### ENERGY STAR and CEE Tier 2 Refrigerator

###### Description

This measure relates to:

1. Time of Sale: the purchase and installation of a new refrigerator meeting either ENERGY STAR or CEE TIER 2 specifications.
2. Early Replacement: the early removal of an existing residential inefficient Refrigerator from service, prior to its natural end of life, and replacement with a new ENERGY STAR or CEE Tier 2 qualifying unit. Savings are calculated between existing unit and efficient unit consumption during the remaining life of the existing unit, and between new baseline unit and efficient unit consumption for the remainder of the measure life.

Energy usage specifications are defined in the table below (note, Adjusted Volume is calculated as the fresh volume + (1.63 \* Freezer Volume):

| **Product Category** | **Existing Unit** | **Assumptions up to September 2014** | | **Assumptions after September 2014** | |
| --- | --- | --- | --- | --- | --- |
| **Based on Refrigerator Recycling algorithm** | **Federal Baseline  Maximum Energy Usage in kWh/year[[1]](#footnote-1)** | **ENERGY STAR Maximum Energy Usage in kWh/year**[[2]](#footnote-2) | **Federal Baseline  Maximum Energy Usage in kWh/year[[3]](#footnote-3)** | **ENERGY STAR Maximum Energy Usage in kWh/year[[4]](#footnote-4)** |
| 1. Refrigerators and Refrigerator-freezers with manual defrost | Use Algorithm in 5.1.8 Refrigerator and Freezer Recycling measure to estimate existing unit consumption | 8.82\*AV+248.4 | 7.056\*AV+198.72 | 6.79AV + 193.6 | 6.11 \* AV + 174.2 |
| 2. Refrigerator-Freezer--partial automatic defrost | 8.82\*AV+248.4 | 7.056\*AV+198.72 | 7.99AV + 225.0 | 7.19 \* AV + 202.5 |
| 3. Refrigerator-Freezers--automatic defrost with top-mounted freezer without through-the-door ice service and all-refrigerators--automatic defrost | 9.80\*AV+276 | 7.84\*AV+220.8 | 8.07AV + 233.7 | 7.26 \* AV + 210.3 |
| 4. Refrigerator-Freezers--automatic defrost with side-mounted freezer without through-the-door ice service | 4.91\*AV+507.5 | 3.928\*AV+406 | 8.51AV + 297.8 | 7.66 \* AV + 268.0 |
| 5. Refrigerator-Freezers--automatic defrost with bottom-mounted freezer without through-the-door ice service | 4.60\*AV+459 | 3.68\*AV+367.2 | 8.85AV + 317.0 | 7.97 \* AV + 285.3 |
| 5A Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service | N/A | N/A | 9.25AV + 475.4 | 8.33 \* AV + 436.3 |
| 6. Refrigerator-Freezers--automatic defrost with top-mounted freezer with through-the-door ice service | 10.20\*AV+356 | 8.16\*AV+284.8 | 8.40AV + 385.4 | 7.56 \* AV + 355.3 |
| 7. Refrigerator-Freezers--automatic defrost with side-mounted freezer with through-the-door ice service | 10.10\*AV+406 | 8.08\*AV+324.8 | 8.54AV + 432.8 | 7.69 \* AV + 397.9 |

Note CEE Tier 2 standard criteria is 25% less consumption than a new baseline unit. It is assumed that after September 2014 when the Federal Standard and ENERGY STAR specifications change, the CEE Tier 2 will remain set at 25% less that the new baseline assumption.

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

The efficient equipment is defined as a refrigerator meeting the efficiency specifications of ENERGY STAR or CEE Tier 2 (defined as requiring >= 20% or >= 25% less energy consumption than an equivalent unit meeting federal standard requirements respectively). The ENERGY STAR standard varies according to the size and configuration of the unit, as shown in table above.

###### Definition of Baseline Equipment

Time of Sale: baseline is a new refrigerator meeting the minimum federal efficiency standard for refrigerator efficiency. The current federal minimum standard varies according to the size and configuration of the unit, as shown in table above.. Note also that this federal standard will be increased for units manufactured after September 1, 2014.

Early Replacement: the baseline is the existing refrigerator 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 measure life is assumed to be 12 years.[[5]](#footnote-5)

Remaining life of existing equipment is assumed to be 4 years[[6]](#footnote-6)

###### Deemed Measure Cost

Time of Sale: The incremental cost for this measure is assumed to be $40[[7]](#footnote-7) for an ENERGY STAR unit and $140[[8]](#footnote-8) for a CEE Tier 2 unit.

