**State of Illinois**

**Energy Efficiency**

**Technical Reference Manual**

**Residential Domestic Hot Water Usage Adjustment Factor**

**5.4.2 Gas Water Heater & 5.4.3 Heat Pump Water Heaters**

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**DCEO/IL PHA Efficient Living Program**

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Table 1 Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **MM/DD/YY** | **Author,Company** | **Summary of Changes** |
|  |  |  |  |
|  |  |  |  |

# Summary

The TRM assumes an average flat rate of 50 GPD per household (i.e. a family of 3) for all residential buildings. The IL PHA Efficient Program serves several different sizes of units that have varying domestic hot water loads. Due to the wide variety of residential units served, proposes adding an adjustment factor to all domestic water heater equations that will scale the average 50 GPD value by residential unit based on the number of occupants in the unit(s) served by the replaced water heater.

## Measure Components Affected

Please check all that apply.

###### Description

###### Definition of Efficient Equipment

###### Definition of Baseline Equipment

###### Deemed Lifetime of Efficient Equipment

###### Deemed Measure Cost

###### Deemed O&M Cost Adjustments

###### Loadshape

###### Coincidence Factor

###### Net To Gross Ratio

Algorithm

###### Calculation of Energy Savings

###### Electric Energy Savings

###### Summer Coincident Peak Demand Savings

###### Natural Gas Savings

###### Water Impact Descriptions and Calculation

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

**Measure code**

## Algorithm and Input Components Affected

### Algorithm / Input 1

### Algorithm / Input 2

## Rationale for the Change

To allow the Efficient Living Staff to vary claimed energy savings from residential domestic hot water heater upgrades based on size of the unit rather than assuming an average consumption for all building types.

### Methodology

The proposed methodology scales the GPD value based on the number of residents per unit with the current GPD being a baseline for 2.6 occupants (as shown in the referenced document).

This is a similar mechanism as the “household” parameter listed in the low-flow showerheads and aerator equations listed in 5.4.4 and 5.4.5. The adjusted water heater equations could look something like the following:

5.4.2 Gas Water Heaters:

ΔTherms = (1/ EFBASE - 1/EFEFFICIENT) \* (GPD/2 \* Household \* 365.25 \* γWater \* (TOUT – TIN) \* 1.0 )/100,000

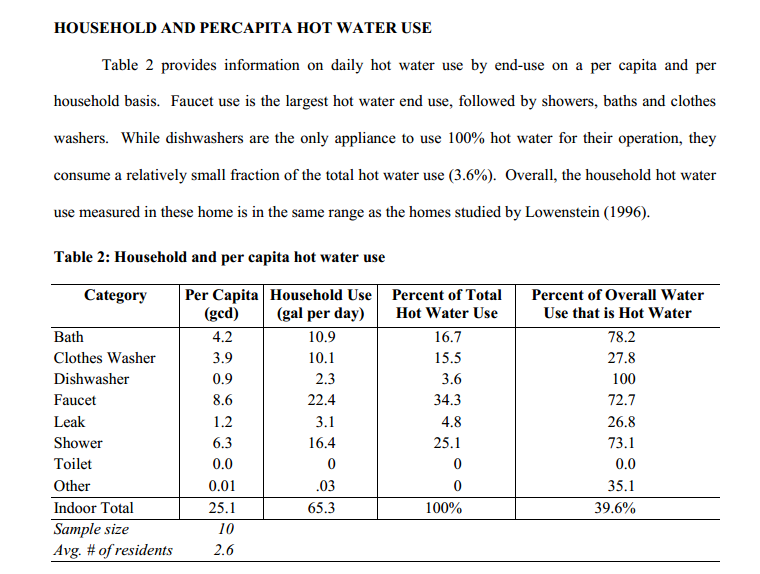
5.4.3 Heat Pump Water Heaters:

