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TETRA TECH

Heat Pump Working Group
Biweekly Agenda
Date: 07/16/2024 @ 11:00 CDT

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Meeting Link	
Access	PUC – Interchange Filing: Case 56510 Interchange - Documents (texas.gov) Teams site: https://tetratechinc.sharepoint.com/:f:/r/teams/PUCTHeatPumpWorkinggroup/Shared%20Documents/General?csf=1&web=1&e=mCHkEh Past Meeting recordings: https://vimeo.com/channels/HPWG
Review of Residential Measure Barriers	Residential Measure 2.2.2 (Review) • Load Calculations (Manual J & S) • Consumption hours • Right-sizing calculations (limitations to different capacities) • Winter savings for gas heat replacement – Baseline as std. heat pump • Winter savings for HP replacement – Pre and post are both equal amount of supplemental heat (77%) • Current ID of VSHP is based on SEER being greater than 15.2 • VSHP do not have the mismatched equipment concern seen with units a few years ago. • New Construction baseline = 115% of summer load • Summer and Winter Peak Coincident demand factors need to adjust based on summer peak capacity and winter supplemental heat. • EFLH is multiplied times SEER/HSPF to determine consumption. • EUL is 15 years for heat pumps.
Identification of Commercial Barriers that vary from Residential	Commercial Measure 2.2.2 • Replacement capacity limited to 20% adjustment • New Construction baseline capacity = Installed capacity • Baseline efficiencies per DOE standards or IECC2015
Discussion Schedule	○ May 7: Identification of VSHP, Load Calculation requirements, Consumption calculation (EFLH), EUL ○ May 21: Summer Peak & Consumption ○ June 4: Winter Peak & Consumption ○ June 18: Baseline equipment, upsizing/downsizing calculation, and coincidence factor ○ July 09: Envelope incorporation ○ **July 16: Draft measure** ○ July 30: Review measure
Draft Measure	Review attached residential measure

Next Meeting	**July 30 at 11:00** Topic – **Measure Review and final comments from HPWG**

Acronym	Term
ACCA	Air Conditioning Contractors of America Manual J is the sizing calculation from ACCA
AHRI	Air Conditioning, Heating, and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CCHP	Cold Climate Heat Pump (as defined by NEEP)
COP	Coefficient of Performance
CPUC	California Public Utilities Commission
DHW	Domestic Hot Water
DOE	United States Department of Energy
EER	Energy Efficiency Ratio
EFLH	Equivalent Full Load Hours
ER	Early Retirement
EUL	Effective Useful Life
HP	Heat Pump
HSPF	Heating Seasonal Performance Factor
IECC	International Energy Conservation Code
NC	New Construction
NEEP	Northeast Energy Efficiency Partnership
PNNL	Pacific Northwest National Laboratory
PUC	Public Utility Commission of Texas
ROB	Replace on Burnout
SEER	Seasonal Energy Efficiency Ratio
TRM	Technical Reference Manual
VSHP	Variable Speed Heat Pump

2.1.2 Variable Speed Heat Pumps Measure Overview

TRM Measure ID: New Measure Code

Market Sector: Residential

Measure Category: HVAC

Applicable Building Types: Single-family, multifamily, manufactured

Fuels Affected: Electricity

Decision/Action Type(s): Replace-on-burnout, early retirement, new construction

Program Delivery Type(s): Prescriptive

Deemed Savings Type: Calculation

Savings Methodology: Engineering algorithms and estimates

Measure Description

Residential replacement of existing heating and cooling equipment with a new heat pump (HP) in an existing building, or the installation of a new central HP in a new residential construction. Each heat pump system consists of a heat pump system that include an indoor unit with a matching remote condensing unit and is applicable to all heat pumps including single speed, dual speed, and variable speed systems.

Eligibility Criteria

The deemed savings apply to units with a capacity of ≤ 65,000 Btu/hour (5.4 tons).

Equipment shall be properly sized for both heating and cooling to the dwelling based on ASHRAE or ACCA Manual J standards. Manufacturer datasheets for installed equipment or documentation of AHRI or DOE CCMS certification must be provided.[1,2]

For early retirement projects, to receive savings, the unit to be replaced must be functioning at the time of removal with a maximum age of 24 years for ACs and 20 years for HPs. Otherwise, claim savings for a replace-on-burnout project. Additional guidance for systems applying the default age is provided in the Savings Algorithms and Input Variables section.

