Posting Date: May 31, 2024

➢ Summary of 60-Day Notice: Residential HVAC

The following 60-Day Notice summarizes Public Service Company of Colorado's (the "Company") action to incorporate the proposed changes from the 2024-2026 Residential HVAC product and the Settlement Agreement from Proceeding 23A-0589EG by updating the tech assumptions, deemed savings, and rebates in the Residential HVAC, Whole Home Efficiency, Income Qualified Multifamily Weatherization, Income Qualified Single-Family Weatherization, and Non-Profit Energy Efficiency products.

The Company is including with this Notice:

- Redlined Program write-up;
- Redlined Deemed Savings worksheets; and
- Updated Technical Assumptions worksheets

A copy of this notice is available on our website at:
https://www.xcelenergy.com/company/rates_and_regulations/filings/colorado_demand-side_management

As agreed to in the settlement for the 2024-2026 Demand Side Management ("DSM") & Beneficial Electrification ("BE") Plan, the Company submits this notice to update the Residential HVAC program in the 2023 DSM Plan to incorporate changes to the program made in the 2024-2026 DSM & BE Plan, as modified in the settlement. The intent of this notice is to ensure these changes are in market as swiftly as possible since this is the time of year when many customers will be installing heat pumps. Generally, the changes are intended to drive customer adoption of heat pump equipment by increasing the proportion of heat pumps in the market which qualify for rebates.

While the Company anticipates these changes will generally increase participation, these changes will have no impact on the 2023 forecast because the 2023 program year is already completed and the 2023 Annual Status Report has already been filed. The program forecasts for 2024-2026 are included in the 2024-2026 DSM & BE Plan.

The Company proposes that these changes take effect July 1, 2024, provided that no comments are submitted. If comments are submitted, the Company will review the comments, incorporate changes as needed, and the changes will take effect August 1, 2024. In either case, the changes will apply to equipment purchased and installed on or after the effective date.

A summary of the changes is as follows:

- Updating efficiency requirements for heat pumps;
- Updating rebate levels for heat pumps, and changing the rebate structure for all heat pumps to a $/ton metric rather than a $/unit metric;
- Updating and clarifying language regarding the bonus for customers who install insulation and a heat pump;

- Incorporating changes ordered in the 2022 Strategic Issues proceeding (No. 22A-0309EG) related to the phase-out of rebates for certain heating and cooling equipment;
- Requiring that customers with pre-existing natural gas heating who install a heat pump retain natural gas heating as a backup heat source, unless the customer installs a cold climate air source heat pump or a ground source heat pump;
- Clarifying that all customers are eligible for rebates for heat pumps or heat pump water heaters, regardless of the customer's service type with the Company;
- Updating language for categorization of heat pumps to be consistent with industry standard terminology;
- Adding language regarding midstream offerings for heat pump water heaters; and
- Removing the rebate for the Western Cooling Control device.

Updating Efficiency Requirements for Heat Pumps

As proposed in the 2024-2026 DSM & BE Plan, the Company is updating the efficiency requirements for heat pumps. The intended purpose of these updates is for more units to qualify and for the requirements to be generally consistent with the requirements for 25C tax credits, although certain requirements may vary to meet the Company's needs. The specific changes are outlined below:

- Removed AC requirements
- Removed Packaged ASHP Requirements
- Cold Climate Air Source Heat Pumps, Ducted or Partially Ducted
    - Reduces the SEER2 requirement from 18 to 15.2
    - Reduces the EER2 requirement from 11.7 to 10
    - Adds a requirement of 1.75 COP at 5 degrees Fahrenheit
    - Adds a requirement for Capacity Maintenance of 70%, based on capacity at 5 degrees Fahrenheit compared to 47 degrees Fahrenheit
- Non-Cold Climate Air Source Heat Pumps, Non-Ducted
    - Increases the EER2 requirement from 11.5 to 11.7
- Cold Climate Air Source Heat Pumps, Non-Ducted
    - Reduces the SEER2 requirement from 18 to 16
    - Reduces the EER2 requirement from 11.5 to 9
    - Adds a requirement of 1.75 COP at 5 degrees Fahrenheit
    - Adds a requirement for Capacity Maintenance of 70%, based on capacity at 5 degrees Fahrenheit compared to 47 degrees Fahrenheit

Updating Rebate Levels and Rebate Structure for Heat Pumps

As proposed in the 2024-2026 DSM & BE Plan Settlement Agreement, the Company is updating the rebate levels and rebate structure for heat pumps. The new rebate structure now includes a $/ton rebate for all types of heat pumps. Previously, a $/ton structure was used for ground source heat pumps and a $/unit rebate was used for air source heat pumps.

The intent of these changes is to incentivize heat pump adoption generally and incentivize customers to properly size systems to meet the full load of the home, so that the heat pump can

offset more natural gas usage, limit the potential use of electric resistance backup, and incentivize whole home systems to a greater degree than partial home solutions. The specific changes are outlined below:

- Rebates for Non-Cold Climate Air Source Heat Pumps are changed from $1,700 to $300/cooling ton at 95 degrees Fahrenheit
- Rebates for Cold Climate Air Source Heat Pumps are changed from $2,200 to $750/heating ton at 5 degrees Fahrenheit
- Rebates for ground source heat pumps are increased from $600/heating ton to $1,100/heating ton

Updating and Clarifying Language for Insulation Bonus

As proposed in the 2024-2026 DSM & BE Plan Settlement Agreement, the Company is updating the requirements for the $600 bonus offered to customers who install both insulation and a heat pump. The previous requirement was that this bonus was offered to customers who installed both measures within six months of each other, regardless of the order of installation. The new requirement is that this bonus is offered to customers who install insulation first and install a heat pump within the next two years.

The intent of this change is to promote best practices for minimizing the heating load of the home, which minimizes upfront costs and bill impacts for the customer, as well as saving energy and peak demands for the utility. The two-year period is intended to allow for time for customers and contractors to address challenges such as availability of funds, equipment, and labor.

Incorporating Phase-Outs of Certain Measures

In Decision No. C23-0413 (Proceeding No. 22A-0309EG) ("Decision"), the Commission ordered that certain measures in the Company's programs be phased out over the next several years, for the purpose of promoting adoption of electrification measures instead (*e.g.*, heat pumps and heat pump water heaters). That Commission Decision has certain impacts to the Residential HVAC program. While the Decision is already in effect, the Company has incorporated those changes in the program write-up so that they are consistent with the Commission's Decision. The specific changes are outlined below:

- Central air conditioner rebates were eliminated January 1, 2024
- Natural gas furnace and boiler rebates may only be offered to customers replacing non-condensing equipment, effective January 1, 2024
- Natural gas water heater rebates will be eliminated January 1, 2025
- Natural gas furnace and boiler rebates will be eliminated January 1, 2027
- All natural gas equipment rebates for new construction (which represents only a small portion of the participants in the Residential HVAC program) were eliminated January 1, 2024

All these changes apply to equipment purchased and installed on or after the effective dates listed above.

Require Natural Gas Backup for Certain Heat Pumps

As proposed in the 2024-2026 DSM & BE Plan settlement, the Company is adding a requirement that customers who currently use natural gas heating and install a non-cold climate air source heat pump must maintain natural gas backup heating. This requirement does not apply to customers who install a cold climate air source heat pump or a ground source heat pump.

The intent of this change is to ensure that customers who choose to fully electrify are incentivized to install a heat pump that will meet most, or all the heating needs of the home, to reduce or eliminate the use of electric resistance backup. This change should help to alleviate impacts of electrification on customer bills and on the utility grid.

Clarifying Heat Pump Eligibility

As proposed in the 2024-2026 DSM & BE Plan Settlement Agreement, the Company is clarifying eligibility for heat pump and heat pump water heater rebates. The Settlement Agreement includes a provision that all customers, regardless of their service type (electric, gas, or combo) with the Company, are eligible for the Company's heat pump and heat pump water heater rebates. The Company notes that this was always the Company's intent but acknowledges there was some language in the program write-up on this subject which lacked clarity. The Company has updated language to clarify this intent.

Update Language for Heat Pumps

As proposed in the 2024-2026 DSM & BE Plan Settlement Agreement, the Company is clarifying language referring to air source heat pumps. This equipment was previously subdivided into "air source heat pumps" and "mini-split heat pumps." The Company has received feedback that this language is not consistent with how this equipment is defined in the industry, and the Company's definition has caused confusion for trade partners.

The Company now subdivides air source heat pumps into "ducted and mixed ducted" air source heat pumps, the requirements for which are the same as for what the Company previously described as "air source heat pumps", and "non-ducted" air source heat pumps, the requirements for which are the same as for what the Company previously described as "mini-split heat pumps."

This new definition acknowledges that "mini-split" systems can be installed in connection with a furnace (or air handler) and ductwork, and when installed in this manner, these systems are comparable to traditional split systems in terms of energy efficiency and cost.

Add Language on Midstream Rebates for Heat Pump Water Heaters

This reflects a language change to incorporate an item agreed to in the 2023 DSM Plan settlement, which reflects the Company's commitment to develop a midstream rebate offering for heat pump water heaters.

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Remove Rebates for the Western Cooling Control

As proposed in the 2024-2026 DSM & BE Plan, the Company is eliminating rebates for the Western Cooling Control ("WCC"). This change is made for two reasons:

- This rebate never caught traction in the market and has had zero participants throughout the entire period the Company has offered this measure.
- The WCC device is intended for older air conditioners or air source heat pumps installed in 2009 or earlier, as newer equipment already includes the features added by the WCC. At this time, equipment that old is at or near the end of its useful life, so it would be preferable to incentivize those customers to install a new heat pump.