ΔkWh = (((1/EFBASE – 1/EFEFFICIENT) \* GPD/2 \*Household \* 365.25 \* γWater \* (TOUT – TIN) \* 1.0) / 3412) + kWh\_cooling - kWh\_heating

ΔTherms = - ((((GPD/3 \*Household \* 365.25 \* γWater \* (TOUT – TIN) \* 1.0) / 3412) – (((GPD/2 \*Household \* 365.25 \* γWater \* (TOUT – TIN) \* 1.0) / 3412) / EFEFFICIENT)) \* LF \* 49% \* 0.03412) / (ηHeat \* % Natural Gas)

Note that a baseline household of 2 people was assumed for the listed 50 GPD DHW usage as outlined in the reference paper:

50 GPD / 65.3 GPD \* 2.6 residents per household = 2 people per household



### Sample Size

### Other Rationale

## Please Specify the Proposed Change

Table 2 Summary of Proposed Change

|  |  |  |  |
| --- | --- | --- | --- |
| **ITEM** | **ORIGINAL SPECIFICATION** | **PROPOSED SPECIFICATION** | **CITATION FOR PROPOSED SPECIFICATION** |
| **In Service Rate** | **ISR = 0.8** | **ISR = 0.9** | **Author, Date, Document Name, Section #, Page #** |
|  |  |  |  |
|  |  |  |  |

Changes are specified in a Redline version of the existing measures.

## Author (Company) and Date

Please reiterate the author and company from the title page.

Ben Reinhart from the DCEO/ IL PHA Efficient Living Program

# Components of TRM Measure Characterizations

###### 5.4.2 Gas Water Heater

###### Description

This measure characterizes the purchase and installation of a new efficient gas-fired water heater, in place of a Federal Standard unit in a residential setting. Savings are provided for power-vented, condensing storage, and whole-house tankless units meeting specific EF criteria.

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 efficient equipment must be a water heater rated with the following minimum efficiency ratings:

|  |  |
| --- | --- |
| **Water heater Type** | **Minimum Energy Factor** |
| Gas Storage | 0.67 |
| Condensing gas storage | 0.80 |
| Tankless whole-house unit | 0.82 |

###### Definition of Baseline Equipment

The baseline condition is assumed to be a standard gas storage water heater of the same capacity as the efficient unit, rated at the federal minimum (0.67 – 0.0019 \* storage size in gallons)[[1]](#footnote-1). For a 40-gallon storage water heater this would be 0.594 EF.

###### Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 13 years[[2]](#footnote-2).

###### Deemed Measure Cost

The incremental capital cost for this measure is dependent on the type of water heater as listed below[[3]](#footnote-3):

|  |  |
| --- | --- |
| **Water heater Type** | **Incremental Cost** |
| Gas Storage | $400 |
| Condensing gas storage | $685 |
| Tankless whole-house unit | $605 |

###### Deemed O&M Cost Adjustments

N/A

###### 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 Energy Savings

ΔTherms = (1/ EFbase - 1/EFefficient) \* (GPD \* Household \* 365.25 \* γWater \* (TOUT – Tin) \* 1.0 )/100,000

Where:

EF\_Baseline = Energy Factor rating for baseline equipment

= (0.67 – 0.0019 \* tank\_size) [[4]](#footnote-4)

|  |  |
| --- | --- |
| **Tank\_size (gallons)** | **EF\_Baseline** |
| 40 | 0.594 |
| 50 | 0.575 |
| 60 | 0.556 |

= If tank size unknown assume 40 gallons and EF\_Baseline of 0.594

EF\_Efficient = Energy Factor Rating for efficient equipment

= Actual. If Tankless whole-house multiply rated efficiency by 0.91[[5]](#footnote-5). If unknown assume values in look up in table below

|  |  |
| --- | --- |
| **Water Heater Type** | **EF\_Efficient** |
| Condensing Gas Storage | 0.80 |
| Gas Storage | 0.67 |
| Tankless whole-house | 0.82 \* 0.91 = 0.75 |