Early Replacement: The measure cost is the full cost of removing the existing unit and installing a new one. The actual program cost should be used. If unavailable assume $451 for ENERGY STAR unit and $551 for CEE Tier 2 unit[[9]](#footnote-9).

The avoided replacement cost (after 4 years) of a baseline replacement refrigerator is $390[[10]](#footnote-10).

###### Loadshape

Loadshape R05 - Residential Refrigerator

###### Coincidence Factor

A coincidence factor is not used to calculate peak demand savings for this measure, see below.

**Algorithm**

###### Calculation of Savings

###### Electric Energy Savings:

Time of Sale: ΔkWh = UECBASE – UECEE

Early Replacement:

ΔkWh for remaining life of existing unit (1st 4 years) = UECEXIST – UECEE

ΔkWh for remaining measure life (next 8 years) = UECBASE – UECEE

Where:

UECEXIST = Annual Unit Energy Consumption of existing unit as calculated in algorithm from 5.1.8 Refrigerator and Freezer Recycling measure.

UECBASE = Annual Unit Energy Consumption of baseline unit as calculated in algorithm provided in table above.

UECEE = Annual Unit Energy Consumption of ENERGY STAR unit as calculated in algorithm provided in table above.

For CEE Tier 2, unit consumption is calculated as 25% lower than baseline.

If volume is unknown, use the following defaults, based on an assumed Adjusted Volume of 25.8[[11]](#footnote-11):

Assumptions prior to standard changes on September 1st, 2014:

| **Product Category** | **Existing Unit UECEXIST[[12]](#footnote-12)** | **New Baseline UECBASE** | **New Efficient**  **UECEE** | | **Early Replacement**  **(1st 4 years)**  **ΔkWh** | | **Time of Sale and**  **Early Replacement (last 8 years) ΔkWh** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ENERGY STAR** | **CEE T2** | **ENERGY STAR** | **CEE T2** | **ENERGY STAR** | **CEE T2** |
| 1. Refrigerators and Refrigerator-freezers with manual defrost | 1027.7 | 475.7 | 380.5 | 356.8 | 647.2 | 671.0 | 95.1 | 118.9 |
| 2. Refrigerator-Freezer--partial automatic defrost | 1027.7 | 475.7 | 380.5 | 356.8 | 647.2 | 671.0 | 95.1 | 118.9 |
| 3. Refrigerator-Freezers--automatic defrost with top-mounted freezer without through-the-door ice service and all-refrigerators--automatic defrost | 814.5 | 528.5 | 422.8 | 396.4 | 391.7 | 418.1 | 105.7 | 132.1 |
| 4. Refrigerator-Freezers--automatic defrost with side-mounted freezer without through-the-door ice service | 1241.0 | 634.0 | 507.2 | 475.5 | 733.7 | 765.4 | 126.8 | 158.5 |
| 5. Refrigerator-Freezers--automatic defrost with bottom-mounted freezer without through-the-door ice service | 814.5 | 577.5 | 462.0 | 433.2 | 352.5 | 381.4 | 115.5 | 144.4 |
| 6. Refrigerator-Freezers--automatic defrost with top-mounted freezer with through-the-door ice service | 814.5 | 618.8 | 495.1 | 464.1 | 319.5 | 350.4 | 123.8 | 154.7 |
| 7. Refrigerator-Freezers--automatic defrost with side-mounted freezer with through-the-door ice service | 1241.0 | 666.3 | 533.0 | 499.7 | 707.9 | 741.3 | 133.3 | 166.6 |

Assumptions after standard changes on September 1st, 2014:

| **Product Category** | **Existing Unit UECEXIST[[13]](#footnote-13)** | **New Baseline UECBASE** | **New Efficient**  **UECEE** | | **Early Replacement**  **(1st 4 years)**  **ΔkWh** | | **Time of Sale and**  **Early Replacement (last 8 years) ΔkWh** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ENERGY STAR** | **CEE T2** | **ENERGY STAR** | **CEE T2** | **ENERGY STAR** | **CEE T2** |
| 1. Refrigerators and Refrigerator-freezers with manual defrost | 1027.7 | 368.6 | 331.6 | 276.4 | 696.1 | 751.3 | 36.9 | 92.1 |
| 2. Refrigerator-Freezer--partial automatic defrost | 1027.7 | 430.9 | 387.8 | 323.2 | 640.0 | 704.6 | 43.1 | 107.7 |
| 3. Refrigerator-Freezers--automatic defrost with top-mounted freezer without through-the-door ice service and all-refrigerators--automatic defrost | 814.5 | 441.7 | 397.4 | 331.2 | 417.2 | 483.3 | 44.3 | 110.4 |
| 4. Refrigerator-Freezers--automatic defrost with side-mounted freezer without through-the-door ice service | 1241.0 | 517.1 | 465.4 | 387.8 | 775.6 | 853.1 | 51.7 | 129.3 |
| 5. Refrigerator-Freezers--automatic defrost with bottom-mounted freezer without through-the-door ice service | 814.5 | 545.1 | 490.7 | 408.8 | 323.9 | 405.8 | 54.4 | 136.3 |
| 5A Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service | 814.5 | 713.8 | 651.0 | 535.3 | 163.6 | 279.2 | 62.8 | 178.4 |
| 6. Refrigerator-Freezers--automatic defrost with top-mounted freezer with through-the-door ice service | 814.5 | 601.9 | 550.1 | 451.4 | 264.4 | 363.2 | 51.7 | 150.5 |
| 7. Refrigerator-Freezers--automatic defrost with side-mounted freezer with through-the-door ice service | 1241.0 | 652.9 | 596.1 | 489.6 | 644.9 | 751.3 | 56.8 | 163.2 |

###### Summer Coincident Peak Demand Savings

ΔkW = (ΔkWh/8766) \* TAF \* LSAF

Where:

TAF = Temperature Adjustment Factor

= 1.25[[14]](#footnote-14)

LSAF = Load Shape Adjustment Factor

= 1.057 [[15]](#footnote-15)

If volume is unknown, use the following defaults:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Product Category** | **Assumptions prior to September 2014 standard change ΔkW** | | | | **Assumptions after September 2014 standard change ΔkW** | | | |
| **Early Replacement (1st 4 years)** | | **Time of Sale and Early Replacement (last 8 years)** | | **Early Replacement (1st 4 years)** | | **Time of Sale and Early Replacement (last 8 years)** | |
| **ENERGY STAR** | **CEE T2** | **ENERGY STAR** | **CEE T2** | **ENERGY STAR** | **CEE T2** | **ENERGY STAR** | **CEE T2** |
| 1. Refrigerators and Refrigerator-freezers with manual defrost | 0.098 | 0.101 | 0.014 | 0.018 | 0.105 | 0.113 | 0.006 | 0.014 |
| 2. Refrigerator-Freezer--partial automatic defrost | 0.098 | 0.101 | 0.014 | 0.018 | 0.096 | 0.106 | 0.006 | 0.016 |
| 3. Refrigerator-Freezers--automatic defrost with top-mounted freezer without through-the-door ice service and all-refrigerators--automatic defrost | 0.059 | 0.063 | 0.016 | 0.020 | 0.063 | 0.073 | 0.007 | 0.017 |
| 4. Refrigerator-Freezers--automatic defrost with side-mounted freezer without through-the-door ice service | 0.111 | 0.115 | 0.019 | 0.024 | 0.117 | 0.129 | 0.008 | 0.019 |
| 5. Refrigerator-Freezers--automatic defrost with bottom-mounted freezer without through-the-door ice service | 0.053 | 0.057 | 0.017 | 0.022 | 0.049 | 0.061 | 0.008 | 0.021 |
| 5A Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service | n/a | n/a | n/a | n/a | 0.025 | 0.042 | 0.009 | 0.027 |
| 6. Refrigerator-Freezers--automatic defrost with top-mounted freezer with through-the-door ice service | 0.048 | 0.053 | 0.019 | 0.023 | 0.040 | 0.055 | 0.008 | 0.023 |
| 7. Refrigerator-Freezers--automatic defrost with side-mounted freezer with through-the-door ice service | 0.107 | 0.112 | 0.020 | 0.025 | 0.097 | 0.113 | 0.009 | 0.025 |