Residential Heating & Cooling

A. Description

The Residential Heating & Cooling product provides incentives to the Company's customers who purchase a variety of qualifying heating and cooling equipment for residential use, including ~~air conditioners,~~ evaporative coolers, heat pumps, natural gas furnaces, natural gas boilers, natural gas water heaters, electric heat pump water heaters, and smart thermostats~~, and the Western Cooling Control device~~.

The Residential Heating & Cooling product combines offerings from several ~~existing products – Evaporative Cooling, High Efficiency Air Conditioning, Residential Heating, Thermostat Optimization, and Water Heating~~types of equipment. This ~~new,~~ holistic approach to residential customers' heating and cooling needs is designed to improve the experience for customers and trade partners, in order to improve participation, energy savings, and customer satisfaction. The smart thermostat offering can also assist customers in managing the timing of their energy usage, to assist customers in saving money on the Company's new Time of Use rates.

~~The Company is looking into ways to provide a more comprehensive experience for our residential customers that simplifies the process of installing capital intensive energy efficient equipment. This may include an end-to-end solution where the customer chooses from any, or all, of the following as applicable:~~

- ~~Advice and analysis of the available equipment options~~
- ~~Financing~~
- ~~Enrollment in Demand Management products~~
- ~~Assistance with choosing qualified contractors~~
- ~~Enrollment in green programs and/or warranty services.~~

More details regarding the specific types of equipment rebated in this product are provided below:

- ~~**Standard AC systems with Quality Installation ("QI")** – 14.2 to 15.19 Seasonal Energy Efficiency Ratio ("SEER2") – Defined as new central Air Conditioning ("AC") systems with "matched" indoor and outdoor components, in new or existing homes. Approximately 75 – 80% of new AC systems purchased are in this efficiency range.~~

  ~~According to energy.gov, approximately 27% of the rated efficiency of a new system can be achieved through Quality QI. QI is a process, based on standards developed by the Air Conditioning Contractors of America ("ACCA") which contractors must follow to ensure that the total energy savings potential of newly installed equipment is realized. QI includes sealing all visible ducts, providing at least 400 cubic feet per minute ("CFM") of air flow per cooling ton, applying ACCA's Manual J (load calculation) and Manual S (equipment sizing) standards to determine the right size and type of equipment for each customer's unique home, and charging the new system with refrigerant to within 3 degrees of the manufacturer's recommended sub-cool target temperature. Only participating trade~~

~~partners who have a technician with Company approve certifications and/or licenses can offer this rebate.~~

- **High Efficiency ~~AC or ASHP~~ Ducted or Partially Ducted Air Source Heat Pump systems with Quality Installation** – ~~Defined~~ This product is defined as new central ~~Air Conditioning and~~ Ducted or Partially Ducted Air Source Heat Pump systems with "matched" indoor and outdoor components, and ~~with~~ thermostatic expansion valves, in new or existing homes, that meet certain energy efficiency standards as outlined in Section G below~~, are eligible for a rebate~~. The ~~intent of the rebate~~rebate intent is to encourage consumers to purchase units that meet or exceed the high efficiency standard of at least ~~a.) 15.2 SEER2 and 12.5 Energy Efficiency Ratio ("EER2") for air conditioners or b.)~~ 15.2 SEER2, 11.7 EER2, and 7.8 HSPF2 ~~for heat pumps~~. Trade partners who have met the ~~AC or~~ ASHP participation requirements can offer this rebate. To be eligible for a cold climate heat pump rebate, units must have a~~n 18~~ 15.2 SEER2, ~~11.7~~10 EER2, 8.1 HSPF2, 1.75 COP at 5 degrees Fahrenheit, and the heating BTU at 5 degrees Fahrenheit must be at least 70% of the heating BTU at 47 degrees Fahrenheit. Customers with preexisting natural gas heating systems must maintain natural gas heating as a backup heat source to qualify for rebates.

- **Evaporative Coolers** - Qualifying equipment must be new, permanently installed evaporative cooling units. Portable coolers or systems with vapor compression backup are not eligible, neither is used or reconditioned equipment.

- ~~**Mini-Split**~~**Non-Ducted Air Source Heat Pumps** ~~**("MSHP")**~~ – ~~-~~ The ~~mini-split~~non-ducted air source heat pump equipment serves residential customers who either cannot install traditional ~~split, central~~ducted ~~air conditioning~~air source heat pump systems, or have hard-to-heat/cool areas of their homes, or who simply prefer this technology. To be eligible to participate, residential ~~electric~~ customers must purchase and install a unit that has a rated efficiency of 15.2 SEER2, ~~11.5~~11.7 EER2, and 7.8 Heating Seasonal Performance Factor ("HSPF2"). Variable-speed systems which meet these requirements are eligible for a rebate. The unit must be used for cooling and heating purposes. There is not a QI component, ~~and~~ nor is certification ~~is not~~ a requirement. ~~Any~~ Thus, any trade partner can offer this rebate. To be eligible for a cold climate heat pump rebate, units must have a~~n 18~~ 16 SEER2, ~~11.5~~9 EER2, 8.5 HSPF2, 1.75 COP at 5 degrees, and the heating BTU at 5 degrees Fahrenheit must be at least 70% of the heating BTU at 47 degrees Fahrenheit. Customers with preexisting natural gas heating systems must maintain natural gas heating as a backup heat source to qualify for rebates.

- **Ground Source Heat Pump with Quality Installation ("GSHP")** – The Ground Source Heat Pump equipment measure serves a small market niche of consumers who seek out the most highly efficient technology. To be eligible to participate, residential ~~electric~~ customers must purchase and install a unit that is ENERGY STAR® certified. The ENERGY STAR® certified. The ENERGY STAR® certified GSHP performance criteria are a minimum of 3.3 Coefficient of Performance ("COP") and 16 EER2. Equipment must be Air-Conditioning, Heating, and Refrigeration Institute ("AHRI") performance-certified at standard rating conditions. Rebates will be given for GSHPs that are installed as closed

loop systems and are used for both heating and cooling. Trade partners who are registered participating contractors for the ~~AC~~ ASHP rebates may offer this rebate.

- **Natural Gas Furnaces** – Furnace rebates are offered for a minimum furnace efficiency of 95% Annual Fuel Utilization Efficiency ("AFUE"). Equipment must be AHRI performance-certified at standard rating conditions. A customer is only eligible for a rebate if replacing a non-condensing furnace. Additionally, the equipment must be invoiced and installed on or before December 31, 2026.

- **Natural Gas Boilers –** Boiler rebates are offered for a minimum boiler efficiency of 95% Annual Fuel Utilization Efficiency ("AFUE"). Equipment must be AHRI performance-certified at standard rating conditions. Higher rebates are available for boilers with a sidearm water heater. A customer is only eligible for a rebate if replacing a non-condensing boiler. Additionally, the equipment must be invoiced and installed on or before December 31, 2026.

- **Water Heaters** - The product is applicable only for the purchase of qualifying new natural gas standard storage tank water heaters, natural gas tankless water heaters or electric heat pump water heaters installed in new or replacement applications. Qualification for an incentive is a minimum efficiency of 0.64 Uniform Energy Factor ("UEF") for medium draw standard tanks, 0.68 UEF for high draw standard tanks, or 0.87 UEF for tankless natural gas water heaters. ENERGY STAR® electric heat pump water heaters also qualify for an incentive. In recognition of future demand response opportunities, heat pump water heaters that are CEA/ANSI enabled will receive a higher incentive. For ~~natural gas water~~all heaters, customers may choose their own independent residential water heating contractor or installer or install the unit themselves. ~~Electric heat pump water heaters must be installed by a registered contractor.~~A midstream incentive approach will be offered for energy efficient Heat Pump Water Heaters. A customer is only eligible for a rebate for a natural gas water heater if the equipment is invoiced and installed on or before December 31, 2024.

- **Smart Thermostat** - The concept of realizing energy savings by programming a thermostat is straight-forward: scheduling temperature setting changes (setbacks) during times when home occupants are away or asleep ensures no energy is wasted when no one is home or awake. Thermostats meeting the ENERGY STAR® Connected Thermostat specification have demonstrated the ability to achieve energy savings through HVAC equipment runtime reductions, specifically an 8% or higher reduction in heating equipment runtime and a 10% or higher reduction for cooling equipment runtime.

  These runtime reductions are achieved by smart thermostats through a variety of methods, starting with the ease of scheduling. These devices make it easier to program efficient setback schedules compared to their non-communicating predecessors.

  In addition to ongoing product innovations by thermostat manufacturers, software firms have begun to provide additional optimization functionality that promises to proactively

manage customer thermostats for deeper energy efficiency and demand management functionality without negatively impacting customer comfort.

- ~~**Western Cooling Control** – The Western Cooling Control ("WCC") device effectively increases the capacity of a central AC or ASHP unit by capturing cooling energy left in the refrigerant within, as well as the water condensed on, the cooling coil after a cooling cycle has completed. Many newer cooling units have built-in features that provide similar benefits to the WCC device; therefore, this measure is available only to customers with units installed in 2009 or prior. There is not a QI component to this measure. Any trade partner can offer this rebate.~~

B. Targets, Participants & Budgets

Targets and Participants

Participation and energy savings levels for this product are based on 2018-2019 participation, as well as increased marketing efforts to the most cost-effective equipment within the product and working through trade partners and stakeholders to engage customer participation.

Budgets

The budget forecast is based upon forecasted participation, and ~~the majority~~most of the budget is for direct customer incentives. For some equipment, contractors and/or retailers are also paid an incentive, to further encourage their support of these products. The budget also includes costs for verifying a percentage of the new equipment installations in the field to ensure they meet expected energy savings, including (where applicable) ACCA standards for quality installation; for advertising and marketing; and for other administrative expenses including labor and contractor training.