The replacement of an evaporative cooler with a refrigerated system is eligible where the decision to change equipment types predates or is independent of the decision to install efficient equipment and should be claimed against the new construction baseline.

The replacement of a room AC with a central or mini-split AC or HP is eligible and should be claimed against the new construction baseline. Refer to the Replace-on-Burnout or Early

[1] Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Directory: https://www.ahridirectory.org/.
[2] Department of Energy Compliance Certification Management System (DOE CCMS): https://www.regulations.doe.gov/certification-data/.

Retirement of an Electric Resistance Furnace section for guidance about the appropriate heating baseline for residences with electric resistance heat.

Additionally, low-income or hard-to-reach programs may use the electric resistance baseline for the following two scenarios:

- The electric resistance baseline may be used for systems upsized by no more than a half-ton in lieu of the new construction baseline. Under this scenario, cooling savings should be claimed against the new construction baseline using the installed (higher) capacity. Heating savings should be claimed against the electric resistance baseline using the existing (lower) capacity. Documentation should be aligned with the rightsizing and electric resistance baseline requirements outlined in this measure.
- The second scenario is for a major multifamily renovation when a centralized system, such as a boiler, is replaced with individual heat pumps. For this scenario, the electric resistance baseline may be claimed in lieu of new construction only if the building owner can document intent to install electric-resistance furnaces without program intervention. The cooling savings should still be claimed against the new construction baseline. Documentation should follow early retirement and electric-resistance baseline requirements.

Baseline Condition

New Construction, Replace-on-Burnout, or Early Retirement of an Air-Source AC or HP

There are two components of the baseline determination that are required, the equipment capacity and the equipment efficiency. The capacity for the calculation can be determined one of two ways, the a sizing calculation, such as the ACCA Manual J, or the lower capacity between the existing equipment and the improved equipment.

The baseline equipment efficiency varies depending on the project situation. New construction baseline efficiency values for HPs are compliant with the current federal standard,[7,8] effective January 1, 2023. The baseline is assumed to be a new system with an AHRI-listed SEER2 rating consistent with the values listed in Table 28 and Table 29.

[7] DOE minimum efficiency standard for residential air conditioners/heat pumps. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=48&action=viewlive.

[8] Walter-Terrinoni, Helen, "New US Energy Efficiency Standards and Refrigerants for Residential ACs and Heat Pumps." Air-Conditioning, Heating, & Refrigeration Institute (AHRI). February 1, 2022.

For replace-on-burnout projects, the cooling baselines are reduced by 4.3 percent. This value is based on Energy Systems Laboratory (ESL) survey data and incorporates an adjustment to the baseline SEER2/EER2 value to reflect the percentage of current replacements that do not include the installation of an AHRI-matched system.[9,10] Heating baselines were not included in original ESL survey data and are not adjusted.

For early retirement projects, baselines are defined in Table 28 and Table 29 based on the applicable federal standard base on manufacture year. These baselines have been converted to SEER2, EER2, and HSPF2 by extrapolating from known values referenced in the current federal standard. Systems manufactured as of January 1, 2023, are not eligible for early retirement.

For early retirement projects involving an HP replacing an AC with gas heat, early retirement cooling baselines should be used in combination with new construction heating baselines.

Replace-on-Burnout or Early Retirement of an Electric Resistance Furnace

Electric resistance heating baselines may refer to residences heated by a centralized forced-air furnace or by individual space heaters.[11] Space heating primarily refers to electric baseboard zonal heaters controlled by thermostats or to portable plug-load heaters.[12] Electric resistance heat controlled by a wall thermostat is eligible to claim the deemed savings presented in this measure. Homes with portable space heaters should calculate savings using a HP baseline.

By the nature of the technology, all electric resistance furnaces have the same efficiency with HSPF = 3.412.[13] Projects in which an electric resistance furnace is replaced, either in replace-on-burnout or early retirement scenarios, use this baseline for heating-side savings.

