of Pipe (in.)	Incremental Cost of Insulation ($/ft.)
3"	$33
4"	$43
5"	$54
6"	$65
8"	$86

Deemed O&M Cost Adjustments
n/a

Coincidence Factor
0.75[546]

REFERENCE SECTION

Calculation of Savings

[544] Engineering Judgment
[545] Based on a review of available manufacturer pricing information
[546] PG&E 1996, RLW Schools, RLW CF, SDG&E Time of Use Surveys.

Energy Savings

$$\Delta kWh = L \times (kW_{baseline} - kW_{eff}) \times HOURS$$

Where:

ΔkWh = non-coincident demand savings
L = Length of pipe to be insulated (ft.)
$kW_{baseline}$ = maximum hourly demand at technology level without insulation
= See table below
kW_{eff} = maximum hourly demand at technology level with pipe insulation
= See table below
HOURS = annual operating hours
= 4962[547]

Summer Coincident Peak Demand Savings

$$\Delta kW = L \times (kW_{baseline} - kW_{eff}) \times CF$$

Where:

CF = Summer Coincident Peak Factor
= 0.75[548]

Fossil Fuel Impact Descriptions and Calculation
n/a

Water Impact Descriptions and Calculation
n/a

Deemed O&M Cost Adjustment Calculation
n/a

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[547] State of Wisconsin Public Service Commission of Wisconsin, Focus on Energy Evaluation, Business Programs: Deemed Savings Parameter Development. August 2009. PA Consulting Group Inc.
[548] PG&E 1996, RLW Schools, RLW CF, SDG&E Time of Use Surveys.

Reference Tables

Electric Demand for Load Temperatures and Duct Diameters

Temperature (°F)	Duct Diameter (in)	$KW_{baseline}$	$KW_{energyefficientmethod}$	ΔKW
160	3	0.03/ft	0.01/ft	0.02/ft
	4	0.04/ft	0.01/ft	0.03/ft
	5	0.05/ft	0.01/ft	0.04/ft
	6	0.06/ft	0.01/ft	0.05/ft
	8	0.09/ft	0.01/ft	0.08/ft
170	3	0.03/ft	0.01/ft	0.03/ft
	4	0.05/ft	0.01/ft	0.04/ft
	5	0.06/ft	0.01/ft	0.05/ft
	6	0.07/ft	0.01/ft	0.06/ft
	8	0.10/ft	0.01/ft	0.09/ft
180	3	0.04/ft	0.01/ft	0.03/ft
	4	0.05/ft	0.01/ft	0.04/ft
	5	0.07/ft	0.01/ft	0.06/ft
	6	0.08/ft	0.01/ft	0.07/ft
	8	0.11/ft	0.01/ft	0.10/ft
190	3	0.04/ft	0.01/ft	0.04/ft
	4	0.06/ft	0.01/ft	0.05/ft
	5	0.07/ft	0.01/ft	0.06/ft
	6	0.09/ft	0.01/ft	0.08/ft
	8	0.13/ft	0.02/ft	0.11/ft
200	3	0.05/ft	0.01/ft	0.04/ft
	4	0.07/ft	0.01/ft	0.06/ft
	5	0.08/ft	0.01/ft	0.07/ft
	6	0.10/ft	0.01/ft	0.09/ft
	8	0.14/ft	0.02/ft	0.12/ft

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Injecting Molding Barrel Wrap (Retrofit – New Equipment)

Official Measure Code (Measure Number: X-X-X-X (Program name, End Use)

Description
Removable insulated blankets enclose the cylindrical barrels of an injection molding machine. Surface temperatures of the barrels range from 300°F to 600°F, depending on the resins processed. Barrels are heated either with electric resistance band heaters or by friction from the mechanical screw which shears plastic material in the barrel generating frictional heat. Insulated blankets minimize the use of resistance heating without affecting temperature control of the resin. Barrel wraps are held in place by straps. Blankets are available either in standard sizes or can be custom manufactured.

Definition of Efficient Equipment
The efficient condition is assumed to be an injection molding machine with an insulating blanket or vest wrapped around the barrel.