C. Application Process

The typical sales cycle begins with a customer hiring a contractor, learning about energy efficient models, and purchasing and installing the unit. Following installation, the customer or trade partner submits a completed Company rebate application and equipment invoice. Invoices must reflect the same information provided on the application form, specifically the model number, serial number, installation address, and purchase date. Other information gathered on the application form includes the customer's account number, mailing address if different from installation address, customer signature, trade partner signature and information related to the equipment such as efficiency ratings, heating and cooling capacity, and size.

The Company is pursuing a more comprehensive rebate application form to minimize paperwork for the customer and trade partners while still collecting all of the information needed to thoroughly review and process the applications as quickly as possible. The Company's online application tool will remain available and will comply with these requirements. The Company may also offer

"instant rebates" at point of sale for certain types of equipment through various retail and wholesale distribution partners, including (but not limited to) an online, Company-branded marketplace.

All information requested on the rebate applications must be provided for the rebate process to be completed. Information needed on the invoice is specified on the back of each rebate application form; this information must be provided in order for the rebate process to be completed.

Equipment eligibility is determined by using the AHRI Directory of Certified Product Performance, the list of ENERGY STAR® Qualified Products on the ENERGY STAR® website, or on the list of qualified model numbers maintained by the Company and available on the Company's web site, as specified on the rebate application for the ~~particular type of~~ equipment. Rebates are typically mailed within eight weeks.

The Company reviews each rebate application and verifies that all the required data has been provided and that all product requirements have been met. When corrections are needed to rebate applications, the Company sends a request to the contractor. Applications may be resubmitted. Customers applying for instant rebates enter information that is verified through a third-party vendor partner's software, which validates the customer's premise, type of service, and eligibility before the instant rebate coupon is generated.

D. Marketing Objectives & Strategies

The Residential Heating & Cooling product seeks to increase awareness and the demand for a variety of heating and cooling products within the Company's service area, help customers and participating contractors offset costs associated with high efficiency equipment and quality installation practices, reduce customers' energy costs, meet customers' environmental goals (such as reducing carbon emissions), and increase their comfort. To support these goals, the Company plans to implement the following marketing strategies to increase product awareness:

- Use of the HVAC contractor community as the primary marketing channel. The Company's Channel Manager is responsible for conducting trade partner training, meetings, telephone calls, emails, and sending newsletters to keep the trade informed and engaged in the product. In addition, a qualified contractor list is available on the Company's website and participating contractors are expected to assist in promoting the product. The Company provides brochures for contractors to distribute to customers as well.
- Company marketing and advertising strategies will be used to create customer awareness. This may include, but is not limited to, e-mail, bill onserts, direct mail, bundled marketing campaigns, community newsletters, webinars, promotional booths at public events, radio and/or television advertising, sponsorships.
- The Company's website also includes information regarding the product and is updated as needed to more effectively reach customers. This includes information on product details, quality installation practices, and where to find qualified contractors. The site also hosts webpages designed specifically for contractors to obtain information about the product.

- When appropriate for a particular type of equipment, the Company will provide Point of Purchase displays at big box stores and appliance retailers.
- The Company will develop, in addition to downstream (customer) rebates, a midstream offering for energy efficient heat pump water heaters to increase market availability and submit a 60 Day Notice with program details within 60 days of filing plan launch.

E. Product-Specific Policies

Contractors who do not comply with the product requirements and guidelines are not allowed to participate in the product. Requirements may include taking and passing Company-provided training classes, for the purpose of increasing the energy savings and/or increasing customer satisfaction with the rebate process.

These rebates are available to residential Xcel Energy account holders, with electric or natural gas service (depending on the type of equipment) provided by Xcel Energy. All equipment must be new and permanently installed. Used or reconditioned equipment is not eligible for a rebate.

For the following types of equipment, customers must have residential electric service with Xcel Energy: ~~AC, ASHP, Electric Heat Pump Water Heaters replacing electric resistance water heater,~~ Evaporative Coolers~~, MSHP, GSHP, and WCC~~.

For the following types of equipment, customers must have residential natural gas service with Xcel Energy: Natural Gas Furnaces, Natural Gas Boilers, Natural Gas Water Heaters.

For the following types of equipment, customers must have residential electric and/or natural gas service with Xcel Energy: Electric Heat Pump Water Heaters, Heat Pumps.

~~For participants who are replacing natural gas water heating equipment with a heat pump water heater, the customer must have residential electric and natural gas service with Xcel Energy.~~

To be eligible for the Smart Thermostat offering, participants must be a residential customer of the Company. For customers with electric service, participants must have central air conditioning or a ducted or partially ducted air source heat pump; for gas-only customers, participants must have central natural gas heating. Customers with electric and gas service must have central air conditioning (or a ducted or partially ducted air source heat pump) and/or central natural gas heating.

To be eligible for ~~Standard AC or ASHP equipment with QI or~~ High-efficiency ~~AC/ASHP~~ ducted or partially ducted equipment with QI rebates:

- The customer must use a registered contractor for the installation of the new system and who annually pass required online classes. These contractors have agreed to the terms of

the product and meet the requirements related to quality installation practices. A list of registered contractors can be found on the Xcel Energy website.

- The "matched system" must be listed in AHRI's Residential Directory. This directory is used to identify product classification, determine efficiency ratings, and confirm matched systems.
- In order to verify that the equipment has been properly installed, the equipment must be installed and tested as specified in the Xcel Energy QI guidelines based on ACCA standards. The equipment installation and testing for QI must be completed before the rebate application is submitted for processing by the Company.
- The use of a furnace's variable speed fan to increase the SEER2 rating above the nominal rating is allowed for determining rebate eligibility, provided that the overall furnace and ~~air conditioning~~ducted or partially ducted air source heat pump combination rating can be found in the AHRI's Residential Directory (www.ahridirectory.org). The furnace does not have to be new, in order to use it for an increased efficiency rating. The homeowner or contractor must supply the furnace model number and serial number on the application and invoice.

To be eligible for a Mini-Split Heat Pump rebate, the unit must be used for cooling and heating purposes; therefore, mini-split air conditioners (cooling only units) do not qualify. The AHRI certificate must be in the residential category of "Variable-speed Mini-Split and Multi-Split Heat Pumps." Multiple head mini-split systems qualify.

~~To be eligible for the WCC device rebate, the existing furnace must have been installed in 2009 or prior.~~

To be eligible for an evaporative cooler rebate, qualifying equipment must be a permanently installed direct, indirect, or two-stage evaporative cooling unit. Customers can replace an existing evaporative cooler or central AC system, or purchase a first-time installed evaporative cooling unit, to qualify for a rebate.

There are three equipment tiers available for evaporative coolers:

- Standard Evaporative Coolers: Qualifying evaporative cooling units with airflow output of 2,500 CFM or greater.
- Premium Evaporative Coolers: Qualifying evaporative cooling units with media saturation effectiveness of 85% or greater. The units must be manufactured with remote thermostat control and periodic purge water control (*e.g.*, purge pump) or have these two items purchased and included on an invoice.

- Multi-Ducted Evaporative Coolers: In addition to 85% saturation effectiveness, remote thermostat control and periodic purge water control, qualifying evaporative cooling units must be indirect/directly cooling the whole house with a minimum of three supply ducts installed, and at least one of the supply ducts must be newly installed along with the new cooler.

To be eligible for a natural gas storage water heater rebate, the storage tank must be no larger than 55 gallons.

To be eligible for a 95% AFUE natural gas furnace rebate, an AHRI certificate must be available, and the customer must be replacing a non-condensing furnace.

To be eligible for a 95% AFUE natural gas boiler rebate, an AHRI certificate must be available, and the customer must be replacing a non-condensing boiler.

To be eligible for a heat pump water heater rebate, the customer must use a registered contractor for the installation of the new system. These contractors have agreed to the terms of the product.

A list of registered contractors can be found on the Xcel Energy website. To be eligible for the higher rebate for a "grid-enabled" water heater, the customer must purchase and install a water heater eligible to participate in the Company's demand management products for water heaters.

The Company maintains a list of eligible model numbers, which is available on the Company's web site.

To be eligible for a smart thermostat rebate, the customer must install a thermostat which meets the ENERGY STAR® Connected Thermostat standard and which is eligible to participate in the Company's demand management products for smart thermostats, AC Rewards. The Company maintains a list of eligible model numbers, which is available on the Company's web-site.

F. Stakeholder Involvement

The Company considers its stakeholders for the Residential Heating and Cooling product to be contractors, distributors, manufacturers, retailers, SWEEP, EEBC, CEO, WRA, RMI, local municipalities within the service area, and other environmental organizations. Stakeholders ~~are able to~~can share their product suggestions during the Company's quarterly DSM Roundtable Meetings. In addition, the Company is a member of the CEE, and monitors its initiatives related to residential heating and cooling equipment.

G. Rebates & Incentives

Rebates are payable to residential account holders with electric or natural gas service (depending on the type of equipment), or to an alternate rebate recipient of their choosing. All types of equipment must meet all requirements to receive the rebate. For rebates which are based upon multiple measures of efficiency, the rebate is paid according to the lesser value of the technical

requirements of the various measures, including SEER2, EER2, HSPF2, and COP. The rebate amount shall not exceed the purchase price.

For certain types of equipment, the Company will also pay incentives associated with customer rebates to participating, registered contractors or retailers in good standing.