GPD = Gallons Per Day of hot water use per capita

= 25.1[[6]](#footnote-6)

Household = Average number of people per household

|  |  |
| --- | --- |
| **Household Unit Type** | **Household** |
| Single-Family - Deemed | 2.56[[7]](#footnote-8) |
| Multi-Family - Deemed | 2.1[[8]](#footnote-9) |
| Custom | Actual Occupancy or Number of Bedrooms[[9]](#footnote-10) |

365.25 = Days per year, on average

γWater  = Specific Weight of water

= 8.33 pounds per gallon

Tout = Tank temperature

= 125°F

Tin = Incoming water temperature from well or municipal system

= 54°F[[10]](#footnote-11)

1.0 = Heat Capacity of water (1 Btu/lb\*°F)

For example, a 40 gallon condensing gas storage water heater, with an energy factor of 0.80 in a single family house:

ΔTherms = (1/0.594) - 1/0.8) \* (25.1 \* 2.56 \* 365.25\* 8.33 \* (125 – 54) \* 1) / 100,000

= 46.8 therms

###### Water Impact Descriptions and Calculation

N/A

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

N/A

###### Measure Code: RS-HWE-GWHT-V01-120601

###### 5.4.3 Heat Pump Water Heaters

###### Description

The installation of a heat pump domestic hot water heater in place of a standard electric water heater in a home. Savings are presented dependent on the heating system installed in the home due to the impact of the heat pump water heater on the heating loads.

This measure was developed to be applicable to the following program types:  TOS, NC, 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 Heat Pump domestic water heater.

###### Definition of Baseline Equipment

The baseline condition is assumed to be a new electric water heater meeting federal minimum efficiency standards.

###### Deemed Lifetime of Efficient Equipment

The expected measure life is assumed to be 13 years.[[11]](#footnote-12)

###### Deemed Measure Cost

The incremental capital cost for this measure is $1,000, for a HPWH with an energy factor of 2.0. The full cost, applicable in a retrofit, is $1,575. For a HPWH with an energy factor of 2.35, these costs are $1,134 and $1,703 respectively.**[[12]](#footnote-13)**

###### Deemed O&M Cost Adjustments

N/A

###### Loadshape

Loadshape R03 - Residential Electric DHW

###### Coincidence Factor

The summer Peak Coincidence Factor is assumed to be 12%**[[13]](#footnote-14)**.

Algorithm

###### Calculation of Savings

###### Electric Energy Savings

ΔkWh = (((1/EFBASE – 1/EFefficient) \* GPD \* Household \* 365.25 \* γWater \* (TOUT – Tin) \* 1.0) / 3412) + kWh\_cooling - kWh\_heating

Where:

EFbase = Energy Factor (efficiency) of standard electric water heater according to federal standards:

= 0.93 – (0.00132 \* rated volume in gallons)[[14]](#footnote-15)

= 0.904 for a 50 gallon tank, the most common size for HPWH

EFefficient  = Energy Factor (efficiency) of Heat Pump water heater

= Actual

GPD = Gallons Per Day of hot water use per capita

= 25.1 [[15]](#footnote-16)

Household = Average number of people per household

|  |  |
| --- | --- |
| **Household Unit Type** | **Household** |
| Single-Family - Deemed | 2.56[[16]](#footnote-18) |
| Multi-Family - Deemed | 2.1[[17]](#footnote-19) |
| Custom | Actual Occupancy or Number of Bedrooms[[18]](#footnote-20) |

365.25 = Days per year

γWater = Specific weight of water

= 8.33 pounds per gallon

Tout = Tank temperature

= 125°F

Tin = Incoming water temperature from well or municiple system

= 54°F[[19]](#footnote-21)

1.0 = Heat Capacity of water (1 Btu/lb\*°F)