Definition of Baseline Equipment
The baseline condition is assumed to be an injection molding machine with no added insulation.

Deemed Savings for this Measure

Annual kWh Savings $= (\Delta E_{Loss} * LEN_{Barrel} * D_{Barrel} * \pi) / 1000 * HOURS$

Summer Coincident Peak kW Savings $= (\Delta E_{Loss} * LEN_{Barrel} * D_{Barrel} * \pi) / 1000$

Deemed Lifetime of Efficient Equipment
5 years[549]

Deemed Measure Cost
The actual measure installation cost should be used (including material and labor).

Deemed O&M Cost Adjustments
n/a

Coincidence Factor
0.75[550]

REFERENCE SECTION

Calculation of Savings

Energy Savings

$$\Delta kWh = (\Delta E_{Loss} * LEN_{Barrel} * D_{Barrel} * \pi) / 1000 * HOURS$$

Where:

ΔE_{Loss} = The difference in heat loss (measured in watts/ft^2 needed to replace lost heat) between an injection molding barrel with insulation compared to an injection molding barrel without insulation. This is dependent on the operating temperatiure (site specific) and the

[549] Engineering judgment
[550] PG&E 1996, RLW Schools, RLW CF, SDG&E Time of Use Surveys. Pending verification based on information to be provided by the utilities.

thickness of the insulation (site specific). See the table "Calculating Barrel Heat Loss" in the reference table section for associated values.

LEN_{Barrel} = The length of the barrel
= Actual installed

D_{Barrel} = The diameter of the barrel
= Actual installed

π = 3.14159

1000 = conversion factor for watts to kilowatts

HOURS = Annual operating hours
= If actual operating hours are unknown, assume 3952[551].

Summer Coincident Peak Demand Savings

$$\Delta kW = (\Delta E_{Loss} * LEN_{Barrel} * D_{Barrel} * \pi) / 1000 * CF$$

Where:

CF = Summer Peak Coincidence Factor
= 0.75

Fossil Fuel Impact Descriptions and Calculation
n/a

Water Impact Descriptions and Calculation
n/a

Deemed O&M Cost Adjustment Calculation
n/a

Reference Tables

Calculating Barrel Heat Loss[552]

Operating Temperature (°F)	No Insulation (Watts/ ft²)	1" Insulation (Watts/ft²)	1.5" Insulation (Watts/ft²)
300	180	18.6	12.4
325	210	20.9	14
350	243	23.4	15.6
375	275	26	17.3
400	313	29	19
425	350	31.5	21
450	387	34.3	22.9
475	425	37.2	24.8
500	465	40.1	25.8
525	505	43.2	26.9
550	550	46.5	28.3
575	605	49.9	29.9
600	660	54.1	32.1

[551] Default annual operating hours estimate assumes equipment operates continuously on a typical 2-shift operation (7am – 11pm, weekdays, minus some holidays and scheduled down time).
[552] Industrial Modeling Supplies (2009). Reference/Conversion Chart. http://www.imscompany.com/pdf/Tech%20Tips%20&%20Conversion%20and%20Reference%20Charts.pdf

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ENERGY STAR Hot Food Holding Cabinet (Time of Sale)

Official Measure Code (Measure Number: X-X-X-X (Program name, End Use)

Description
Commercial insulated hot food holding cabinet models that meet program requirements incorporate better insulation, reducing heat loss, and may also offer additional energy saving devices such as magnetic door electric gaskets, auto-door closures, or dutch doors. The insulation of the cabinet also offers better temperature uniformity within the cabinet from top to bottom. This means that qualified hot food holding cabinets are more efficient at maintaining food temperature while using less energy.