Homeowners may receive the equipment rebate directly or may provide written permission for the rebate to be paid directly to the contractor or to another designated alternate rebate recipient. Builders, as the original purchaser of equipment, are eligible to receive an equipment rebate; however, the rebate will only be issued once so builders should coordinate with the homeowners as to who will receive the rebate. Contractor incentives are paid to the contractor company ~~at the same time that~~while the associated rebate is paid to the account holder or alternate rebate recipient. Retailer incentives are paid on a quarterly basis.

Customers, contractors, or retailers who receive an incentive through another DSM product (e.g., Whole Home Efficiency or ENERGY STAR® New Homes) for the same equipment are not eligible to receive a rebate through this product. By accepting a rebate, the customer agrees to reasonably accommodate M&V consultants.

Additionally, the Company will begin to offer a bonus rebate of $600 for customers who install insulation and air sealing ~~within six months of installation of a heat pump~~first and then install a Company rebate qualifying heat pump within two years of installation of the insulation. ~~The bonus will be paid at the same time as whichever rebate is paid later.~~ The insulation must qualify for the requirements of the Company's Insulation and Air Sealing program. Providing this bonus and requiring the completion of the measures in this order promotes best practices for minimizing the heating load of the home, which minimizes upfront costs and bill impacts for the customer, as well as saving energy and peak demands for the utility. The two-year period is intended to allow for time for customers and contractors to address challenges such as availability of funds, equipment, and labor.

18.0 Residential HVAC Deemed Tables

Table 18.0.1: Effective Full Load Hours, Altitude	EFLH Cooling		EFLH Heat		EFLH_Heating_HP (Heat Pump Impacted heating hours) ****			
	Single Family	Multi-Family	Single Family	Multi-Family	Single Family	Multi-Family	Altitude Adjustment Factor	HSPF Climate Zone Adjustment
Zone 1 - CO Front Range *	590	699	1,825	1,409	750	579	0.177	100%
Zone 2 - CO Western Slope **	837	992	1,971	1,522	779	601	0.163	100%
Zone 3 - CO Mountain Areas ***	210	249	2,104	1,625	536	414	0.244	85%
Zone 4 - CO Very High Altitude Areas *****	2	2	2,739	2,115	673	520	0.303	85%

* Zone 1 (Front Range as represented by Denver International Airport TMY3 data);
** Zone 2 (Western Slope as represented by Grand Junction TMY3 Data)
*** Zone 3 (Mountain Areas as represented by Alamosa TMY3 Data)
**** the heat pump impacted hours are determined at a cutoff temperature of 35 F.
*** Zone 4 (Very High Altitude Areas as represented by Lake CO Airport TMY3 Data)

Table 18.0.1a: Effective Full Load Hours Cold Climate Heat Pumps	Cold Climate Heat Pump Full Load Hours w/ 5 F Cutover *****		Cold Climate Heat Pump Full Load Hours w/ 10 F Cutover *****		Cold Climate Heat Pump Full Load Hours w/ 15 F Cutover *****		Cold Climate Heat Pump Full Load Hours w/ 20 F Cutover *****		Cold Climate Heat Pump Full Load Hours w/ 25 F Cutover *****	
	Single Family	Multi-Family	Single Family	Multi-Family	Single Family	Multi-Family	Single Family	Multi-Family	Single Family	Multi-Family
Zone 1 - CO Front Range	1,809	1,397	1,776	1,371	1,714	1,323	1,566	1,209	1,409	1,088
Zone 2 - CO Western Slope	1,971	1,522	1,963	1,515	1,925	1,486	1,835	1,417	1,495	1,154
Zone 3 - CO Mountain Areas	1,748	1,349	1,589	1,227	1,381	1,066	1,216	939	920	710
Zone 4 - CO Very High Altitude Areas	2,521	1,946	2,384	1,840	2,145	1,656	1,908	1,473	1,360	1,050

**** All Cutover Temperatures are defined as the Outdoor Ambient Temperature where Backup Heat takes over the load.

Table 18.0.2: Minimum Qualifying Efficiency	for units manufactured before 1/1/2023				for units manufactured after 1/1/2023					
Measure	Minimum Qualifying SEER	Minimum Qualifying EER	Minimum qualifying HSPF	Minimum qualifying Heating COP	Minimum Qualifying SEER2	Minimum Qualifying EER2	Minimum qualifying HSPF2	Minimum qualifying Heating COP	Minimum Qualifying COP at 5 F	Capacity Maintenance (5 F Max / 47 F Rated)
~~High Efficiency Air Conditioner - Split System~~	~~15.00~~	~~12.50~~	~~N/A~~	~~N/A~~	~~15.20~~	~~12.50~~	~~N/A~~	~~N/A~~		
~~High Efficiency Air Conditioner - Packaged System~~	~~15.00~~	~~12.50~~	~~N/A~~	~~N/A~~	~~15.20~~	~~12.50~~	~~N/A~~	~~N/A~~		
~~Air Source Heat Pump~~ Ducted & Mixed Duct-Ductless Heat Pumps - Split System	15.00	11.50	9.00	N/A	15.20	11.70	7.80	N/A		
~~Air Source Heat Pump - Packaged System~~	~~15.00~~	~~11.50~~	~~9.00~~	~~N/A~~	~~15.20~~	~~10.60~~	~~7.20~~	~~N/A~~		
~~Mini-Split & Multi-Split~~ Ductless Heat Pumps	15.00	11.50	9.00	N/A	15.20	~~11.50~~ 11.70	7.80	N/A		
Cold Climate Ducted & Mixed Duct-Ductless Heat Pumps ~~Air Source Heat Pumps (Ducted & Mixed Ducted / Non-Ducted)~~ ++	18.00	11.50	9.50	N/A	~~18.00~~ 15.20	~~11.70~~ 10.00	8.10	N/A	1.75	70%
Cold Climate Ductless Heat Pumps ~~Mini-Split & Multi-Split Heat Pumps (Non-Ducted)~~ ++	18.00	11.50	9.50	N/A	~~18.00~~ 16.00	~~11.50~~ 9.00	8.50	N/A	1.75	70%
Gorund Source Heat Pump **	N/A	16.00	N/A	3.30	N/A	16.00	N/A	3.30		

** Ground Loop Brine to Air with entering temperatures of 77 F cooling mode and 32 F heating mode. This GSHP equipment not subject to the new SEER2 / EER2 requirements.
++ Cold climate air source heat pumps and mini-split heat pumps must have a low temp heating efficiency (COP at 5 F) that is >= 1.75.

Table 18.0.3: Baseline Efficiencies	~~BASELINE Efficiency units manufactured before 1/1/2023~~				BASELINE Efficiency units manufactured after 1/1/2023			
Measure	~~SEER~~	~~EER~~	~~HSPF~~	~~Heating COP~~	SEER2	EER2	HSPF2	Heating COP2
High Efficiency Air Conditioner - Split System	~~13.00~~	~~11.18~~	~~N/A~~	~~N/A~~	13.40	11.42	N/A	N/A
High Efficiency Air Conditioner - Packaged System	~~14.00~~	~~11.76~~	~~N/A~~	~~N/A~~	13.40	11.42	N/A	N/A
~~Air Source Heat Pump~~ Ducted & Mixed Duct-Ductless Heat Pumps - Split System - Gas Backup *	~~13.00~~	~~11.18~~	~~0.00~~	~~0.95~~	13.40	11.42	N/A	0.95
~~Air Source Heat Pump~~ Ducted & Mixed Duct-Ductless Heat Pumps - Split System - Elec Resist. Backup *	~~13.00~~	~~11.18~~	~~3.412~~	~~1.00~~	13.40	11.42	3.412	1.00
~~Mini-Split & Multi-Split~~ Ductless Heat Pumps - Gas Backup *	~~13.00~~	~~11.18~~	~~0.00~~	~~0.95~~	13.40	11.42	0.00	0.95
~~Mini-Split & Multi-Split~~ Ductless Heat Pumps - Elec Resist. Backup *	~~13.00~~	~~11.18~~	~~3.412~~	~~1.00~~	13.40	11.42	3.412	1.00
Cold Climate ~~Air Source~~ Ducted & Mixed Duct-Ductless Heat Pumps - Gas Backup *	~~13.00~~	~~11.18~~	~~0.00~~	~~0.95~~	13.40	11.42	0.00	0.95
Cold Climate ~~Air Source~~ Ducted & Mixed Duct-Ductless Heat Pumps - Elec Resist. Backup *	~~13.00~~	~~11.18~~	~~3.412~~	~~1.00~~	13.40	11.42	3.412	1.00
Cold Climate ~~Mini-Split & Multi-Split~~ Ductless Heat Pumps - Gas Backup *	~~13.00~~	~~11.18~~	~~0.00~~	~~0.95~~	13.40	11.42	0.00	0.95
Cold Climate ~~Mini-Split & Multi-Split~~ Ductless Heat Pumps - Elec Resist. Backup *	~~13.00~~	~~11.18~~	~~3.412~~	~~1.00~~	13.40	11.42	3.412	1.00
Gorund Source Heat Pump w/ Furance & AC Baseline**	~~13.00~~	~~11.18~~	~~N/A~~	~~0.80~~	13.40	11.42	N/A	0.80
Gorund Source Heat Pump w/ ER in Air Handler & AC Baseline**	~~13.00~~	~~11.18~~	~~N/A~~	~~1.00~~	13.40	11.42	N/A	1.00
Gorund Source Heat Pump w/ Boiler + Air Handler & AC Baseline**	~~13.00~~	~~11.18~~	~~N/A~~	~~0.84~~	13.40	11.42	N/A	0.84

* ASHP & MSHP baseline case is a Standard AC with Condensing Furnace, Boiler, or Electric Resistance Heat
** Ground Loop Brine to Air with entering temperatures of 77 F cooling mode and 32 F heating mode. This GSHP equipment not subject to the new SEER2 / EER2 requirements.