3412 = Conversion from BTU to kWh

kWh\_cooling[[20]](#footnote-22) = Cooling savings from conversion of heat in home to water heat

=(([(GPD \* Household \* 365.25 \* γWater \* (TOUT – Tin) \* 1.0) / 3412) –

(GPD \* Household \* 365.25 \* γWater \* (TOUT – Tin) \* 1.0) / 3412) / EFNEW] \* LF \* 27%) / COPCOOL) \* LM

Where:

LF = Location Factor

= 1.0 for HPWH installation in a conditioned space

= 0.5 for HPWH installation in an unknown location

= 0.0 for installation in an unconditioned space

27% = Portion of reduced waste heat that results in cooling savings[[21]](#footnote-23)

COPCOOL = COP of central air conditioning

= Actual, if unknown, assume 3.08 (10.5 SEER / 3.412)

LM = Latent multiplier to account for latent cooling demand

= 1.33 [[22]](#footnote-24)

kWh\_heating = Heating cost from conversion of heat in home to water heat (dependent on heating fuel)

For Natural Gas heating, kWh\_heating = 0

For electric heating:

= ([(GPD \* Household \* 365.25 \* ρ \* (TOUT – Tin) \* 1.0) / 3412) –

(GPD \* Household \* 365.25 \* ρ \* (TOUT – Tin) \* 1.0) / 3412) / EFNEW] \* LF \* 49%) / COPHEAT

Where:

49% = Portion of reduced waste heat that results in increased heating load[[23]](#footnote-25)

COPHEAT  = COP of electric heating system

= actual. If not available use[[24]](#footnote-26):

|  |  |  |  |
| --- | --- | --- | --- |
| **System Type** | **Age of Equipment** | **HSPF Estimate** | **COPHEAT**  **(COP Estimate)** |
| Heat Pump | Before 2006 | 6.8 | 2.00 |
| After 2006 | 7.7 | 2.26 |
| Resistance | N/A | N/A | 1.00 |

For example, a 2.0 EF heat pump water heater, in a conditioned space in a single family home with gas space heat and central air conditioning (SEER 10.5) in Belleville:

ΔkWh = [(1 / 0.904 – 1 / 2.0) \* 25.1 \* 2.56 \* 365.25\* 8.33 \* (125 – 54)] / 3412 + 185 - 0

= 2650 kWh

###### Summer Coincident Peak Demand Savings

ΔkW = ΔkWh / Hours \* CF

Where:

Hours = Full load hours of water heater

= 2533 [[25]](#footnote-27)

CF = Summer Peak Coincidence Factor for measure

= 0.12 **[[26]](#footnote-28)**

For example, a 2.0 COP heat pump water heater, in a conditioned space in a home with gas space heat and central air conditioning in Belleville:

kW = 2650 / 2533 \* 0.12

= 0.126 kW

###### Natural Gas Savings

ΔTherms = - ((((GPD \* Household \* 365.25 \* γWater \* (TOUT – TIN) \* 1.0) / 3412) – (((GPD \* Household \* 365.25 \* γWater \* (TOUT – TIN) \* 1.0) / 3412) / EFEFFICIENT)) \* LF \* 49% \* 0.03412) / (ηHeat \* % Natural Gas)

Where:

ΔTherms = Heating cost from conversion of heat in home to water heat for homes with Natural Gas heat.[[27]](#footnote-29)

0.03412 = conversion factor (therms per kWh)

ηHeat = Efficiency of heating system

= Actual.[[28]](#footnote-30) If not available use 70%.[[29]](#footnote-31)

% Natural Gas = Factor dependent on heating fuel:

|  |  |
| --- | --- |
| **Heating System** | **%Natural Gas** |
| Electric resistance or heat pump | 0% |
| Natural Gas | 100% |
| Unknown heating fuel[[30]](#footnote-32) | 87% |

Other factors as defined above

For example, a 2.0 COP heat pump water heater in conditioned space, in a home with gas space heat (70% system efficiency):

ΔTherms = - (1582.9 \* 1 \* 0.49 \* 0.03412) / 0.7 \* 1

= - 35.1 therms

###### Water Impact Descriptions and Calculation

N/A

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

N/A

###### Measure Code: RS-HWE-HPWH-V01-120601

# References

Please refer to the Chicago style for variances on format citations.