###### Natural Gas Savings

N/A

###### Water Impact Descriptions and Calculation

N/A

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

N/A

###### Measure Code: RS-APL-ESRE-V03-160601

1. http://www1.eere.energy.gov/buildings/appliance\_standards/product.aspx/productid/43 [↑](#footnote-ref-1)
2. [http://www.energystar.gov/ia/products/appliances/refrig/NAECA\_calculation.xls?c827-f746](http://205.254.135.7/consumption/residential/data/2009/xls/HC7.1%20Air%20Conditioning%20by%20Housing%20Unit%20Type.xls?c827-f746) [↑](#footnote-ref-2)
3. http://www1.eere.energy.gov/buildings/appliance\_standards/product.aspx/productid/43 [↑](#footnote-ref-3)
4. http://www.energystar.gov/products/specs/sites/products/files/ENERGY%20STAR%20Final%20Version%205.0%20Residential%20Refrigerators%20and%20Freezers%20Specification.pdf [↑](#footnote-ref-4)
5. From ENERGY STAR calculator: http://www.energystar.gov/buildings/sites/default/uploads/files/appliance\_calculator.xlsx?7224-046c=&7224-\_\_046ceiling\_fan\_calculator\_xlsx=&f7d8-39dd&f7d8-39dd [↑](#footnote-ref-5)
6. Standard assumption of one third of effective useful life. [↑](#footnote-ref-6)
7. From ENERGY STAR calculator linked above. [↑](#footnote-ref-7)
8. Based on weighted average of units participating in Efficiency Vermont program and retail cost data provided in Department of Energy, “TECHNICAL REPORT: Analysis of Amended Energy Conservation Standards for Residential Refrigerator-Freezers”, October 2005; [http://www1.eere.energy.gov/buildings/appliance\_standards/pdfs/refrigerator\_report\_1.pdf](http://www.bpa.gov/energy/n/reports/evaluation/residential/faucet_aerator.cfm) [↑](#footnote-ref-8)
9. ENERGY STAR full cost is based upon IL PHA Efficient Living Program data on sample size of 910 replaced units finding average cost of $430 plus an average recycling/removal cost of $21. The CEE Tier 2 estimate uses the delta from the Time of Sale estimate. [↑](#footnote-ref-9)
10. Calculated using incremental cost from Time of Sale measure. [↑](#footnote-ref-10)
11. Volume is based on the ENERGY STAR calculator average assumption of 14.75 ft3 fresh volume and 6.76 ft3 freezer volume. [↑](#footnote-ref-11)
12. Estimates of existing unit consumption are based on using the 5.1.8 Refrigerator and Freezer Recycling algorithm and the inputs described here: Age = 10 years, Pre-1990 = 0, Size = 21.5 ft3 (from ENERGY STAR calc and consistent with AV of 25.8), Single Door = 0, Side by side = 1 for classifications stating side by side, 0 for classifications stating top/bottom, and 0.5 for classifications that do not distinguish, Primary appliances = 1, unconditioned = 0, Part use factor = 0. [↑](#footnote-ref-12)
13. Estimates of existing unit consumption are based on using the 5.1.8 Refrigerator and Freezer Recycling algorithm and the inputs described here: Age = 10 years, Pre-1990 = 0, Size = 21.5 ft3 (from ENERGY STAR calc and consistent with AV of 25.8), Single Door = 0, Side by side = 1 for classifications stating side by side, 0 for classifications stating top/bottom, and 0.5 for classifications that do not distinguish, Primary appliances = 1, unconditioned = 0, Part use factor = 0. [↑](#footnote-ref-13)
14. Average temperature adjustment factor (to account for temperature conditions during peak period as compared to year as a whole) based on Blasnik, Michael, "Measurement and Verification of Residential Refrigerator Energy Use, Final Report, 2003-2004 Metering Study", July 29, 2004 (p. 47). It assumes 90 °F average outside temperature during peak period, 71°F average temperature in kitchens and 65°F average temperature in basement, and uses assumption that 66% of homes in Illinois having central cooling (CAC saturation: "Table HC7.9 Air Conditioning in Homes in Midwest Region, Divisions, and States, 2009 from Energy Information Administration", 2009 Residential Energy Consumption Survey; [http://www.eia.gov/consumption/residential/data/2009/xls/HC7.9%20Air%20Conditioning%20in%20Midwest%20Region.xls](http://www1.eere.energy.gov/buildings/appliance_standards/residential/clothes_washers_support_stakeholder_negotiations.html) ) [↑](#footnote-ref-14)
15. Daily load shape adjustment factor (average load in peak period /average daily load) also based on Blasnik, Michael, "Measurement and Verification of Residential Refrigerator Energy Use, Final Report, 2003-2004 Metering Study", July 29, 2004 (p. 48, using the average Existing Units Summer Profile for hours 13 through 17) [↑](#footnote-ref-15)