### Gas High Efficiency Boiler

###### Description

High efficiency boilers achieve most 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 characterizes:

1. Time of Sale:
   1. The installation of a new high efficiency, gas-fired hot water boiler in a residential 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 in a new home.
2. 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 (<$709 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 = 82%.
    - If the operational status, repair cost or AFUE of the existing unit is unknown, use time of sale assumptions.

A weighted average early replacement rate is provided for use when the actual baseline early replacement rates are unknown[[2]](#footnote-3).

Deemed Early Replacement Rates For Boilers

|  |  |
| --- | --- |
|  | **Deemed Early Replacement Rate** |
| Early Replacement Rate for Boiler participants | 7% |

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

###### Definition of Efficient Equipment

To qualify for this measure the installed Boiler must be ENERGY STAR qualified (AFUE rated at or greater than 85% and input capacity less than 300,000 Btu/hr).

###### Definition of Baseline Equipment

Time of sale: The baseline equipment for this measure is a new, gas-fired, standard-efficiency water boiler. The current Federal Standard minimum is 82% AFUE.

Early replacement: The baseline for this measure is the efficiency of the existing equipment for the assumed remaining useful life of the unit and the new baseline as defined above for the remainder of the measure life.

###### Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 25 years[[3]](#footnote-4).

Early replacement: Remaining life of existing equipment is assumed to be 8 years[[4]](#footnote-5).

###### Deemed Measure Cost

Time of sale: The incremental install cost for this measure is dependent on tier[[5]](#footnote-6):

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Type** | **Installation Cost** | **Incremental Install Cost** | |
| AFUE 82% | $3543 | n/a |
| AFUE 85% (Energy Star Minimum) | $4268 | $725 | |
| AFUE 90% | $4815 | $1,272 | |
| AFUE 95% | $5328 | $1,785 | |

Early Replacement: The full installation cost is provided in the table above. The assumed deferred cost (after 8 years) of replacing existing equipment with a new baseline unit is assumed to be $3543. 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

N/A

###### Summer Coincident Peak Demand Savings

N/A

###### Natural Gas Savings

Time of Sale:

ΔTherms = Gas\_Boiler\_Load \* HF \* (1/AFUE(base) - 1/AFUE(eff))

Early replacement[[6]](#footnote-7):

ΔTherms for remaining life of existing unit (1st 8 years):

= Gas\_Boiler\_Load \* HF \* (1/AFUE(exist) - 1/AFUE(eff)))

ΔTherms for remaining measure life (next 17 years):

= Gas\_Boiler\_Load \* HF \* (1/AFUE(base) - 1/AFUE(eff)))

Where:

Gas\_Boiler\_Load[[7]](#footnote-8) = Estimate of annual household Load for gas boiler heated single-family homes. If location is unknown, assume the average below[[8]](#footnote-9).

= or Actual if informed by site-specific load calculations, ACCA Manual J or equivalent[[9]](#footnote-10).

| **Climate Zone**  **(City based upon)** | **Gas\_Boiler Load**  **(therms)** |
| --- | --- |
| 1 (Rockford) | 1275 |
| 2 (Chicago) | 1218 |
| 3 (Springfield) | 1043 |
| 4 (Belleville) | 805 |
| 5 (Marion) | 819 |
| Average | 1158 |

HF = Household factor, to adjust heating consumption for non-single-family households.

|  |  |
| --- | --- |
| **Household Type** | **HF** |
| Single-Family | 100% |
| Multi-Family | 65%[[10]](#footnote-11) |
| Actual | Custom[[11]](#footnote-12) |

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

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

If unknown, assume 61.6 AFUE% [[12]](#footnote-13).

AFUE(base) = Baseline Boiler Annual Fuel Utilization Efficiency Rating

= 82%

AFUE(eff) = Efficent Boiler Annual Fuel Utilization Efficiency Rating

= Actual. If unknown, use defaults dependent[[13]](#footnote-14) on tier as listed below:

| **Measure Type** | **AFUE(eff)** |
| --- | --- |
| ENERGY STAR® | 87.5% |
| AFUE 90% | 92.5% |
| AFUE 95% | 95% |

Time of Sale:

For example, a default sized ENERGY STAR boiler purchased and installed near Springfield

ΔTherms = 1043 \* (1/0.82 - 1/0.875)

= 80.0 Therms

Early Replacement:

For example, an existing function boiler with unknown efficiency is replaced with an ENERGY STAR boiler purchased and installed in Springfield.

ΔTherms for remaining life of existing unit (1st 8 years):

= 1043 \* (1/0.616 – 1/0.875)

= 501 Therms

ΔTherms for remaining measure life (next 17 years):

= (1043) \* (1/0.82 - 1/0.875)

= 80.0 Therms

###### Water Impact Descriptions and Calculation

N/A

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

N/A

###### Measure Code: RS-HVC-GHEB-V04-160601

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. Based upon research from “Home Energy Efficiency Rebate Program GPY2 Evaluation Report” which outlines early replacement rates for both primary and secondary central air cooling (CAC) and residential furnaces. This is used as a reasonable proxy for boiler installations since boiler specific data is not available. Report presented to Nicor Gas Company February 27, 2014, available at http://www.ilsag.info/evaluation-documents.html. [↑](#footnote-ref-3)
3. Table 8.3.3 The Technical support documents for federal residential appliance standards: <http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/fb_fr_tsd/chapter_8.pdf> [↑](#footnote-ref-4)
4. Assumed to be one third of effective useful life [↑](#footnote-ref-5)
5. Based on data provided in 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-6)
6. 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-7)
7. Boiler consumption values are informed by an evaluation which did not identify any fraction of heating load due to domestic hot water (DHW) provided by the boiler. Thus these values are an average of both homes with boilers only providing heat, and homes with boilers that also provide DHW. Heating load is used to describe the household heating need, which is equal to (gas heating consumption \* AFUE ) [↑](#footnote-ref-8)
8. Values are based on household heating consumption values and inferred average AFUE results from Table 3-4, Program Sample Analysis, *Nicor R29 Res Rebate Evaluation Report 092611\_REV FINAL to Nicor*). Adjusting to a statewide average using relative HDD values to adjust for the evaluation results focus on northern region. Values for individual cities are then calculated by comparing average HDD to the individual city’s HDD. [↑](#footnote-ref-9)
9. The Air Conditioning Contractors of America Manual J, Residential Load Calculation 8th Edition produces equipment sizing loads for Single Family, Multi-single, and Condominiums using input characteristics of the home. A best practice for equipment selection and installation of Heating and Air Conditioning, load calculations should be completed by contractors during the selection process and may be readily available for program data purposes. [↑](#footnote-ref-10)
10. Multifamily household heating consumption relative to single-family households is affected by overall household square footage and exposure to the exterior. This 65% reduction factor is applied to MF homes with electric resistance, based on professional judgment that average household size, and heat loads of MF households are smaller than single-family homes [↑](#footnote-ref-11)
11. Program-specific household factors may be utilized on the basis of sufficiently validated program evaluations. [↑](#footnote-ref-12)
12. Average nameplate efficiencies of all Early Replacement qualifying equipment in Ameren PY3-PY4. [↑](#footnote-ref-13)
13. Default values per tier selected based upon the average AFUE value for the tier range except for the top tier where the minimum is used due to proximity to the maximum possible. [↑](#footnote-ref-14)