Table 18.0.4: Coincidence Factors, Baseline Efficiencies and Lifetimes

Equipment Type	Deemed Equipment Coincidence Factor	Deemed QI Coincidence Factor	Lifetime	Notes
High Efficiency Air Conditioner - Split System *	90%	100%	18	(Reference 17)
~~Air Source~~ Ducted Heat Pump - Split System - with Gas Backup	90%	100%	18	(Reference 17)
~~Air Source~~ Ducted Heat Pump - Split System - with Elec Resist. Backup	90%	100%	18	(Reference 17)
~~Mini-Split & Multi-Split~~ Ductless Heat Pumps	90%	N/A	15	
Mixed Duct-Ductless Heat Pumps	90%	N/A	15	
Cold Climate Air Source Heat Pump - Split System	90%	100%	18	(Reference 17)
Cold Climate Mini-Split & Multi-Split Heat Pumps	90%	N/A	15	
Gorund Source Heat Pump **	90%	100%	20	

** Baseline for GSHP is Code minimum AC and Gas Fired Furnace.

Table 18.0.5: QI Factors (Reference 4, Reference 6, Reference 7, Reference 14)

Home Type - equipment type	Sizing Loss	Refrigeration Charge	Improper Airflow	Duct Leakage	Loss NO Field QI	Loss_Uncorr
New Home - AC~~/ASHP~~	0%	7.0%	2.0%	0.0%	9.00%	0.0%
Existing Home - AC~~/ASHP~~	2.0%	7.0%	2.0%	8.3%	17.30%	3.7%
New Home - Ducted Heat Pump	0%	7.0%	2.0%	0.0%	9.00%	0.0%
Existing Home - Ducted Heat Pump	0.0%	7.0%	2.0%	8.3%	17.30%	3.7%
New Home - GSHP	0%	0.0%	2.0%	0.0%	2.00%	0.0%
Existing Home - GSHP	2.0%	0.0%	2.0%	8.3%	10.30%	3.7%
New Home ~~MSHP~~ Ductless & Mixed Duct-Ductless *	0.0%	0.0%	0.0%	0.0%	0.00%	0.0%
Existing Home ~~MSHP~~ Ductless & Mixed Duct-Ductless *	0.0%	0.0%	0.0%	0.0%	0.00%	0.0%

* The Ductless and Mixed Duct-Ductless cases use AC as the baseline case. And the AC equipment's QI Factors will be applied to their part of the savings calculations

Table 18.0.6: Conversion Factors and Constants

Conversion Factor from BTUH to kW	3,412	BTU/kW-hr
Btu to Dth	1,000,000	BTU/Dth
Therm to Dth	10	Therm/Dth
Btu to Therm	100,000	Btu/Therm
Convert from Btu/wh to kW/ton	12	Btu/wh per kW/ton
Conversion between Watts and kiloWatts	1,000	watts/kilowatt
Conversion between BTU/h and tons	12,000	BTUh / ton
Water Lb/gallon	8.34	lb/gal
Water_h_fg	1,059	BTU/lb (Evaporative energy / lb water)

Table 18.0.7: Cooling & Heating Weather Data for Load Estimates	Maximum Outside Air Temperature (F)	Mimimum Outside Air Temperature (F)	~~Balance~~ No Load Point OSA Temperature (F)	~~Balance Point~~ No Load Point (BTUH)
Zone 1 - CO Front Range	104	-3	60	0
Zone 2 - CO Western Slope	99	7	60	0
Zone 3 - CO Mountain Areas	87	-26	60	0
Zone 4 - CO Mountain Areas	81	-17	60	0

Table 18.0.8: Heating Type Deemed Efficiency	Heating Efficinecy
Condensing Furnace	0.95
Non-Condensing Furnace	0.8
Condensing Boiler	0.95
Non-Condensing Boiler	0.84
Electric Resistance	1

Changes from Recent Filing:

Modified Hours for non-cold climate heat pumps. Cutover temperature was raised from 25F to 35F.
Clarified baseline efficiencies to reflect actual baseline equipment, which may be different than Proposed Efficient equipment.
Added a flexible cutover temperature for cold climate ASHP and cold climate MSHP equipment.

18.2 Residential Ground Source Heat Pump

Algorithms

$Customer\ kW\ Savings = Customer\ kW_{EqCooling} + Customer\ kW_{QICooling}$

$Customer\ Coincident\ kW\ Savings = Customer\ Coincident\ kW_{Equipment} + Customer\ Coincident\ kW_{QI}$

AC Cooling with Gas Heat Baseline EE Savings:

$Customer\ kWh\ Cooling\ Savings = Customer\ kWh_{EqCooling} + Customer\ kWh_{QICooling}$

$EE\ Incrmenetal\ Capital\ Cost = EE\text{-}BE\ Cost\ Split\ x\ (\ Incremental\ Capital\ Cost_{Equipment}\ + Incremental\ Capital\ Cost_{QI}\ )$

$Customer\ Rebate = Rebate/Heating\ ton\ x\ \frac{Size_{Heat}}{12{,}000}$

$EE\ Rebate = Customer\ Rebate\ x\ EE\text{-}BE\ Cost\ Split$

AC Cooling with Gas Heat Baseline BE Savings:

$Customer\ kWh\ \sout{Cooling}\ Heating\ Savings = Customer\ kWh_{EQ}\&_{QIHeating}\ Penalty + Customer\ Furnace\ Fan\ kWh$

$BE\ Incremental\ Cost = (\ Incremental\ Capital\ Cost_{Equipment}\ + Incremental\ Capital\ Cost_{QI}\ )\ \text{-}\ EE\ Incremental\ Cost$

$BE\ Rebate = Customer\ Rebate\ -\ EE\ Rebate$

$Customer\ DTherms\ Savings = Customer\ GSHP\ DTh_{EQ}\&_{QIHeating}$

AC Cooling with Electric Resistance Heat Baseline:

$Customer\ kWh\ Savings = Customer\ kWh_{EqCooling} + Customer\ kWh_{QICooling} + Customer\ kWh_{EQHeating} + Customer\ kWh_{QIHeating}$

Detailed Caluculations:

$$Customer\ kW_{EqCooling} = \frac{Full\_Load\_Cool}{12{,}000} \times \left(\left(\frac{12}{EER_{baseline}}\right) - \left(\frac{12}{EER_{proposed}}\right)\right)$$

$$Customer\ kW_{QICooling} = \frac{Full\_Load\_Cool}{12{,}000} * 12/(EER\_proposed\ ) * ((\frac{1}{1 - Loss_{NoQI}}) - \left(\frac{1}{1 - Loss_{Uncorr}}\right))$$

$$Customer\ Coincident\ kW_{Equipment} = Coincidence\ Factor * \frac{Full\_Load\_Cool}{12{,}000} * (\left(\frac{12}{EER_{baseline}}\right) - \left(\frac{12}{EER_{Cooling}}\right))$$

$$Customer\ Coincident\ kW_{QI} = Coincidence\ Factor * \frac{12}{EER_{Cooling}} * \frac{Full\_Load\_Cool}{12{,}000} * ((\frac{1}{1 - Loss_{NoQI}}) - \left(\frac{1}{1 - Loss_{Uncorr}}\right))$$

$$Customer\ kWh_{EqCooling} = \frac{Full\_Load\_Cool}{12{,}000} * EFLH_{cooling} * ((\frac{12}{SEER_{baseline}}) - \left(\frac{12}{SEER_{proposed}}\right))$$

$$Customer\ kWh_{QICooling} = \frac{Full\_Load\_Cool}{12{,}000} * EFLH_{cooling} * \frac{12}{SEER_{proposed}} * ((\frac{1}{1 - Loss_{NoQI}}) - \left(\frac{1}{1 - Loss_{Uncorr}}\right))$$

$$Incremental\ Capital\ Cost_{Equipment} = \frac{Size_{Heat}}{12{,}000} * (\ GSHP\_Cost\_per\_Heat\_Ton\ ) - Full_{Load_{Cooling}}/12000 * Base\_AC\_Cost\_per\_Ton - Base\_Furnace\_Cost$$

$$Incremental\ Capital\ Cost_{QI}\ New\ Home = Inc\ Cost_{QI}$$

$$Incremental\ Capital\ Cost_{QI}\ E\ Home = MAX(75, Inc\ Cost_{QI} - \frac{Size\_Heat}{12{,}000} * (\left(\frac{1}{1 - Sizing\ Loss}\right) - 1) * Cost\ per\ Ton_{baseline}))$$

$$load\ profile\ slope\ (m) = \frac{(-1 * Size_{Heat} - \sout{balance\ pt}\ No\ load\ Point)}{(\ Min\ OAT\ - \sout{balance}\ NoLoad\ pt\ temp\ )}$$

*load profile y intercept (b) = (-1 * Size_Heat) - (m * Min OAT)*

*Full_Load_Cooling = m * Max OAT + b*

$Customer\ kWh_{EQ}\&_{QIHeating}\ Penalty = Size\_Heat * EFLH\_Heat * (1 / (COP\_Eff * 3.412\ ) / 1000 * (\ (\ 0\ -\ 1/(\ 1 - Loss\_uncorr)\ )$

$$Customer\ GSHP\ DTh_{EQ}\&_{QIHeating} = Size\_Heat * 1/(1 - Loss\_No\_QI\_Duct\_Leakage\ ) * EFLH\_Heat * (\ 1 / Baseline\ Gas\ Eff\ ) / 100000$$