Table 1. Central and Mini-Split ACs—Baseline Efficiencies

Project type	Capacity (Btu/hr)	Cooling mode
New construction, split air conditioners	< 45,000	14.3 SEER2 11.7 EER2
	≥ 45,000	13.8 SEER2 11.2 EER2

[9] Frontier Energy on behalf of the Electric Utility Marketing Managers of Texas (EUMMOT). "Petition to revise Existing Commission-Approved Deemed Savings Values for Central Air Conditioning and Heat Pump Systems: Docket No. 36780." Public Utility Commission of Texas. Approved August 27, 2009. https://interchange.puc.texas.gov/. Adapted for new 14 SEER baseline.

[10] The original petition defines the reduced baseline as 12.44 SEER compared to a 13 SEER federal standard. This deemed value was converted to a percentage reduction to accommodate a transition from SEER to SEER2. No EER adjustment is discussed in the original petition because the previous deemed savings structure only awarded savings based on SEER ratings. However, supporting documentation of the original filing makes it clear that the adjustment is appropriate for both part- and full-load cooling efficiency values. Therefore, the deemed percentage reduction is applied to both SEER2 and EER2 ROB baselines.

[11] Electric Resistance Heating: https://www.energy.gov/energysaver/home-heating-systems/electric-resistance-heating.

[12] Portable Heaters: https://www.energy.gov/energysaver/home-heating-systems/portable-heaters.

[13] COP = HSPF × 1,055 J/BTU / 3,600 J/W-hr. For Electric Resistance, heating efficiency is 1 COP. Therefore, HSPF = 1 × 3,600 / 1,055 = 3.412.

Project type	Capacity (Btu/hr)	Cooling mode
New construction, packaged air conditioners	All	13.4 SEER2 10.9 EER2
Replace-on-burnout, split air conditioners	< 45,000	13.7 SEER2 11.2 EER2
	≥ 45,000	13.2 SEER2 10.7 EER2
Replace-on-burnout, packaged air conditioners	All	12.8 SEER2 10.4 EER2
Early retirement, air conditioners (manufactured 1/1/2015 through 12/31/2022)	All	12.8 SEER2 10.4 EER2
Early retirement, air conditioners (when applying default age)[14]	All	12.3 SEER2 10.0 EER2
Early retirement, air conditioners (manufactured 1/23/2006 through 12/31/2014)	All	11.9 SEER2 9.7 EER2
Early retirement, air conditioners (manufactured before 1/23/2006)	All	9.1 SEER2 7.4 EER2
All systems rated at 15.2 SEER2 or higher[15]	All	9.8 EER2

Table 2. Central and Mini-Split HPs—Baseline Efficiencies

Project type	Cooling mode	Heating mode (HHV)
New construction, split heat pumps	14.3 SEER2 11.7 EER2	7.5 HSPF2
New construction, packaged heat pumps	13.4 SEER2 10.9 EER2	6.7 HSPF2
Replace-on-burnout, split heat pumps	13.7 SEER2 11.2 EER2	7.5 HSPF2
Replace-on-burnout, packaged heat pumps	12.8 SEER2 10.4 EER2	6.7 HSPF2
Early retirement, split heat pumps (manufactured 1/1/2015 through 12/31/2022)	12.8 SEER2 10.4 EER2	6.9 HSPF2
Early retirement, packaged heat pumps (manufactured 1/1/2015 through 12/31/2022)	12.8 SEER2 10.4 EER2	6.7 HSPF2

[14] Baseline efficiencies are calculated by taking the average the early retirement categories for 2006-2014 and 2015-2022.

[15] When installing any system with a part-load efficiency rating of 15.2 SEER2 or higher, the reduced 9.8 EER2 full-load efficiency baseline should be applied in lieu of the applicable value presented earlier in the table except where the specified baseline EER2 value is lower than 9.8 EER2.

Project type	Cooling mode	Heating mode (HHV)
Early retirement, split heat pumps (when applying default age)[16]	12.3 SEER2 10.0 EER2	6.7 HSPF2
Early retirement, packaged heat pumps (when applying default age)[17]	12.3 SEER2 10.0 EER2	6.6 HSPF2
Early retirement, heat pumps (manufactured 1/23/2006 through 12/31/2014)	11.9 SEER2 9.7 EER2	6.5 HSPF2
Early retirement, heat pumps (manufactured before 1/23/2006)	9.1 SEER2 7.4 EER2	5.7 HSPF2
All systems rated at 15.2 SEER2 or higher[18]	9.8 EER2	–
Replace-on-burnout or early retirement, electric resistance furnace[19]	–	3.412 HSPF2

High-Efficiency Condition

There are two components of the high efficiency that are required, the equipment capacity and the equipment efficiency. The capacity varies between cooling and heating and the rated capacity needs to be documented for cooling, heating at 47 degrees (HHV) and heating at 17 degrees (LHV).

