### Combination Oven

###### Description

This measure applies to both natural gas fired and electric high efficiency combination convection and steam ovens installed in a commercial kitchen.

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 new natural gas or electric combination oven meeting the ENERGY STAR idle rate and cooking efficiency requirements as specified below.[[1]](#footnote-1)

**ENERGY STAR Requirements (Version 2.1, Effective January 1, 2014)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Fuel Type** | **Operation** | **Idle Rate, (Btu/h for Gas, kW for Electric)** | **Cooking-Energy Efficiency, (%)** |
| Natural Gas | Steam Mode  Convection Mode | ≤ 200P+6,511  ≤ 150P+5,425 | ≥ 41  ≥ 56 |
| Electric | Steam Mode  Convection Mode | ≤ 0.133P+0.6400  ≤ 0.080P+0.4989 | ≥ 55  ≥ 76 |

Note: P = Pan capacity as defined in Section 1.S, of the Commercial Ovens Program Requirements Version 2.1[[2]](#footnote-2)



###### Definition of Baseline Equipment

The baseline equipment is a natural gas or electric combination oven that is not ENERGY STAR certified.

###### Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 12 years.[[3]](#footnote-4)

###### Deemed Measure Cost

The costs vary based on the efficiency and make of the equipment. Actual costs should be used.

###### Loadshape

Loadshape C01 - Commercial Electric Cooking

###### Coincidence Factor

Summer Peak Coincidence Factor for measure is provided below for different building type[[4]](#footnote-8):

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

**Algorithm**

###### Calculation of Savings

###### Electric Energy Savings

The algorithm below applies to electric combination ovens only.[[5]](#footnote-9)

∆kWh = (CookingEnergyConvElec + CookingEnergySteamElec + IdleEnergyConvElec + IdleEnergySteamElec) \* Days / 1,000

Where:

CookingEnergyConvElec = Change in total daily cooking energy consumed by electric oven in convection mode

= LBElec \* (EFOODConvElec / ElecEFFConvBase - EFOODConvElec / ElecEFFConvEE) \* %Conv

CookingEnergySteamElec = Change in total daily cooking energy consumed by electric oven in steam mode

= LBElec \* (EFOODSteamElec / ElecEFFSteamBase – EFOODSteamElec / ElecEFFSteamEE) \* %Steam

IdleEnergyConvElec = Change in total daily idle energy consumed by electric oven in convection mode

= [(ElecIDLEConvBase \* ((HOURS – LBElec/ElecPCConvBase) \* %Conv)) - (ElecIDLEConvEE \* ((HOURS - LBElec/ElecPCConvEE) \* %Conv))]

IdleEnergySteamElec = Change in total daily idle energy consumed by electric oven in convection mode

= [(ElecIDLESteamBase \* ((HOURS – LBElec/ElecPCSteamBase) \* %Steam)) - (ElecIDLESteamEE \* ((HOURS - LBElec/ElecPCSteamEE) \* %Steam))]

Where:

LBElec  = Estimated mass of food cooked per day for electric oven (lbs/day)

= Custom, or if unknown, use 200 lbs (If P <15) or 250 lbs(If P >= 15)

EFOODConvElec = Energy absorbed by food product for electric oven in convection mode

= Custom or if unknown, use 73.2 Wh/lb

ElecEFF = Cooking energy efficiency of electric oven

= Custom or if unknown, use values from table below

|  |  |  |
| --- | --- | --- |
|  | **Base** | **EE** |
| ElecEFFConv | 72% | 76% |
| ElecEFFSteam | 49% | 55% |

%Conv = Percentage of time in convection mode

= Custom or if unknown, use 50%

EFOODSteamElec = Energy absorbed by food product for electric oven in steam mode

= Custom or if unknown, use 30.8 Wh/lb

%steam = Percentage of time in steam mode

= 1 - %conv

ElecIDLEBase = Idle energy rate (W) of baseline electric oven

= Custom or if unknown, use values from table below

|  |  |  |
| --- | --- | --- |
| **Pan Capacity** | **Convection Mode**  **(ElecIDLEConvBase)** | **Steam Mode**  **(ElecIDLESteamBase)** |
| < 15 | 1,320 | 5,260 |
| > = 15 | 2,280 | 8,710 |

HOURS = Average daily hours of operation

= Custom or if unknown, use 12 hours

ElecPCBase = Production capacity (lbs/hr) of baseline electric oven

= Custom of if unknown, use values from table below

|  |  |  |
| --- | --- | --- |
| **Pan Capacity** | **Convection Mode (ElecPCConvBase)** | **Steam Mode (ElecPCSteamBase)** |
| < 15 | 79 | 126 |
| > = 15 | 166 | 295 |