Definition of Efficient Equipment
The efficient equipment is assumed to be an ENERGY STAR qualified hot food holding cabinet with an idle energy rate of $0.04kW/ft^3$

Definition of Baseline Equipment
The baseline equipment is assumed to be a standard hot food holding cabinet with an idle energy rate of $0.1kW/ft^3$

Deemed Savings for this Measure

Annual kWh Savings =

Full Size	Three-Quarter Size	Half Size
5,256	2,847	1,862

Summer Coincident Peak kW Savings =

Full Size	Three-Quarter Size	Half Size
0.80	0.44	0.29

Deemed Lifetime of Efficient Equipment
12 years[553]

Deemed Measure Cost
The incremental cost for Energy Star hot food holding cabinet is assumed to be $1,110[554]

Deemed O&M Cost Adjustments
n/a

Coincidence Factor
0.84[555]

REFERENCE SECTION

Calculation of Savings

Energy Savings

$$kW_{save} = (W_{foot\ base} - W_{foot\ eff}) \times VOLUME \times 1000$$
$$kWH = kW_{save} \times HOURS$$

553 Food Service Technology Center (FSTC). Default value from life cycle cost calculator. http://www.fishnick.com/saveenergy/tools/calculators/ecombicalc.php
554 NYSERDA Deemed Savings Database
555 RLW Analytics. Coincidence Factor Study – Residential and Commercial Industrial Lighting Measures. Spring 2007.

Where:

kW_{save} = the difference in connected load between the baseline and the efficient equipment (before the coincidence factor is applied)

HOURS = Annual operating hours
= 5475[556]

Summer Coincident Peak Demand Savings

$$kW_{save} = (W_{foot\ base} - W_{foot\ eff}) \times VOLUME \times 1000$$
$$\Delta kW = kW \times CF$$

Where:

kW_{save} = the difference in connected load between the baseline and the efficient equipment (before the coincidence factor is applied)

$W_{foot\ base}$ = the electrical demand per cubic foot of the baseline equipment

$W_{foot\ eff}$ = the electrical demand per cubic foot of the efficient equipment

VOLUME = the internal volume of the holding cabinet (ft^3)

1,000 = conversion of W to kW

Parameter	Full Size	Three-Quarter Size	Half Size
VOLUME[557]	20	12	8
$W_{foot\ base}$	70	70	70
$W_{foot\ eff}$	22	27	29
kWsave	0.96	0.52	0.34

CF = Summer Peak Coincidence Factor
= 0.84

Fossil Fuel Impact Descriptions and Calculation
n/a

Water Impact Descriptions and Calculation
n/a

Deemed O&M Cost Adjustment Calculation
n/a

Reference Tables
n/a

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[556] Food Service Technology Center (FSTC), based on assumption that restaurant is open 15 hours a day, 365 days a year.
[557] Sizes are from ENERGY STAR calculator

Steam Cookers (Time of Sale)

Official Measure Code (Measure Number: X-X-X-X (Program name, End Use)

Description
Energy efficient steam cookers that have earned the ENERGY STAR offer shorter cook times, higher production rates, and reduced heat loss due to better insulation and more efficient steam delivery system. Energy usage calculations are based on 12 hours a day, 365 days per year, with one preheat and cooking 100 pounds per day of food.

Definition of Efficient Equipment
The efficient condition assumes the installation of an ENERGY STAR qualified steam cooker.

Definition of Baseline Equipment
The baseline condition assumes a conventional boiler-style steam cooker meeting minimum federal standards for electricity and water consumption.

Deemed Calculations for this Measure

Annual kWh Savings = $kWH_{base} - kWh_{eff}$

Summer Coincident Peak kW Savings = (Annual kWh Savings / HOURS) x CF

Deemed Lifetime of Efficient Equipment
12 years[558]

Deemed Measure Cost
The incremental cost of an ENERGY STAR steam cooker is $2,000[559]

Deemed O&M Cost Adjustments
n/a

Coincidence Factor
0.84[560]

REFERENCE SECTION

Calculation of Savings

Energy Savings

$$kWH = [LB \times E_{FOOD}/EFF + IDLE \times (HOURS_{DAY} - LB/PC - PRE_{TIME}/60) + PRE_{ENERGY}] \times DAYS$$

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

Where:

kWH_{base} = the annual energy usage of the baseline equipment calculated using baseline values
kWH_{eff} = the annual energy usage of the efficient equipment calculated using efficient values
$HOURS_{DAY}$ = Daily operating hours

558 Food Service Technology Center (FSTC). Default value from life cycle cost calculator. http://www.fishnick.com/saveenergy/tools/calculators/esteamercalc.php
559 NYSERDA Deemed Savings Database
560 RLW Analytics. Coincidence Factor Study – Residential and Commercial Industrial Lighting Measures. Spring 2007.