Rated system cooling (SEER2) and heating (HSPF2) efficiencies must meet or exceed the federal standard specified in Table 28 and Table 29. HVAC equipment with SEER2 meeting federal standard minimum requirements is eligible for early retirement cooling savings with verification of age of existing equipment and removal of functional inefficient equipment. HPs with HSPF2 meeting the minimum federal standard replacing electric resistance furnaces should follow the electric resistance documentation requirements.

Since there is no full-load efficiency requirement specified in the current federal standard, systems that comply with SEER2 and HSPF2 requirements but do not comply with the EER2 requirements outlined in Table 28 and Table 29 may still be eligible to claim savings. Systems with qualifying SEER2 and HSPF2 energy ratings are permitted to claim cooling energy savings, heating energy savings, and winter demand savings for systems, but not summer demand savings where the EER2 rating does not comply with the minimum requirement.

[16] Baseline efficiencies are calculated by taking the average the early retirement categories for 2006–2014 and 2015–2022.

[17] Ibid.

[18] When installing any system with a part-load efficiency rating of 15.2 SEER2 or higher, the reduced 9.8 EER2 full-load efficiency baseline should be applied in lieu of the applicable value presented earlier in the table except where the specified baseline EER2 value is lower than 9.8 EER2.

[19] When installing a heat pump replacing a split air conditioner with an electric resistance furnace, the reduced 3.412 HSPF2 heating baseline efficiency should be applied in lieu of the applicable value presented earlier in the table.

Energy and Demand Savings Methodology

Savings Algorithms and Input Variables

Energy and demand savings algorithms and associated input variables are listed below.

Inputs Variables

Equipment Specifications

- Type of Heat Pump (Single Speed, Dual Speed, Variable Speed, Other)
- Electric Resistance auxillary heating capacity (kW)

AHRI directory

- Cooling Capacity (AFull) - Single or High Stage (95F) btuh
- Heating Capacity (H1Full) - Single or High Stage (47F), btuh
- Heating Capacity at 17°F as calculated by M1
- Heating Capacity at 5°F as calculated by M1
- EER2 (AFull) - Single or High Stage (95F)
- SEER2
- HSPF2 (Region IV)
- Heating COP at 5°F as calculated by M1

Baseline equipment specifications (if available)

- Year of manufacture
- Cooling Capacity (btuh) - Not nominal tonnage
- Heating Capacity

Load Calcuation

- Manual J Cooling Load at Design Temperature
- Manual J Heating Load at Design Temperature

For early retirement, if age is unknown, assume a default age equal to the replaced unit estimated useful life (EUL) resulting in a remaining useful life (RUL) of 7 (ACs) or 6 years (HPs). Default age may be used exclusively if applied consistently for all early retirement projects. This is the only scenario where an early retirement baseline can be applied to systems older than 24 years for ACs and 20 years for HPs. Otherwise, the default should only be used when a project is reported and documented as having a nameplate that is illegible. Default early retirement baselines are specified in Table 28 and Table 29 for use with the default age.

Energy Savings Algorithms

$$Total\ Energy\ Savings\ [\Delta kWh] = kWh_C + kWh_H$$

Equation 1

$$Cooling\ Energy\ Savings\ [kWh_C] = Load_C \left(\frac{1}{\eta_{baseline,C}} - \frac{1}{\eta_{installed,C}}\right) \times EFLH_C \times FLH_{des} \times \frac{1\ kW}{1{,}000\ W}$$

Equation 2

$$Heating\ Energy\ Savings\ [kWh_H]\ \textbf{with}\ \text{electric resistance auxillary heat} = \left[\left(\frac{CD_{H,pre}}{\eta_{baseline,H}} - \frac{CD_{H,post}}{\eta_{installed,H}}\right) + \left(\frac{CD_{H,\text{post}} - CD_{H,pre}}{\eta_{Aux,H}}\right)\right] \times EFLH_H \times \frac{1\ kW}{1{,}000\ W}$$

$$Heating\ Energy\ Savings\ [kWh_H]\ \textbf{without}\ \text{electric resistance auxillary heat} = \left[\left(\frac{CD_{H,post}}{\eta_{baseline,H}} - \frac{CD_{H,post}}{\eta_{installed,H}}\right)\right] \times EFLH_H \times \frac{1\ kW}{1{,}000\ W}$$