ElecIDLEConvEE = Idle energy rate of ENERGY STAR electric oven in convection mode

= (0.08\*P +0.4989)\*1000

ElecPCEE = Production capacity (lbs/hr) of ENERGY STAR electric oven

= Custom of if unknown, use values from table below

|  |  |  |
| --- | --- | --- |
| **Pan Capacity** | **Convection Mode (ElecPCConvEE)** | **Steam Mode (ElecPCSteamEE)** |
| < 15 | 119 | 177 |
| > = 15 | 201 | 349 |

ElecIDLESteamEE = Idle energy rate of ENERGY STAR electric oven in steam mode

= (0.133\* P+0.64)\*1000

Days = Days of operation per year

= Custom or if unknown, use 365 days per year

1,000 = Wh to kWh conversion factor

**EXAMPLE**

For example, a 10-pan capacity electric combination oven would save:

∆kWh = (CookingEnergyConvElec + CookingEnergySteamElec + IdleEnergyConvElec + IdleEnergySteamElec) \* Days / 1,000

CookingEnergyConvElec = 200 \* (73.2 / 0.72 – 73.2 / 0.76) \* 0.50

= 535 Wh

CookingEnergySteamElec = 200 \* (30.8 / 0.49 – 30.8 / 0.55) \* (1 – 0.50)

= 686 Wh

IdleEnergyConvElec = [(1,320 \* ((12 – 200/79) \* 0.50)) - (1,299 \*((12 - 200/119) \* 0.50))]

= -453 Wh

IdleEnergySteamElec = [(5,260 \* ((12 – 200/126) \* (1 – 0.50))) - (1,970 \* ((12 - 200/177) \* (1 – 0.50)))]

= 16,678 Wh

∆kWh = (535 + 686 + -453 + 16,678) \* 365 /1,000

= 6,368 kWh

###### Summer Coincident Peak Demand Savings

∆kW = ∆kWh / (HOURS \* DAYS) \*CF

Where:

CF = Summer peak coincidence factor is dependent on building type[[6]](#footnote-12):

|  |  |
| --- | --- |
| Location | CF  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 |

All other variables as defined above.

**EXAMPLE**

For example, a 10-pan capacity electric combination oven in a Full Service Limited Menu restaurant would save:

∆kW = ∆kWh / (HOURS \* DAYS) \*CF

= 6,368/ (12 \* 365) \* 0.51

= 0.74 kW

###### Natural Gas Energy Savings

The algorithm below applies to natural gas combination ovens only.[[7]](#footnote-15)

∆Therms = (CookingEnergyConvGas + CookingEnergySteamGas + IdleEnergyConvGas + IdleEnergySteamGas) \* Days / 100,000

Where:

CookingEnergyConvGas = Change in total daily cooking energy consumed by gas oven in convection mode

= LBGas \* (EFOODConvGas / GasEFFConvBase - EFOODConvGas / GasEFFConvEE) \* %Conv

CookingEnergySteamGas = Change in total daily cooking energy consumed by gas oven in steam mode

= LBGas \* (EFOODSteamGas / GasEFFSteamBase – EFOODSteamGas / GasEFFSteamEE) \* %Steam

IdleEnergyConvGas = Change in total daily idle energy consumed by gas oven in convection mode

= [(GasIDLEConvBase \* ((HOURS – LBGas/GasPCConvBase) \* %Conv)) - (GasIDLEConvEE \* ((HOURS - LBGas/GasPCConvEE) \* %Conv))]

IdleEnergySteamGas = Change in total daily idle energy consumed by gas oven in convection mode

= [(GasIDLESteamBase \* ((HOURS – LBGas/GasPCSteamBase) \* %Steam)) - (GasIDLESteamEE \* ((HOURS - LBGas/GasPCSteamEE) \* %Steam))]

Where:

LBGas = Estimated mass of food cooked per day for gas oven (lbs/day)

= Custom, or if unknown, use 200 lbs (If P <15), 250 lbs(If 15 <= P 30), or 400 lbs (If P = >30)

EFOODConvGas = Energy absorbed by food product for gas oven in convection mode

= Custom or if unknown, use 250 Btu/lb

GasEFF = Cooking energy efficiency of gas oven

= Custom or if unknown, use values from table below

|  |  |  |
| --- | --- | --- |
|  | **Base** | **EE** |
| GasEFFConv | 52% | 56% |
| GasEFFSteam | 39% | 41% |

