### 4.4.11 High Efficiency Furnace

**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:

* 1. 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:

Early Replacement determination will be based on meeting the following conditions:

* + - The existing unit is operational when replaced, or
    - The existing unit requires minor repairs (<$528 per ton)[[1]](#footnote-2).
    - All other conditions will be considered Time of Sale.

The Baseline AFUE of the existing unit replaced:

* + - If the AFUE of the existing unit is known and <=75%, the Baseline AFUE is the actual AFUE value of the unit replaced. If the AFUE is >75%, the Baseline AFUE = 80%.
    - If the operational status, repair cost or AFUE of the existing unit is unknown, use time of sale assumptions.

**Definition of Efficient Equipment**

To qualify for this measure the installed equipment must be a furnace with input energy less than 225,000 Btu/hr 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%. 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[[2]](#footnote-3)

Remaining life of existing equipment is assumed to be 5.5 years[[3]](#footnote-4).

**Deemed Measure Cost**

Time of Sale: The incremental capital cost for this measure depends on efficiency as listed below[[4]](#footnote-5):

|  |  |  |
| --- | --- | --- |
| **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.

**Loadshape**

N/A

**Coincidence Factor**

N/A

**Algorithm**

**Calculation of Savings**

**Electric Energy Savings**

ΔkWh = Heating Savings + Cooling Savings + Shoulder Season Savings

Where:

Heating Savings = Brushless DC motor or Electronically commutated motor (ECM) = 418 kWh[[5]](#footnote-6)

Cooling Savings = Brushless DC motor or electronically commutated motor (ECM) savings during cooling season

If air conditioning = 263 kWh

If no air conditioning = 175 kWh

If unknown (weighted average)= 241 kWh[[6]](#footnote-7)

Shoulder Season Savings = Brushless DC motor or electronically commutated motor (ECM) savings during shoulder seasons

= 51 kWh

EXAMPLE

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

ΔkWh = Heating Savings + Cooling Savings + Shoulder Season Savings

= 418 +241 + 51

= 710 kWh

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

ΔkW = (CoolingSavings/HOURSyear) \* CF

Where:

HOURSyear = Actual hours per year if known, otherwise use hours from Table below for building type[[7]](#footnote-8).

|  |  |
| --- | --- |
| **Building Type** | **HOURSyear** |
| Assembly | 2150 |
| Assisted Living | 4373 |
| College | 1605 |
| Convenience Store | 2084 |
| Elementary School | 3276 |
| Garage | 2102 |
| Grocery | 2096 |
| Healthcare Clinic | 1987 |
| High School | 3141 |
| Hospital - VAV econ | 2788 |
| Hospital - CAV econ | 2881 |
| Hospital - CAV no econ | 8760 |
| Hospital - FCU | 8729 |
| Manufacturing Facility | 2805 |
| MF - High Rise | 4237 |
| MF - Mid Rise | 2899 |
| Hotel/Motel – Guest | 4479 |
| Hotel/Motel - Common | 8712 |
| Movie Theater | 2120 |
| Office - High Rise - VAV econ | 2038 |
| Office - High Rise - CAV econ |  |
| Office - High Rise - CAV no econ | 5682 |
| Office - High Rise - FCU | 3069 |
| Office - Low Rise | 2481 |
| Office - Mid Rise | 1881 |
| Religious Building | 2830 |
| Restaurant | 3350 |
| Retail - Department Store | 2528 |
| Retail - Strip Mall | 2266 |
| Warehouse | 770 |
| Unknown | 2718 |