$Customer\ Furnace\ Fan\ kWh = Furnace\_Fan\_kW * EFLH\_Heat$

$Customer\ kWh_{EQHeating} = Size\_Heat * EFLH\_Heat * (\ (\ 1 / (COP\_baseline * 3.412\ ) - (1 / (COP\_Eff * 3.412)\ ))/1000$

$$Customer\ kWh_{QIHeating} = Size_{Heat} * EFLH_{Heat} * (\ 1 / (COP\_baseline * 3.412\ )/1000 * \left(\frac{1}{1 - Sizing\ Loss} - 1\right) + \frac{1}{(\ COP_{Eff} * 3.412\ )}/1000 * \left(\frac{1}{1 - loss_{NoQI}} - \frac{1}{1 - Loss_{uncorr}}\right))$$

Variables

m_load_profile	Calculated	load profile slope (m)
b_load_profile	Calculated	load profile y intercept (b)
Full Load Cooling	Calculated	calculated full load cooling BTUH required to serve the home or space at the maximum Outside Air Temperature
COP_Baseline	See Table 18.0.3	Baseline COP for Ground Source Heat Pump system with Electric Resistance
Baseline Gas Eff	See Table 18.5.2	Efficinecy of the baseline gas furnace
EER_Base	See Table 18.0.3	Efficinecy of the baseline Air Condtioner
GSHP_Cost_per_Heat_Ton	See Table 18.2.1	Cost per heating ton of a ground source heat pump system including wells
Base_AC_Cost_per_Ton	See Table 18.2.1	Cost per cooling ton of a baseline AC unit sized to meet cooling load
Base_Furnace_Cost	See Table 18.2.1	Cost of a furnace sized to meet GSHP heating load including oversize and altitude adjustment factors.
EFLH cooling	See Table 18.0.1	Effective Full Load Hours for cooling load energy savings
EFLH_Heat	See Table 18.0.1	Effective Full Load Hours for heating load energy savings
~~Balance~~ No Load Pt Temp	See Table 18.0.7	Outdoor Ambient Temperature at which residential cooling and heating loads are zero BTUH
Max OAT	See Table 18.0.7	Maximum Outdoor Ambient Temperature used in building ASHP load profile
Min OAT	See Table 18.0.7	Minimum Outdoor Ambient Temperature for caluclating full load heating.
~~Balance Pt~~ No Load Point	See Table 18.0.7	BTUH - Heating and cooling loads are zero at the balance point outdoor ambient
Furnace_Fan_kW	~~0.357~~ 0.257	Furnace Fan EC Motor kW demand for baseline energy calculations
Electric Resistance Heat HSPF	3.412	Electric resistance heat assumed heating season performance factor based on a COP of 1. no climate zone correction required.
EE-BE Cost Split	~~23.5%~~ 21.4%	The total incremental cost and the rebate for each new heat pump measure will be divided using this split into a Beneficial Electrification (BE) portion for heating and an Energy Efficiency (EE) portion for Cooling.
Minimum Qualifying Efficiency	See Table 18.0.2	
Lifetime	See Table 18.0.4	

Customer Inputs	**M&V Verified**	
Size_Heat	Yes	AHRI rated Heating Capacity
COP_Eff	Yes	AHRI rated Heating COP
Size_Cool	Yes	AHRI rated Cooling Capacity
EER_Eff	Yes	AHRI rated Cooling Efficiency
Home Type	Yes	Existing or New home
Baseline Heat Type	No	For Existing Homes there is a choice of Electric Resistance or Gas Heat. For New Homes the baseline will be Electric Resistance.
County	No	Location of the home for determining weather zones.

Table 18.2.1 Incremental Capital Costs - New Construction (Plan A) - Reference 8

	Baseline AC Cost per Ton w/ Labor	Baseline Cost of Heat / kBTUH	Baseline Air Handler	Proposed Cost per Heat Ton Including Wells
GSHP - w/ Gas Furance & AC Baseline	$ 2,507.42	$ 48.37		$ 6,960.00
GSHP - w/ ER Heat & Air Handler & AC Bas	$ 2,507.42	$ 40.00	$ 1,200.00	$ 6,960.00
GSHP - w/ Boiler Heat & Air Handler & AC B	$ 2,507.42	$ 74.22	$ 1,200.00	$ 6,960.00

References:

See 18.1 Residential AC for references

Changes from Recent Filing:

modified application of QI Sizing Loss factors to apply to size heat in lieu of full load size cool (which is a calculated value).

18.3 Residential ~~Air Source~~ Ducted Heat Pumps

Algorithms

$Customer\ kW\ Savings = \sout{Customer\ kW_{EqCooling} + Customer\ kW_{QICooling}}\ Customer\ kW_{Cooling}$

$Customer\ Coincident\ kW\ Savings = \sout{Customer\ Coincident\ kW_{Equipment} + Customer\ Coincident\ kW_{QI}}\ Customer\ Coincident\ kW_{Cooling}$

$Customer\ Rebate = Rebate/Cooling\ ton\ x\ \frac{Size\_Cool}{12{,}000}$

Electric Resistance Heat Baseline:

$Customer\ kWh\ Savings = Customer\ kWh_{Cooling} + \sout{Customer\ kWh_{EqCooling} + Customer\ kWh_{QICooling} +}\ Customer\ kWh_{EQHeating} + Customer\ kWh_{QIHeating}$

Dual Fuel Gas Heat Baseline EE Savings:

$Customer\ Coincident\ kW\ Savings = Customer\ Coincident\ kW_{Cooling}$

$Customer\ kWh\ Cooling\ Savings = Customer\ kWh_{Cooling}\ \sout{Customer\ kWh_{EqCooling} + Customer\ kWh_{QICooling} + Customer\ kWh\_Heating\ Penalty}$

$EE\ Incremental\ Capital\ Cost = EE\text{-}BE\ Cost\ Split\ x\ (Incremental\ Capital\ Cost_{Equipment} + Incremental\ Capital\ Cost_{QI})$

$EE\ Rebate = Customer\ Rebate\ x\ EE\text{-}BE\ Cost\ Split$

Dual Fuel Gas Heat Baseline BE Savings:

$Customer\ kWh\ Heating\ Savings = Customer\ kWh\_Heating\ Penalty$

$BE\ Incrmental\ Capital\ Cost = (Incremental\ Capital\ Cost_{Equipment} + Incremental\ Capital\ Cost_{QI})$ - *EE Incrmental Capital Cost*

$BE\ Rebate = Customer\ Rebate$ - *EE Rebate*

$Customer\ Dtherm\ Savings = Customer\ DTherms\_EQ\ Heating + Customer\ DTherm\_QI\ Heating$

Detailed Calculations:

$\sout{Customer\ kW_{EqCooling} = \frac{Size\_Cool}{12{,}000} \times \left(\left(\frac{12}{EER_{baseline}}\right) - \left(\frac{12}{EER_{proposed}}\right)\right)}$

$\sout{Customer\ kW_{QICooling} = \frac{Size\_Cool}{12{,}000} * 12/(EER\_proposed) * \left(\left(\frac{1}{1 - Loss_{NoQI}}\right) - \left(\frac{1}{1 - Loss_{Uncorr}}\right)\right)}$

$Customer\ kW_{Cooling} = \frac{Size_{Cool} * (1/(1-Sizing\ Loss)) * 1/(1+AC\ Oversize\ Factor)}{12{,}000} * \left(\frac{12}{EER_{baseline} * (1-Loss_{NoQI})}\right) - \frac{Size_{Cool} * 1/(1+AC\ Oversize\ Factor)}{12{,}000} * \left(\frac{12}{EER_{proposed} * (1-Loss_{Uncorr})}\right)$

$Customer\ Coincident\ kW_{Cooling} = Coincidence\ Factor\ *\ Customer\ kW_{Cooling}$

$\sout{Customer\ kWh_{EqCooling} = \frac{Size\_Cool}{12{,}000} * EFLH_{cooling} * \left(\left(\frac{12}{SEER_{baseline}}\right) - \left(\frac{12}{SEER_{proposed}}\right)\right)}$

$\sout{Customer\ kWh_{QICooling} = \frac{Size\_Cool}{12{,}000} * EFLH_{cooling} * \left(\frac{12}{SEER_{baseline}} * \left(\frac{1}{1 - Sizing_{Loss}} - 1\right) + \frac{12}{SEER_{proposed}} * \left(\left(\frac{1}{1 - Loss_{NoQI}}\right) - \left(\frac{1}{1 - Loss_{Uncorr}}\right)\right)\right)}$

$Customer\ kWh_{Cooling} = EFLH_{cooling} * \left(\frac{Size_{Cool} * (1/(1-Sizing\ Loss)) * 1/(1+AC\ Oversize\ Factor)}{12{,}000} * \left(\frac{12}{SEER_{baseline} * (1-Loss_{NoQI})}\right) - \frac{Size_{Cool} * 1/(1+AC\ Oversize\ Factor)}{12{,}000} * \left(\frac{12}{SEER_{proposed} * (1-Loss_{Uncorr})}\right)\right)$

$\sout{Customer\ Coincident\ kW_{equipment} = Coincidence\ Factor * \frac{Size\_Cool}{12{,}000} * \left(\left(\frac{12}{EER_{baseline}}\right) - \left(\frac{12}{EER_{Proposed}}\right)\right)}$

$\sout{Customer\ Coincident\ kW_{QI} = Coincidence\ Factor * \frac{Size_{Cool}}{12{,}000} * \left(\frac{12}{EER_{baseline}} * \left(\frac{1}{1 - Sizing_{Loss}} - 1\right) + \frac{12}{EER_{cooling}} * \left(\left(\frac{1}{1 - Loss_{NoQI}}\right) - \left(\frac{1}{1 - Loss_{Uncorr}}\right)\right)\right)}$