EFOODSteamGas = Energy absorbed by food product for gas oven in steam mode

= Custom or if unknown, use 105 Btu/lb

GasIDLEBase = Idle energy rate (Btu/hr) of baseline gas oven

= Custom or if unknown, use values from table below

|  |  |  |
| --- | --- | --- |
| **Pan Capacity** | **Convection Mode (GasIDLEConvBase)** | **Steam Mode (GasIDLESteamBase)** |
| < 15 | 8,747 | 18,658 |
| 15-30 | 7,823 | 24,562 |
| >30 | 13,000 | 43,300 |

GasPCBase = Production capacity (lbs/hr) of baseline gas oven

= Custom of if unknown, use values from table below

|  |  |  |
| --- | --- | --- |
| **Pan Capacity** | **Convection Mode (GasPCConvBase)** | **Steam Mode (GasPCSteamBase)** |
| < 15 | 125 | 195 |
| 15-30 | 176 | 211 |
| >30 | 392 | 579 |

GasIDLEConvEE = Idle energy rate of ENERGY STAR gas oven in convection mode

= 150\*P + 5,425

GasPCEE = Production capacity (lbs/hr) of ENERGY STAR gas oven

= Custom of if unknown, use values from table below

|  |  |  |
| --- | --- | --- |
| **Pan Capacity** | **Convection Mode (GasPCConvEE)** | **Steam Mode (GasPCSteamEE)** |
| < 15 | 124 | 172 |
| 15-30 | 210 | 277 |
| >30 | 394 | 640 |

GasIDLESteamEE = Idle energy rate of ENERGY STAR gas oven in steam mode

= 200\*P +6511

100,000 = Conversion factor from Btu to therms

All other variables as defined above.

###### Water Impact Descriptions and Calculation

**EXAMPLE**

For example, a 10-pan capacity gas combination oven would save:

∆Therms = (CookingEnergyConvGas + CookingEnergySteamGas + IdleEnergyConvGas + IdleEnergySteamGas) \* Days / 100,000

CookingEnergyConvGas = 200 \* (250 / 0.52 – 250 / 0.56) \* 0.50

=3,434 therms

CookingEnergySteamGas = 200 \* (105 / 0.39 – 105 / 0.41) \* (1 – 0.50)

= 1,313 therms

IdleEnergyConvGas = [(8,747 \* ((12 – 200/125) \* 0.50)) - (6,925 \*((12 - 200/124) \* 0.50))]

= 9,519 therms

IdleEnergySteamGas = [(18,658 \* ((12 – 200/195) \* (1 – 0.50))) - (8,511 \* ((12 - 200/172) \* (1 – 0.50)))]

= 56,251 therms

∆Therms = (3,434 + 1,313 + 9,519 + 56,251) \* 365 /100,000

= 257 therms

N/A

###### Deemed O&M Cost Adjustment Calculation

N/A

###### Measure Code: CI-FSE-CBOV-V02-160601

1. ENERGY STAR Commercial Ovens Key Product Criteria

   http://www.energystar.gov/index.cfm?c=ovens.pr\_crit\_comm\_ovens [↑](#footnote-ref-1)
2. Pan capacity is defined as the number of steam table pans the combination oven is able to accommodate as

   per the ASTM F-1495-05 standard specification.

   http://www.energystar.gov/products/specs/system/files/Commercial%20Ovens%20Program%20Requirements%20V2%201.pdf?965d-c5ec&3b06-d2f5 [↑](#footnote-ref-2)
3. http://www.fishnick.com/saveenergy/tools/calculators/gcombicalc.php [↑](#footnote-ref-4)
4. Values taken from Minnesota Technical Reference Manual, ‘Electric Oven and Range’ measure and is based upon “Project on Restaurant Energy Performance-End-Use Monitoring and Analysis”, Appendixes I and II, Claar, et. al., May 1985 [↑](#footnote-ref-8)
5. Algorithms and assumptions derived from ENERGY STAR Commercial Kitchen Equipment Savings Calculator

   https://www.energystar.gov/sites/default/files/asset/document/commercial\_kitchen\_equipment\_calculator.xlsx [↑](#footnote-ref-9)
6. Values taken from Minnesota Technical Reference Manual, ‘Electric Oven and Range’ measure and is based upon “Project on Restaurant Energy Performance-End-Use Monitoring and Analysis”, Appendixes I and II, Claar, et. al., May 1985 [↑](#footnote-ref-12)
7. Algorithms and assumptions derived from ENERGY STAR Commercial Kitchen Equipment Savings Calculator

   https://www.energystar.gov/sites/default/files/asset/document/commercial\_kitchen\_equipment\_calculator.xlsx [↑](#footnote-ref-15)