<http://www.chicagomanualofstyle.org/tools_citationguide.html>

EXAMPLES:

**Paper presented at a meeting or conference (Including internal work papers and evaluations)**

Author Name, “’Paper title” (paper presented at the annual meeting for the Organization Name, City, State, Month Day, Year).

**Website**

“Title,” last modified Month Day, Year, URL

**E-mail**

Author Name, e-mail message to author, Month Day, Year.

**Item in a commercial database**

Author Name. “Source Title” Publisher, Year. Database Name

**Book: Chapter or other part of a book**

Author Name, “Chapter,” in Title, City: Publisher, Year, page range

**Book: Published electronically**

Author Name, “Chapter,” in Title, City: Publisher, Year, Accessed Month Day, Year. URL.

**Journal Article in a print journal**

Author Name, “Article Title,” Journal Name edition (Year): page

**Journal Article in an online journal**

Author Name, “Article Title,” Journal Name edition (Year): page, accessed Month Day, Year, dio:xx.xxxx/xxxxxx.

# Stakeholder Comments

## Author (Company) and Date

1. Federal Standard as of January 2004, [http://www1.eere.energy.gov/buildings/appliance\_standards/residential/pdfs/water\_heater\_fr.pdf](http://205.254.135.7/consumption/residential/data/2009/xls/HC7.1%20Air%20Conditioning%20by%20Housing%20Unit%20Type.xls) [↑](#footnote-ref-1)
2. DOE, 2010 Residential Heating Products Final Rule Technical Support Document, Table 8.2.14 http://www1.eere.energy.gov/buildings/appliance\_standards/residential/pdfs/htgp\_finalrule\_ch8.pdf Note: This source is used to support this category in aggregate. For all water heaters, life expectancy will depend on local variables such as water chemistry and homeowner maintenance. Some categories, including condensing storage and tankless water heaters do not yet have sufficient field data to support separate values. Preliminary data show lifetimes may exceed 20 years, though this has yet to be sufficiently demonstrated. [↑](#footnote-ref-2)
3. Source for cost info; DOE, 2010 Residential Heating Products Final Rule Technical Support Document, Table 8.2.14 (http://www1.eere.energy.gov/buildings/appliance\_standards/residential/pdfs/htgp\_finalrule\_ch8.pdf) [↑](#footnote-ref-3)
4. Algorithm based on current Federal Standard; [http://www1.eere.energy.gov/buildings/appliance\_standards/residential/pdfs/water\_heater\_fr.pdf](http://205.254.135.7/consumption/residential/data/2009/xls/HC7.1%20Air%20Conditioning%20by%20Housing%20Unit%20Type.xls)

   Note that changes to the Federal Standard will be applied from April 16, 2015, see link below for more details:

   [http://www1.eere.energy.gov/buildings/appliance\_standards/residential/heating\_products\_fr.html](http://www.icc.illinois.gov/docket/files.aspx). [↑](#footnote-ref-4)
5. The disconnect between rated energy factor and in-situ energy consumption is markedly different for tankless units due to significantly higher contributions to overall household hot water usage from short draws. In tankless units the large burner and unit heat exchanger must fire and heat up for each draw. The additional energy losses incurred when the mass of the unit cools to the surrounding space in-between shorter draws was found to be 9% in a study prepared for Lawrence Berkeley National Laboratory by Davis Energy Group, 2006. “Field and Laboratory Testing of Tankless Gas Water Heater Performance” Due to the similarity (storage) between the other categories and the baseline, this derating factor is applied only to the tankless category. [↑](#footnote-ref-5)
6. Mayer, Peter, William DeOreo. Residential End Uses of Water. Published by AWWA Research Foundation and American Water Works Association. 1999. [↑](#footnote-ref-6)
7. 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 citing 2006-2008 American Community Survey data from the US Census Bureau for Illinois cited on p. 17 of the PY2 Evaluation report. 2.75 \* 93% evaluation adjustment [↑](#footnote-ref-8)
8. Navigant, ComEd PY3 Multi-Family Home Energy Savings Program Evaluation Report Final, May 16, 2012. [↑](#footnote-ref-9)
9. Bedrooms are suitable proxies for household occupancy, and may be preferable to actual occupancy due to turnover rates in residency and non-adult population impacts. [↑](#footnote-ref-10)
10. US DOE Building America Program. Building America Analysis Spreadsheet. For Chicago, IL [http://www1.eere.energy.gov/buildings/building\_america/analysis\_spreadsheets.html](http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf) [↑](#footnote-ref-11)
11. DOE, 2010 Residential Heating Products Final Rule Technical Support Document, Page 8-52 [http://www1.eere.energy.gov/buildings/appliance\_standards/residential/pdfs/htgp\_finalrule\_ch8.pdf](http://www.icc.illinois.gov/downloads/public/edocket/303834.pdf) [↑](#footnote-ref-12)
12. DOE, 2010 Residential Heating Products Final Rule Technical Support Document, Table 8.2.14 [http://www1.eere.energy.gov/buildings/appliance\_standards/residential/pdfs/htgp\_finalrule\_ch8.pdf](http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/LightingCalculator.xlsx) [↑](#footnote-ref-13)
13. Calculated from Figure 8 "Combined six-unit summer weekday average electrical demand" in FEMP study; Field Testing of Pre-Production Prototype Residential Heat Pump Water Heaters

    [http://www1.eere.energy.gov/femp/pdfs/tir\_heatpump.pdf](http://www.aquacraft.com/sites/default/files/pub/DeOreo-(2001)-Disaggregated-Hot-Water-Use-in-Single-Family-Homes-Using-Flow-Trace-Analysis.pdf) as (average kW usage during peak period \* hours in peak period) / [(annual kWh savings / FLH) \* hours in peak period] = (0.1 kW \* 5 hours) / [(2100 kWh (default assumptions) / 2533 hours) \* 5 hours] = 0.12 [↑](#footnote-ref-14)
14. Current Federal Standard EF, since 2004, for a 50-gal electric storage WH, Federal Register Vol. 66, No. 11/1/17/2001, page 4497, [http://www1.eere.energy.gov/buildings/appliance\_standards/residential/pdfs/water\_heater\_fr.pdf](http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf) [↑](#footnote-ref-15)
15. Mayer, Peter, William DeOreo. Residential End Uses of Water. Published by AWWA Research Foundation and American Water Works Association. 1999. [↑](#footnote-ref-16)
16. 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 citing 2006-2008 American Community Survey data from the US Census Bureau for Illinois cited on p. 17 of the PY2 Evaluation report. 2.75 \* 93% evaluation adjustment [↑](#footnote-ref-18)
17. Navigant, ComEd PY3 Multi-Family Home Energy Savings Program Evaluation Report Final, May 16, 2012. [↑](#footnote-ref-19)
18. Bedrooms are suitable proxies for household occupancy, and may be preferable to actual occupancy due to turnover rates in residency and non-adult population impacts. [↑](#footnote-ref-20)
19. US DOE Building America Program. Building America Analysis Spreadsheet. For Chicago, IL [http://www1.eere.energy.gov/buildings/building\_america/analysis\_spreadsheets.html](http://www.energystar.gov/ia/products/appliances/refrig/NAECA_calculation.xls) [↑](#footnote-ref-21)
20. This algorithm calculates the heat removed from the air by subtracting the HPWH electric consumption from the total water heating energy delivered. This is then adjusted to account for location of the HP unit and the coincidence of the waste heat with cooling requirements, the efficiency of the central cooling and latent cooling demands. [↑](#footnote-ref-22)
21. REMRate determined percentage (27%) of lighting savings that result in reduced cooling loads (lighting is used as a proxy for hot water heating since load shapes suggest their seasonal usage patterns are similar). [↑](#footnote-ref-23)
22. A sensible heat ratio (SHR) of 0.75 corresponds to a latent multiplier of 4/3 or 1.33. SHR of 0.75 for typical split system from page 10 of “Controlling Indoor Humidity Using Variable-Speed Compressors and Blowers” by M. A. Andrade and C. W. Bullard, 1999: www.ideals.illinois.edu/bitstream/handle/2142/11894/TR151.pdf [↑](#footnote-ref-24)
23. REMRate determined percentage (49%) of lighting savings that result in increased heating loads (lighting is used as a proxy for hot water heating since load shapes suggest their seasonal usage patterns are similar). [↑](#footnote-ref-25)
24. These default system efficiencies are based on the applicable minimum Federal Standards. In 2006 the Federal Standard for Heat Pumps was adjusted. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time mean that using the minimum standard is appropriate. [↑](#footnote-ref-26)
25. Full load hours assumption based on Efficiency Vermont analysis of Itron eShapes. [↑](#footnote-ref-27)
26. Calculated from Figure 8 "Combined six-unit summer weekday average electrical demand" in FEMP study; Field Testing of Pre-Production Prototype Residential Heat Pump Water Heaters