Equation 3A&B

Demand Savings Algorithms

$$Summer\ Peak\ Demand\ Savings\ [\Delta kW] = \left(\frac{Cap_{C,pre}}{\eta_{baseline,C}} - \frac{Cap_{C,post}}{\eta_{installed,C}}\right) \times CF_S \times \frac{1\ kW}{1{,}000\ W}$$

Equation 4

$$Winter\ Peak\ Demand\ Savings\ [\Delta kW]\ \boldsymbol{with}\ electric\ resistance\ auxillary\ heat = \left[\left(\frac{CD_{H,pre}}{\eta_{baseline,H}} - \frac{CD_{H,post}}{\eta_{installed,H}}\right) + \left(\frac{CD_{H,\text{post}} - CD_{H,pre}}{\eta_{Aux,H}}\right)\right] \times CF_W \times \frac{1\ kW}{1{,}000\ W}$$

$$Heating\ Energy\ Savings\ [kWh_H]\ \textbf{without}\ \text{electric resistance auxillary heat} = \left[\left(\frac{CD_{H,post}}{\eta_{baseline,H}} - \frac{CD_{H,post}}{\eta_{installed,H}}\right)\right] \times CF_W \times \frac{1\ kW}{1{,}000\ W}$$

Equation 5A&B

Where:

Cap_C = *Minimum of rated capacity of existing equipment or new equipment [Btuh]; 1 ton = 12,000 Btuh*

$Load_C$ = Calculated Cooling Design Load at Manual J temperature

or the Cap_C times 0.85

$Load_H$ = Calculated Heating Design Load at Manual J temperature or the $Load_C$ times Winter Load Adjustment

Climate Zone	Winter Load Adjustment
1	153%
2	103%
3	90%
4	79%
5	103%

CD_H = Minimum of Heating Capacity at Design Temp or $Load_H$

$$CD_H = CAP_{H,47} - \left(CAP_{H,47} - CAP_{H,17}\right) \times R_{MJ}$$

$CAP_{H,47}$ = Rated heating capacity at 47 degrees

$CAP_{H,17}$ = Rated heating capacity at 17 degrees

R_{MJ} = Design temperature from Manual J to determine heating capacity assuming a straightline between $CAP_{H,47}$ and $CAP_{H,17}$

Climate Zone	R_{MJ}
1	110%
2	70%
3	47%
4	33%
5	70%

$\eta_{baseline,C}$ = *Baseline cooling efficiency of existing equipment (ER) or standard equipment (ROB/NC) [Btuh/W]*

$\eta_{installed,C}$ = *Rated cooling efficiency of the newly installed equipment (must exceed ROB/NC baseline efficiency standards in Table 28 and Table 29) [Btuh/W]*

$\eta_{baseline,H}$ = *Baseline heating efficiency of existing equipment (ER) or standard equipment (ROB/NC) [Btuh/W]*

$\eta_{installed,H}$ = *Rated heating efficiency of the newly installed equipment (must exceed baseline efficiency standards in Table 29) [Btuh/W]*

$\eta_{aux,H}$ = *Rated heating efficiency of the auxillary heat source, 3.412 if electric resistance*

Note: Use SEER2 for cooling kWh, EER2 for summer kW, and HSPF2 for heating kWh and winter kW savings calculations.

$EFLH_{C/H}$ = *Cooling/heating equivalent full-load hours (Table 30)*

$CF_{S/W}$ = *Summer/winter seasonal peak coincidence factor (Table 31)*

Table 3. Central and Mini-Split AC/HPs—Equivalent Full Load Cooling/Heating Hours[20]

Climate zone	$EFLH_C$	$EFLH_H$
Zone 1: Amarillo	1,142	1,880
Zone 2: Dallas	1,926	1,343
Zone 3: Houston	2,209	1,127
Zone 4: Corpus Christi	2,958	776
Zone 5: El Paso	1,524	1,559

Table 4. Central and Mini-Split AC/HPs—Coincidence Factors[21]

Season	CF
Summer[22]	0.87
Winter[23]	0.83

Early Retirement

Annual energy (kWh) and summer peak demand (kW) savings must be calculated separately for two time periods:

1. The estimated remaining life of the equipment that is being removed, designated the remaining useful life (RUL), and

[20] ENERGY STAR Central AC/HP Savings Calculator.