CF =Summer Peak Coincidence Factor for measure is provided below for different building types[[8]](#footnote-9):

| **HVAC Pumps** | **CF** |
| --- | --- |
| Assembly | 48.3% |
| Assisted Living | 52.9% |
| College | 14.2% |
| Convenience Store | 57.1% |
| Elementary School | 33.3% |
| Garage | 61.9% |
| Grocery | 47.5% |
| Healthcare Clinic | 61.9% |
| High School | 28.8% |
| Hospital - VAV econ | 57.6% |
| Hospital - CAV econ | 61.5% |
| Hospital - CAV no econ | 64.8% |
| Hospital - FCU | 60.9% |
| Manufacturing Facility | 43.3% |
| MF - High Rise - Common | 43.7% |
| MF - Mid Rise | 24.3% |
| Hotel/Motel - Guest | 62.9% |
| Hotel/Motel - Common | 64.6% |
| Movie Theater | 41.9% |
| Office - High Rise - VAV econ | 43.2% |
| Office - High Rise - CAV econ | 48.3% |
| Office - High Rise - CAV no econ | 50.3% |
| Office - High Rise - FCU | 46.2% |
| Office - Low Rise | 47.4% |
| Office - Mid Rise | 42.8% |
| Religious Building | 43.3% |
| Restaurant | 48.8% |
| Retail - Department Store | 50.5% |
| Retail - Strip Mall | 52.8% |
| Warehouse | 22.5% |
| Unknown | 42.4% |

EXAMPLE

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

ΔkW = (241 / 2481) \* 0.474

= 0.05 kW

**Natural Gas Energy Savings**

Time of Sale:

ΔTherms = EFLH \* Capacity \* ((AFUE(eff) – AFUE(base))/AFUE(base))/ 100,000 Btu/Therm

Early replacement[[9]](#footnote-10):

ΔTherms for remaining life of existing unit (1st 5.5 years):

ΔTherms = EFLH \* Capacity \* ((AFUE(eff) – AFUE(exist))/ AFUE(exist)) / 100,000 Btu/Therm

ΔTherms for remaining measure life (next 11 years):

ΔTherms = EFLH \* Capacity \* ((AFUE(eff) - AFUE(base))/AFUE(base)) / 100,000 Btu/Therm

Where:

EFLH = Equivalent Full Load Hours for heating are provided in section 4.4 HVAC End Use

Capacity = Nominal Heating Input Capacity Furnace Size (Btu/hr) for efficient unit not existing unit

= custom Furnace input capacity in Btu/hr

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% **[[10]](#footnote-11)**.

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

Dependent on program type as listed below[[11]](#footnote-12):

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

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

= Actual. If Unknown, assume 95%[[12]](#footnote-13)

EXAMPLE

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

ΔTherms = 1428 \* 150,000 \* ((0.92-0.80)/0.80)/ 100,000

= 321 Therms

**Water Impact Descriptions and Calculation**

N/A

**Deemed O&M Cost Adjustment Calculation**

N/A

###### Measure Code: CI-HVC-FRNC-V05-160601

1. The Technical Advisory Committee agreed that if the cost of repair is less than 20% of the new baseline replacement cost it can be considered early replacement. [↑](#footnote-ref-2)
2. Average of 15-18 year lifetime estimate made by the Consortium for Energy Efficiency in 2010. [↑](#footnote-ref-3)
3. Assumed to be one third of effective useful life [↑](#footnote-ref-4)
4. 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). Where efficiency ratings are not provided, the values are interpolated from those that are. [↑](#footnote-ref-5)
5. 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. [↑](#footnote-ref-6)
6. The weighted average value is based on assumption that 75% of buildings installing BPM furnace blower motors have Central AC. [↑](#footnote-ref-7)
7. Hours per year are estimated using the eQuest models as the total number of hours the cooling system is operating for each building type. [↑](#footnote-ref-8)
8. Coincidence Factors are estimated using the eQuest models.. [↑](#footnote-ref-9)
9. 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). [↑](#footnote-ref-10)
10. Average nameplate efficiencies of all Early Replacement qualifying equipment in Ameren PY3-PY4. [↑](#footnote-ref-11)
11. 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. [↑](#footnote-ref-12)
12. Minimum ENERGY STAR efficiency after 2.1.2012. [↑](#footnote-ref-13)