$Incremental\ Capital\ Cost_{Equipment} = Cost\ per\ Ton_{Proposed} * \frac{Size_{Cool}}{12{,}000} - Cost\ per\ Ton_{baseline} * \frac{Size_{Cool}}{12{,}000}$ - *Cost / kBTUh_Heat * Full_Load_Heat / 1000 - Baseline Air Handling*

$Incremental\ Capital\ Cost_{QI}\ New\ Home = Inc\ Cost_{QI}$

$Incremental\ Capital\ Cost_{QI}\ E\ Home = MAX\left(75, Inc\ Cost_{QI} - \frac{Size\_Cool}{12{,}000} * \left(\left(\frac{1}{1 - Sizing\ Loss}\right) - 1\right) * Cost\ per\ Ton_{baseline}\right)$

ASHP Heating Energy Savings

*m_load_profile = (~~balance pt~~ No load Point - Size_Cool * 1/(1 + AC Oversize Factor)) / (~~balance~~ No Load pt temp - Max OAT)*

*b_load_profile = Size_Cool * 1/(1 + AC Oversize Factor) - (m_load_profile * Max OAT)*

*Full Load Heat = m_load_profile * Min OAT + b_load_profile*

Electric Resistance Heat Baseline:

$\sout{Customer\ kWh_{EqHeating} = -1 * Full\_Load\_Heat * EFLH\_Heating\_HP * (1/(HSPF\_Baseline * HSPF\_Adj\_Factor) - 1/(HSPF\_Proposed * HSPF\_Adj\_Factor)) / 1000}$

$\sout{Customer\ kWh_{qiHeating} = -1 * Full\_Load\_Heat * EFLH\_Heating\_HP * 1/(HSPF\_Proposed * HSPF\_Adj\_Factor) * (1/(1 - loss\_No\_QI) - 1/Loss\_uncorr) / 1000}$

$Customer\ kWh_{ER\_Base\_Heating} = -1 * Full\_Load\_Heat * EFLH\_Heating\_HP * (1/(HSPF\_Baseline * HSPF\_Adj\_Factor) - 1/(HSPF\_Proposed * HSPF\_Adj\_Factor * (1 - Uncorr\_Loss))) / 1000$

Dual Fuel Gas Heat Baseline

*Customer DTherms_EQ Saved = (-1 * Full_Load_Heat * EFLH_Heating_HP * (1 / (1 - Loss_DuctLeakage)))/ COP_Baseline / 1,000,000*

*Customer kWh_Heating Penalty = Furnace_Fan_kW * EFLH_Heating_HP * (1 / (1 - Loss_DuctLeakage)) - Full_Load_Heat * EFLH_Heating_HP * (1 / (1 - Uncorr_Loss)) * (0 - (1 / (HPSF_Proposed*HSPF_Adj_Factor))) / 1000*

Customer DTherms_QI = -1 Full_Load_Heat * (EFLH_Heat - EFLH_Heating_HP) * (1/ COP_Baseline * (1 / (1 - Loss_DuctLeakage) - 1/ COP_Backup_Heat * 1 / (1 - Uncorr_Loss)) / 1,000,000*

Customer Remaining Dtherms_Full Electrification = -1 Full_Load_Heat * (EFLH_Heat - EFLH_Heating_HP) / COP_Baseline * (1 / (1 - Loss_DuctLeakage)) / 1,000,000*

*Customer kWh_Heating Full Electrification = Customer kWh_Heating Penalty + Furnace_Fan_kW * (EFLH_Heat - EFLH_Heating_HP) - Full_Load_Heat * (EFLH_Heat - EFLH_Heating_HP) * (0 - 1 /(COP_Backup_Heat * 3.412)* (1 / (1- Uncorr_Loss))) / 1000*

Customer DTherms/Hr_Full Electrification = -1 Full_Load_Heat / COP_Baseline / 1,000,000*

Note: All formulas using SEER, EER, and HSPF are valid with SEER2, EER2, HSPF2 substitutions.

Variables

Cost per Ton_Proposed	See Table #.X.5	Deemed Plan A Incremental Capital Cost per Ton, Based On Unit Efficiency (New Construction)
Cost per Ton_Baseline	See Table #.X.5	Baseline capital cost per ton for AC equipment
EER baseline	See Table 18.0.3	Baseline EER as calculated for residential equipment from the code required SEER.
SEER baseline	See Table 18.0.3	IECC 2012 identified code minimum SEER
COP_Baseline	See Table 18.0.3	Baseline heating efficiency. Based on the type of backup heat selected. Condensing will be 0.95, Non-Condensing will be 0.8, and Electric Resistance will be 1.0. A COP of 1 ~~and~~ does not require climate zone correction.
COP_Backup_Heat	See Table 18.0.3	Backup heating efficiency. Based on the type of backup heat selected. Condensing will be 0.95, Non-Condensing will be 0.8, and Electric Resistance will be 1.0. A COP of 1 and does not require climate zone correction.
Sizing Loss	See Table 18.0.5	
Loss_NoQI	See Table 18.0.5	
Loss_Uncorr	See Table 18.0.5	
Inc Cost_QI	See Table 18.0.5	
Coincidence Factor_EQ	See Table 18.0.4	
Coincidence Factor_QI	See Table 18.0.4	
~~Oversize_Factor__e~~	~~20%~~	~~Deemed Oversize Safety Factor for heating equipment.~~
EFLH cooling	See Table 18.0.1	Effective Full Load Hours for cooling load energy savings
EFLH_Heat	See Table 18.0.1	Effective Full Load Hours for heating load QI energy savings
EFLH_Heating_HP	See Table 18.0.1	Effective Full Load Hours for Heat Pump impacted energy savings
~~Balance~~ No Load Pt Temp	See Table 18.0.7	Outdoor Ambient Temperature at which residential cooling and heating loads are zero BTUH
Max OAT	See Table 18.0.7	Maximum Outdoor Ambient Temperature used in building ASHP load profile
Min OAT	See Table 18.0.7	Minimum Outdoor Ambient Temperature for caluclating full load heating.
Electric Resistance Heat HSPF	3.412	Electric resistance heat assumed heating season performance factor based on a COP of 1. no climate zone correction required.
~~Balance Pt~~ No Load Point	See Table 18.0.7	Heating and cooling loads are zero at the ~~balance~~ No Load point outdoor ambient temperature
Furnace_Fan_kW	~~0.357~~ 0.257	Furnace Fan EC Motor kW demand for baseline energy calculations
ASHP / MSHP operating temperature cutoff	35	Outdoor Ambient Temperature below which heat pump operation ceases and gas furnace or electric resistance heating begins.
Cost / kBTUh Heat - Baseline Furnace	$ 59.72	Average High Efficiency Furnace Cost / kBTUH; installed costs
Cost / kBTUh Heat - Baseline Boiler	$ 89.77	Average High Efficiency Boiler Cost / kBTUH; installed costs
Cost / kBTUh Heat - Baseline Electric Resistance	$ 40.00	Average Cost for electric duct heater / kBTUH; installed costs
Baseline Air Handler	$ 1,200.00	Average Cost for Baseline Air Handler for use with ER Heat or Boiler Heat associated with Air Conditioning; installed costs
HSPF_Adj_Factor	See Table 18.0.1	Adjustment factor for correcting HSPF from published data in AHRI's Climate Zone IV to AHRI's Climate Zone V. The HSPF_Adjustment_Factor for Electric Resistance Heat will be 1.
HSPF_Basline	See Table 18.0.3	Heating season performance factor of baseline equipment. For electric resistance heat baseline, a COP of 1 is assumed with no climate zone correction required.
AC Oversize Factor	10%	Air Conditioning Oversize factor to account for safety factors in load calculations and rounding to available equipment sizes.
Measure Life - Matched Split-System Air -Source Heat Pump	See Table 18.0.3	Reference 16
Measure Life - Quality Installation	18	Reference 16
Conversion Factors	See Table 18.0.5	
EE-BE Cost Split	~~36.1%~~ 28.1%	The total incremental cost and the rebate for each new heat pump measure will be divided using this split into a Beneficial Electrification (BE) portion for heating and an Energy Efficiency (EE) portion for Cooling.

Customer Inputs	**M&V Verified**	
Size Cool	Yes	AHRI rated Cooling Capacity
Quantity proposed equipment	Yes	
EER proposed	Yes	AHRI rated full load Cooling Efficiency
SEER proposed	Yes	AHRI rated part load Cooling Efficiency
Home Type	Yes	Single Family, Multi-Family
County	Yes	Location of the home for determining weather zones.
Baseline Heat ~~Type~~ Efficiency	Yes	baseline heating ~~type; gas furnace or electric resistance backup heat~~ Eff; Condensing, Non-Condensing, Electric Resistance
HSPF Proposed	Yes	AHRI rated Heating HSPF

Table 18.3.1. Incremental Capital Costs - New Construction (Plan A) - ~~Reference 6~~ Reference 28

SEER	ASHP Cost per Ton	ASHP Incremental Cost per Ton
~~13 SEER~~ 13.4 SEER2 Baseline Air Conditioner	N/A	N/A
		$ 2,507.42
~~14/14.5 SEER~~ 14.2+ SEER2 Non-Cold Climate Heat Pump	$ 3,065.00	N/A
~~15 SEER~~	~~$ 4,070.00~~	~~$ 1,005.00~~
~~16 SEER~~	~~$ 4,070.00~~	~~$ 1,005.00~~
~~17/18+ SEER~~	~~$ 4,070.00~~	~~$ 1,005.00~~
15.2+ SEER2 Non-Cold Climate Heat Pump with Furnace	$ 7,962.61	N/A
15.2+ SEER2 Non-Cold Climate Heat Pump w/out Furnace	$ 5,360.52	N/A