[21] Coincidence factors calculated in accordance with the current peak definition are lower than expected for the Texas climate. Residential HVAC measures will temporarily revert to the coincidence factors used in TX TRM v4.0 before the change to the peak definition. These values will be reevaluated in upcoming TRM cycles to better align with the current peak definition.

[22] Air Conditioning Contractors of America (ACCA) Manual S recommends that residential heat pumps be sized at 115 percent of the maximum cooling requirement of the residence (for cooling-dominated climates). Assuming that maximum cooling occurs during the peak period, the guideline leads to a coincidence factor of 1 / 1.15 = 0.87.

[23] Air Conditioning Contractors of America (ACCA) Manual S recommends that residential heat pumps be sized at 115 percent of the maximum cooling requirement of the residence (for cooling-dominated climates). Based on AHRI data for 1.5–5 ton HVAC systems, the average ratio of rated heating capacity to cooling capacity is 0.96. Assuming that maximum heating occurs during the peak period and adjusting for the average ratio of heating to cooling capacity, the guideline leads to a coincidence factor of 0.96 / 1.15 = 0.83.

2. The remaining time in the EUL period (EUL – RUL)

Annual energy and summer peak demand savings are calculated by weighting the early retirement and replace-on-burnout savings by the RUL of the unit and the remainder of the EUL period, as outlined in the Volume 3 appendices.

Where:

RUL	=	*Remaining useful life (see Table 32 or Table 33). If individual system components were installed at separate times, use the condenser age as a proxy for the entire system. For HPs replacing an AC with an electric resistance furnace, use the AC RUL table.*
EUL	=	*Estimated useful life = 18 years (AC); 20 years (HP)*

Table 5. Central and Mini-Split AC/HPs—RUL of Replaced AC

Age of replaced unit (years)	Remaining useful life (years)	Age of replaced unit (years)	Remaining useful life (years)
1	16.8	14	8.6
2	15.8	15	8.2
3	14.9	16	7.9
4	14.1	17	7.6
5	13.3	18	7.0
6	12.6	19	6.0
7	11.9	20	5.0
8	11.3	21	4.0
9	10.8	22	3.0
10	10.3	23	2.0
11	9.8	24	1.0
12	9.4	25[24,25]	0.0
13	9.0		

Table 6. Central and Mini-Split AC/HPs—RUL of Replaced HP

Age of replaced unit (years)	Remaining useful life (years)	Age of replaced unit (years)	Remaining useful life (years)
1	13.7	12	7.9
2	12.7	13	7.6
3	12.0	14	7.0

[24] RULs are capped at the seventy-fifth percentile as determined based on DOE survival curves (see Figure 1). Systems older than this age should use the ROB baseline. See the January 2015 memo, "Considerations for Early Replacement of Residential Equipment," for further detail.

[25] Ward, B., Bodington, N., Farah, H., Reeves, S., and Lee, L. "Considerations for Early Replacement of Residential Equipment." Prepared by the Evaluation, Measurement, and Verification (EM&V) team for the Electric Utility Marketing Managers of Texas (EUMMOT). January 2015. This document has been made available to Texas investor-owned utilities through the EM&V team's SharePoint.