= 12[561]

PRE_{TIME} = Preheat time (min/day), the amount of time it takes a steamer to reach operating temperature when turned on
= 15 min/day[562]

PRE_{ENERGY} = Preheat energy (kWh/day)
= 1.5 kWh/day[563]

E_{FOOD} = ASTM Energy to Food (kWh/lb); the amount of energy absorbed by the food during cooking, per pound of food
= 0.038[564]

DAYS = Operating days per year
= 365

The following variables are dependent on the pan capacity of efficient equipment which is a site specific variable. See the 'Reference Tables' section for the associated values

EFF = Heavy load cooking energy efficiency (%)
IDLE = Idle energy rate
PC = Production capacity (lbs/hr)
LB = Pounds of food cooked per day (lb/day)

Summer Coincident Peak Demand Savings

$$\Delta kW = (\Delta kWh / HOURS) \times CF$$

Where:

ΔkWh = Annual energy savings (kWh)
HOURS = Equivalent full load hours
= 4380
CF = Summer Peak Coincidence Factor for measure
= 0.84

Fossil Fuel Impact Descriptions and Calculation
n/a

Water Impact Descriptions and Calculation

$$\Delta Water = (Rate_{base} - Rate_{eff}) \times EFLH$$
$$= 30 \times EFLH$$

Where

ΔWater = Annual water savings (gal)
$Rate_{base}$ = Water consumption rate (gal/h) of baseline equipment
= 40[565]
$Rate_{eff}$ = Water consumption rate (gal/h) of baseline equipment
= 10[566]
EFLH = Equivalent full load hours
= 4380

[561] Food Service Technology Center (FSTC), based on assumption that restaurant is open 12 hours a day, 365 days a year.
[562] FSTC (2002). *Commercial Cooking Appliance Technology Assessment*. Chapter 8: Steamers.
[563] Ibid.
[564] American Society for Testing and Materials. Industry Standard.
[565] FSTC (2002). *Commercial Cooking Appliance Technology Assessment*. Chapter 8: Steamers.
[566] Ibid.

Deemed O&M Cost Adjustment Calculation
n/a

Reference Tables
Values for ASTM parameters for baseline and efficient conditions (unless otherwise noted) were determined by FSTC according to ASTM F1484, the Standard Test Method for Performance of Steam Cookers. These parameters include the three of the four listed below: Idle Energy Rate, Production Capacity, and Heavy Load Cooking Efficiency. Pounds of Food Cooked per Day based on the default value for a 3 pan steam cooker (100 lbs from FSTC) and scaled up based on the assumption that steam cookers with a greater number of pans cook larger quantities of food per day. It is not known which specific models were tested but the values presented are thought to be the averages of tested models.

Parameters that vary with number of pans:

# of Pans	Parameter	Baseline Model	Efficient Model
3	Idle Energy Rate (kW)[567]	1	0.24
	Production Capacity (lb/h)	70	50
	Pounds of Food Cooked per Day	100	100
	Heavy Load Cooking Energy Efficiency[568]	20%	59%
4	Idle Energy Rate (kW)	1.325	0.27
	Production Capacity (lb/h)	87	67
	Pounds of Food Cooked per Day	128	128
	Heavy Load Cooking Energy Efficiency	20%	52%
5	Idle Energy Rate (kW)	1.675	0.24
	Production Capacity (lb/h)	103	83
	Pounds of Food Cooked per Day	160	160
	Heavy Load Cooking Energy Efficiency	20%	62%
6	Idle Energy Rate (kW)	2	0.31
	Production Capacity (lb/h)	120	100
	Pounds of Food Cooked per Day	192	192
	Heavy Load Cooking Energy Efficiency	20%	62%

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[567] Efficient values calculated from a list of ENERGY STAR qualified products. See "ES Steam Cooker Analysis.xls" for details.
[568] Ibid.