    [http://www1.eere.energy.gov/femp/pdfs/tir\_heatpump.pdf](http://www.eia.gov/consumption/residential/data/2009/) as (average kW usage during peak period \* hours in peak period) / [(annual kWh savings / FLH) \* hours in peak period] = (0.1 kW \* 5 hours) / [(2100 kWh / 2533 hours) \* 5 hours] = 0.12 [↑](#footnote-ref-28)
27. This is the additional energy consumption required to replace the heat removed from the home during the heating season by the heat pump water heater. kWh\_heating (electric resistance) is that additional heating energy for a home with electric resistance heat (COP 1.0). This formula converts the additional heating kWh for an electric resistance home to the MMBtu required in a Natural Gas heated home, applying the relative efficiencies. [↑](#footnote-ref-29)
28. Ideally, the System Efficiency should be obtained either by recording the AFUE of the unit, or performing a steady state efficiency test. The Distribution Efficiency can be estimated via a visual inspection and by referring to a look up table such as that provided by the Building Performance Institute: ([http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf](http://www.cee1.org/gov/led/led-ace3/ace3led.pdf) ) or by performing duct blaster testing. [↑](#footnote-ref-30)
29. This has been estimated assuming that natural gas central furnace heating is typical for Illinois residences (66% of Illinois homes have a Natural Gas Furnace (based on Energy Information Administration, 2009 Residential Energy Consumption Survey: [http://www.eia.gov/consumption/residential/data/2009/xls/HC6.9%20Space%20Heating%20in%20Midwest%20Region.xls](http://www.icc.illinois.gov/ags/consumereducation.aspx) ))

    In 2000, 24% of furnaces purchased in Illinois were condensing (based on data from GAMA, provided to Department of Energy during the federal standard setting process for residential heating equipment - see Furnace Penetration.xls). Furnaces tend to last up to 20 years and so units purchased 10 years ago provide a reasonable proxy for the current mix of furnaces in the State. Assuming typical efficiencies for condensing and non-condensing furnaces and duct losses, the average heating system efficiency is estimated as follows:

    (0.24\*0.92) + (0.76\*0.8) \* (1-0.15) = 0.70 [↑](#footnote-ref-31)
30. 2010 American Community Survey. [↑](#footnote-ref-32)