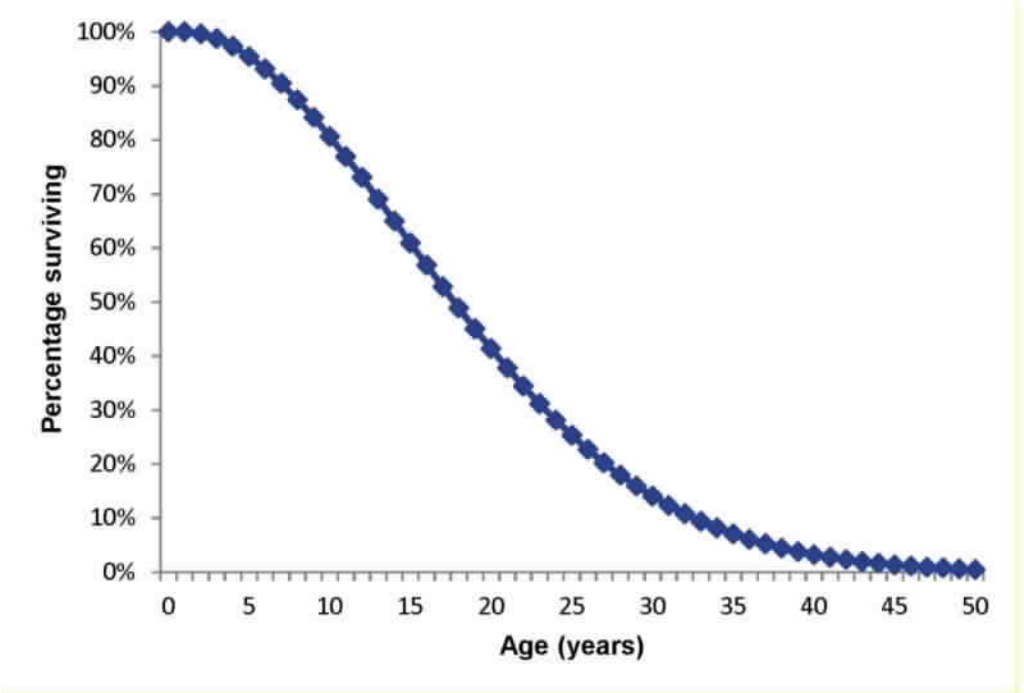
Age of replaced unit (years)	Remaining useful life (years)
4	11.3
5	10.7
6	10.2
7	9.7
8	9.3
9	8.9
10	8.5
11	8.2

Age of replaced unit (years)	Remaining useful life (years)
15	6.0
16	5.0
17	4.0
18	3.0
19	2.0
20	1.0
21[26]	0.0

Derivation of RULs

ACs have an estimated useful life of 18 years, and HPs have an estimated useful life of 15 years. This estimate is consistent with the age at which approximately 50 percent of ACs and HPs installed in a given year will no longer be in service, as described by the survival function in Figure 1 and Figure 2.

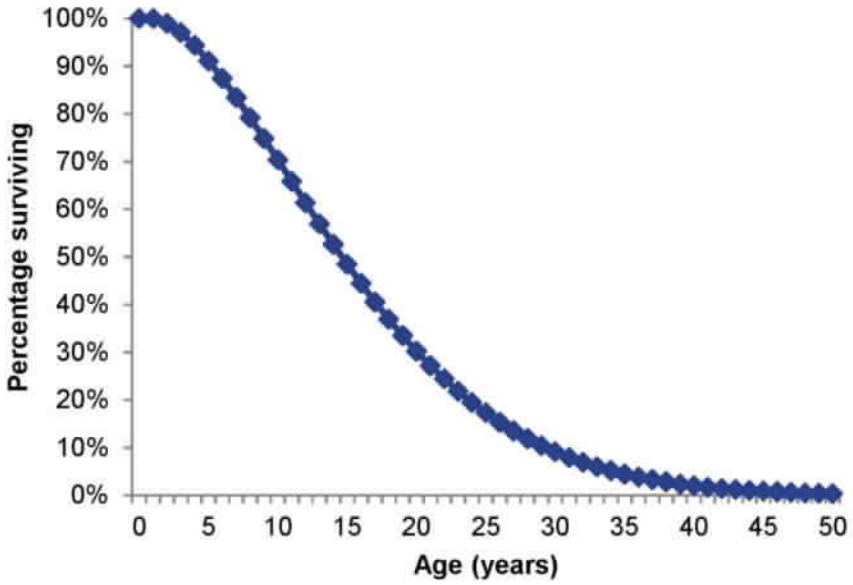
Figure 1. Central and Mini-Split AC/HPs—AC Survival Function[27]



[26] See footnotes on default age from previous table.

[27] Department of Energy, Federal Register, 76 FR 37408, Technical Support Document: 8.2.3.5 Lifetime. June 2011. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75. Download TSD at: http://www.regulations.gov/#!documentDetail;D=EERE-2011-BT-STD-0011-0012.