ENERGY STAR Fryers (Time of Sale)

Official Measure Code (Measure Number: X-X-X-X (Program name, End Use)

Description
Commercial fryers that have earned the ENERGY STAR offer shorter cook times and higher production rates through advanced burner and heat exchanger designs. Frypot insulation reduces standby losses resulting in a lower idle energy rate. Fryers that have earned the ENERGY STAR are up to 30% more efficient than standard models. Energy savings estimates are based on a 15" fryer.

Definition of Efficient Equipment
The efficient equipment is assumed to be an ENERGY STAR qualified electric fryer

Definition of Baseline Equipment
The baseline equipment is assumed to be a standard electric fryer with a heavy load efficiency of 75%.

Deemed Savings for this Measure

Annual kWh Savings = 982.71 kWh/yr

Summer Coincident Peak kW Savings = 0.22 kW

Deemed Lifetime of Efficient Equipment
12 years[569]

Deemed Measure Cost
The incremental cost for commercial combination ovens is assumed to be $500[570]

Deemed O&M Cost Adjustments
n/a

Coincidence Factor
0.84[571]

REFERENCE SECTION

Calculation of Savings

Energy Savings

$$kWH = [LB \times E_{FOOD}/EFF + IDLE \times (HOURS_{DAY} - LB/PC - PRE_{TIME}/60) + PRE_{ENERGY}] \times DAYS$$

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

Where:

kWH_{base} = the annual energy usage of the baseline equipment calculated using baseline values
kWH_{eff} = the annual energy usage of the efficient equipment calculated using efficient values
$HOURS_{DAY}$ = Daily operating hours
= 16[572]

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569 Food Service Technology Center (FSTC). Default value from life cycle cost calculator. http://www.fishnick.com/saveenergy/tools/calculators/ecombicalc.php
570 NYSERDA Deemed Savings Database
571 RLW Analytics. Coincidence Factor Study – Residential and Commercial Industrial Lighting Measures. Spring 2007.

PRE_{TIME} = Preheat time (min/day), the amount of time it takes a fryer to reach operating temperature when turned on
= 15 min/day[573]

E_{FOOD} = ASTM Energy to Food (kWh/lb); the amount of energy absorbed by the food during cooking, per pound of food
= 0.167[574]

LB = Pounds of food cooked per day (lb/day)
= 150[575]

DAYS = 365

EFF = Heavy load cooking energy efficiency (%)

IDLE = Idle energy rate

PC = Production capacity (lbs/hr)

PRE_{ENERGY} = Preheat energy (kWh/day)

Performance Metrics: Baseline and Efficient Values[576]

Metric	Baseline Model	Energy Efficient Model
PRE_{ENERGY}	2.3	1.7
IDLE	1.05	0.84
EFF	75%	84%
PC	65	70

Summer Coincident Peak Demand Savings

$$\Delta kW = (\Delta kWh / HOURS) \times CF$$

Where:

ΔkWh = Annual energy savings (kWh)

HOURS = Equivalent full load hours
= 4380

CF = Summer Peak Coincidence Factor for measure
= 0.84

Fossil Fuel Impact Descriptions and Calculation
n/a

Water Impact Descriptions and Calculation
n/a

Deemed O&M Cost Adjustment Calculation
n/a

Version Date & Revision History
Draft: Portfolio #
Effective date: Date TRM will become effective
End date: Date TRM will cease to be effective (or TBD)

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572 Food Service Technology Center (FSTC), based on assumption that restaurant is open 16 hours a day, 365 days a year.
573 FSTC (2002). *Commercial Cooking Appliance Technology Assessment*. Chapter 7: Fryers.
574 American Society for Testing and Materials. Industry Standard for Commercial Ovens.
575 Food Service Technology Center (FSTC). Default value from life cycle cost calculator. http://www.fishnick.com/saveenergy/tools/calculators/ecombicalc.php
576 Baseline values based on assumptions from FSTC life cycle cost calculator. Efficient values reflect averages from a list of qualifying models found on the ENERGY STAR website (accessed June 2010)

Combination Oven (Time of Sale)

Official Measure Code (Measure Number: X-X-X-X (Program name, End Use)

Description
A combination oven is a convection oven that includes the added capability to inject steam into the oven cavity and typically offers at least three distinct cooking modes.

Definition of Efficient Equipment
The efficient equipment is assumed to be an electric combination oven with a heavy load cooking energy efficiency of at least 60%.

Definition of Baseline Equipment
The baseline equipment is assumed to be a typical low-efficiency oven with a heavy load efficiency of 44%.

Deemed Savings for this Measure

Annual kWh Savings	= 18,432 kWh
Summer Coincident Peak kW Savings	= 3.53 kW

Deemed Lifetime of Efficient Equipment
12 years[577]

Deemed Measure Cost
The incremental cost for commercial combination ovens is assumed to be $2,125[578]

Deemed O&M Cost Adjustments
n/a

Coincidence Factor
0.84[579]

REFERENCE SECTION

Calculation of Savings

Energy Savings

$$kWH = [LB \times E_{FOOD}/EFF + IDLE \times (HOURS_{DAY} - LB/PC - PRE_{TIME}/60) + PRE_{ENERGY}] \times DAYS$$
$$\Delta kWh = kWH_{base} - kWh_{eff}$$

Where:

kWH_{base} = the annual energy usage of the baseline equipment calculated using baseline values
kWH_{eff} = the annual energy usage of the efficient equipment calculated using efficient values
$HOURS_{DAY}$ = Daily operating hours
= 12[580]

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577 Food Service Technology Center (FSTC). Default value from life cycle cost calculator. http://www.fishnick.com/saveenergy/tools/calculators/ecombicalc.php
578 NYSERDA Deemed Savings Database
579 RLW Analytics. Coincidence Factor Study – Residential and Commercial Industrial Lighting Measures. Spring 2007.
580 Food Service Technology Center (FSTC). based on assumption that restaurant is open 12 hours a day, 365 days a year.

DAYS	= Days per year of operation = 365
PRE_{TIME}	= Preheat time (min/day), the amount of time it takes a steamer to reach operating temperature when turned on = 15 min/day[581]
E_{FOOD}	= ASTM Energy to Food (kWh/lb); the amount of energy absorbed by the food during cooking, per pound of food = 0.0732[582]
LB	= Pounds of food cooked per day (lb/day) = 200[583]
EFF	= Heavy load cooking energy efficiency (%)
IDLE	= Idle energy rate
PC	= Production capacity (lbs/hr)
PRE_{ENERGY}	= Preheat energy (kWh/day)

Performance Metrics: Baseline and Efficient Values[584]

Metric	Baseline Model	Energy Efficient Model
PRE_{ENERGY} (kWh)	3	1.5
IDLE (kW)	7.5	3
EFF	44%	60%
PC (lb/hr)	80	100

Summer Coincident Peak Demand Savings

$$\Delta kW = (\Delta kWh / HOURS) \times CF$$

Where:

ΔkWh	= Annual energy savings (kWh)
HOURS	= Equivalent full load hours = 4380
CF	= Summer Peak Coincidence Factor for measure = 0.84

Fossil Fuel Impact Descriptions and Calculation
n/a

Water Impact Descriptions and Calculation
The water savings for commercial combination ovens are assumed to be 87,600 gallons per year[585]

Deemed O&M Cost Adjustment Calculation
n/a

[581] Food Service Technology Center (2002). *Commercial Cooking Appliance Technology Assessment.* Prepared by Don Fisher.. Chapter 7: Ovens.
[582] American Society for Testing and Materials. Industry Standard for Commercial Ovens.
[583] Food Service Technology Center (FSTC). Default value from life cycle cost calculator. http://www.fishnick.com/saveenergy/tools/calculators/ecombicalc.php
[584] Ibid.
[585] Food Service Technology Center (FSTC). Based on assumption that baseline ovens use water at an average rate of 40 gal/h while efficient models use water at an average rate of 20 gal/h