Figure 2. Central and Mini-Split AC/HPs—HP Survival Function[28]



The method for estimating the RUL of a replaced system uses the age of the existing system to re-estimate the projected unit lifetime based on the survival function shown in Figure 1 and Figure 2. The age of the system being replaced is found on the horizontal axis, and the corresponding percentage of surviving system is determined from the chart. The surviving percentage value is then divided in half, creating a new estimated useful lifetime applicable to the current unit age. The age (year) that corresponds to this new percentage is read from the chart. RUL is estimated as the difference between that age and the current age of the system being replaced.

Deemed Energy Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Summer Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Deemed Winter Demand Savings Tables

There are no lookup tables available for this measure. See engineering algorithms in the previous section for calculating energy and demand savings.

Claimed Peak Demand Savings

Refer to Volume 1, Section 4 for further details on peak demand savings and methodology.

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[28] Ibid.

Additional Calculators and Tools

Not applicable.

Measure Life and Lifetime Savings

The estimated useful life (EUL) is 20 years for a HP.[29]

Program Tracking Data and Evaluation Requirements

Primary inputs and contextual data that should be specified and tracked by the program database to inform the evaluation and apply the savings properly are:

- Climate zone or county
- Decision/action type (early retirement, replace-on-burnout, new construction)
- Manufacturer, model, and serial number of newly installed unit
    - AHRI/DOE CCMS certificate or reference number matching manufacturer and model number
- Cooling capacity of the newly installed unit (Btuh)
- Heating capacity of the newly installed unit (Btuh) at 47 degrees and 17 degrees and 5 degrees
- Heating capacity (kW) of auxillary electric resistance heat
- Seasonal energy efficiency ratio (SEER2) and energy efficiency ratio (EER2) of the newly installed unit
- Heating seasonal performance factor (HSPF2) of the newly installed unit
- Type of unit replaced (AC with gas furnace, AC with electric resistance furnace, air-source HP)
    - Baseline equipment used for savings (if different from unit replaced)
- Type of unit installed (single speed HP, dual speed HP, variable speed HP, mini-split HP)
- Unit type subcategory (split, packaged)
- Age of the replaced unit (early retirement only unless default EUL is applied consistently across the program)
- Retired or replaced heating unit model number, serial number, manufacturer, and heating capacity (electric resistance only)
    - Photograph of retired heating unit nameplate, utility inspection, recording nameplate information, or other evaluator-approved approach. Sampling is allowed for multifamily complexes

[29] https://energizect.com/sites/default/files/documents/X2001BFINALReport_051523.pdf & https://www.calmac.org/publications/CPUC_Group_A_2023_Res_HVAC_and_DHW_EUL_Study_Final_ReportES.pdf

    - If documentation is not provided, an adjustment factor of 0.75 will be applied to the heating energy and winter demand savings
- Retired cooling unit model number, serial number, manufacturer, and cooling capacity (rightsizing or early retirement unless default EUL is applied consistently across the program)
- Manual J load calculation (rightsizing). See the Eligibility Criteria section for applicable scenarios.
- Photograph of retired cooling unit nameplate (required for all rightsizing projects and early retirement projects unless default age is applied consistently across the program)
    - If a photograph of the retired unit nameplate is unavailable or not legible, provide a photo and/or description documenting the reason why the nameplate photo was unobtainable (early retirement only)
    - If a photograph of the retired unit nameplate is unavailable or not legible, provide estimated square footage of conditioned area served by the retired unit (rightsizing only)
- Photograph demonstrating functionality of existing equipment and/or customer responses to survey questionnaire documenting the condition of the replaced unit and their motivation for measure replacement for early retirement eligibility determination (early retirement only). This requirement also applies to projects using the default age.
- For installed HVAC systems meeting minimum federal standard SEER2 efficiency:
    - Age of existing equipment
    - Proof of functionality of existing equipment
    - Rated SEER, if available
- If replacing an evaporative cooler, application should include a statement that the customer decision to change equipment types predates or is independent of the decision to install efficient equipment
- Proof of purchase with date of purchase and quantity
    - Alternative: photo of unit installed or other pre-approved method of installation verification

References and Efficiency Standards

Petitions and Rulings

Not applicable.

Relevant Standards and Reference Sources

Please refer to measure citations for relevant standards and reference sources.

Document Revision History

Table 7. Variable Speed HPs—Revision History

TRM version	Date	Description of change
v12.0	10/2023	TRM v12.0 origin.