~~**Table 18.3.2. Baseline Costs**~~

~~ASHP Scenario~~	~~Baseline Cost per Ton (Res AC) Installed~~
~~Dual Fuel ASHP~~	~~$ 2,507.42~~
~~ASHP w/ ER Baseline~~	~~$ 2,507.42~~

References:

1. Building America, Research Benchmark Definitions, 2010. (see p. 10) http://www.nrel.gov/docs/fy10osti/47246.pdf
2. ASHRAE, 2019, Applications Handbook, Ch. 38, table 4, Comparison of Service Life Estimates
3. DOE Appliance Standards Website, Residential Central Air Conditioners and Heat Pumps. https://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75
4. Neme, Proctor, Nadel, ACEEE, 1999. Energy Savings Potential From Addressing Residential Air Conditioner and Heat Pump Installation Problems, http://aceee.org/research-report/a992
5. State of Minnesota Technical reference Manual For Energy Conservation Improvement Programs, Version 3.1 https://mn.gov/commerce/industries/energy/utilities/cip/technical-
6 ENERGY STAR Quality Installation standards (ESVI). https://www.energystar.gov/index.cfm?c=hvac_install.hvac_install_index
7. NREL 2011 Measure Guideline Sealing and Insulating Ducts in Existing Homes. http://www.nrel.gov/docs/fy12osti/53494.pdf
8. State of Illinois Technical Reference Manual Version 8, dated 2020
9. For explanation of duct sealing requirements for new homes see "Significant Changes to the 2015 Minnesota Residential Codes (MR 1303, 1309 and 1322)". http://www.ci.minneapolis.mn.us/www/groups/public/@regservices/documents/webcontent/wcms1p-142763.pdf
10. Incremental costs for MSHPs were determined from the NEEP Incremental Cost Study Phase 2 Report
11. MSHP equipment life is from Measure Life Report Residential and Commercial/Industrial Lighting and HVAC Measures; http://library.cee1.org/content/measure-life-report-residential-and-commercialindustrial-lighting-and-hvac-measures
12. For estimated life of GSHP see http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12640 (indoor components up to 25 years; ground loop =50 years)
13. Costs obtained from "2010-2012 WO017 Ex Ante Measure Cost Study Final Report", by Itron, May 2014. These are used in the DEER 2016 database.
14.For assumptions on losses related to overcharge or undercharge on refrigerant see "Sensitivity Analysis of Installation Faults on Heat Pump Performance", by P. Domanski, et. al., Sept 2014, http://www.acca.org/HigherLogic/System/DownloadDocumentFile.ashx?DocumentFileKey=f02c1f61-4d1d-4a24-971d-cc9ea3e626b2&forceDialog=0
15. ENERGY STAR Connected Thermostat Key Product Criteria, Version 1.0, Rev. Jan 2017 -
16. Code of Federal Regulations Title 10: Energy PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS Subpart C—Energy and Water
17: "Measure Life Report - Residential and Commercial/Industrial Lighting and HVAC Measures", dated June 2007 for The New England State Program Working Group prepared
18. Assumptions on EC fan operating modes. Center for Energy and Environment Comments to Docket Number EERE-2010-BT-STD-0011-0022, July 27, 2010
19. ECM Furnace Impact Assessment Report https://focusonenergy.com/sites/default/files/emcfurnaceimpactassessment_evaluationreport.pdf
20. Xcel Energy, January 2019. Typical MN Residential Smart Switch Load Relief 2011-2015.
21. Xcel Energy, January 2019. Saver's Switch Control History.
22. Xcel Energy. January 2006. Residential Saver's Switch 2005 Impact Evaluation.
23. http://wpb-radon.com/radon_fan_performance.html33:5032:50A33:50
24. Information from manufacturer and contractors (Radonaway)
25. https://www.radonaway.com/products/radon-fans/rp140-pro.php
26. Energy Information Administration's (EIA) 2009 Residential Energy Consumption Survey (RECS)
27. Bin analysis using RECS data for thermostat operation and typical CO home cooling and heating conditions.
28. Analysis of Invoices from Xcel Energy Rebated systems in 2022

Changes from Recent Filing:

Modified calculation of Incremental Cost to include the following items in the baseline costs: AC in lieu of ASHP, Baseline HE Furnace or Boiler or ER Heat, and Baseline air moving equipment when the baseline is electric resistance w/ AC or Boiler w/ AC.
Modified Deemed Cutover temperature to Backup Heat source from 25 F to 35 F. Updated Proposed and Baseline Costs
Included Minimum Qualifying levels for SEER2, EER2, and HSPF2 for all AC and Heat Pump equipment based on IECC2021 where applicable. See Deemed Tables tab.
modified QI Sizing Loss Factor formula applications.

18.4 ~~Mini-Split~~ Ductless and Mixed Duct-Ductless Heat Pumps

Algorithms

$$Customer\ kW\ Savings = Customer\ kW_{EqCooling}$$

$$Customer\ Coincident\ kW\ Savings = Customer\ Coincident\ kW_{Equipment}$$

$$Customer\ Rebate = Rebate/Cooling\ ton\ x\ \frac{Size\_Cool}{12{,}000}$$

Electric Resistance Heat Baseline:

$$Customer\ kWh\ Savings = Customer\ kWh_{EqCooling} + Customer\ kWh_{EQHeating}$$

Dual Fuel Gas Heat Baseline EE Savings:

$$Customer\ kWh\ Cooling\ Savings = Customer\ kWh_{EqCooling}$$

$$Incremental\ EE\ Cost = EE\text{-}BE\ Cost\ Split\ x\ Incremental\ Capital\ Cost_{Equipment}$$

$$EE\ Rebate = EE\text{-}BE\ Cost\ Split\ x\ Customer\ Rebate$$

Dual Fuel Gas Heat Baseline BE Savings:

$$Customer\ kWh\ Heating\ Savings = Customer\ kWh\_Heating\ Penalty$$

$$Customer\ Dtherm\ Savings = Customer\ DTherms\_EQ\ Heating$$

$$Incremental\ BE\ Cost = Incremental\ Capital\ Cost_{Equipment} - Incremental\ EE\ Cost$$

$$BE\ Rebate = Customer\ Rebate - EE\ Rebate$$

$$EER_{baseline} = iCoef0\_c * SEER\_Base\ ^2 + iCoef1\_c * SEER\_Base + iCoef2\_c$$

$$Customer\ kW_{EqCooling} = Qty_{prop} * \frac{Size_{Cool}}{12{,}000} * \left(\left(\frac{12}{EER_{baseline} * (1 - Loss_{NoQI})}\right) - \left(\frac{12}{EER_{proposed}}\right)\right)$$

$$Customer\ kWh_{EqCooling} = Qty_{Prop} * \frac{Size\_Cool}{12{,}000} * EFLH_{cooling} * \left(\left(\frac{12}{SEER_{baseline} * (1 - Loss_{NoQI})}\right) - \left(\frac{12}{SEER_{proposed}}\right)\right)$$

$$Customer\ Coincident\ kW_{equipment} = Qty_{Prop} * Coincidence\ Factor * \frac{Size\_Cool}{12{,}000} * \left(\left(\frac{12}{EER_{baseline} * (1 - Loss_{NoQI})}\right) - \left(\frac{12}{EER_{Proposed}}\right)\right)$$

$NOTE: \quad (1 - Loss_{NoQI})$ *is based on the Baseline AC QI Factor*

$$Incremental\ Capital\ Cost_{Equipment} = Qty_{Prop} * (Qty\_Indoor\_Heads * Cost/Eff\_Indoor\_Head - Cost\ Per\ Ton\ Baseline * \frac{Size\_Cool}{12{,}000} - Cost\ per\ kBTUh\ heat * (Full\_Load\_Heat/COP\_Baseline)/1000 - Baseline\_Air\_Handler)$$

MSHP Heating Energy Savings

m_load_profile = (~~balance pt~~ No load Point - Size_Cool) / (~~balance~~ No Load pt temp - Max OAT)

*b_load_profile = Size_Cool - (m_load_profile * Max OAT)*

*Full Load Heat = m_load_profile * Min OAT + b_load_profile*

*HSPF_Baseline_Adj = HSPF_Baseline * HSPF_Adjustment_Factor*

*HSPF_Proposed_Adj = HSPF_Proposed * HSPF_Adjustment_Factor*

$$Customer\ kWh_{EQHeating} = Qty_{Prop} * (-1 * Full\_Load\_Heat * EFLH\_Heating\_HP * (1 / HSPF\_Baseline\_Adj - 1 / HSPF\_Proposed\_Adj) / 1000$$

*Customer DTherms_EQ Saved = (-1 * Full_Load_Heat * EFLH_Heating_HP) / COP_Baseline / 1,000,000*

*Customer kWh_Heating Penalty = - 1 * Full_Load_Heat * EFLH_Heating_HP*
** (0 - (1 / (HPSF_Proposed*HSPF_Adj_Factor))) / 1000*

Note: All formulas using SEER, EER, and HSPF are valid with SEER2, EER2, HSPF2 substitutions.

Variables

$Inc\ Cost\ per\ Ton\_EQ$	See Table 18.4.2	Deemed Plan A Incremental Capital Cost per Ton, Based On Unit Efficiency (New Construction)
$Cost\ per\ Ton\_baseline$	See Table 18.4.2	Baseline capital cost per ton for equipment
EER baseline	See Table 18.0.3	Baseline EER or EER2 for the Proposed Equipment as selected in the table.
SEER baseline	See Table 18.0.3	Baseline SEER or SEER2 for the Proposed Equipment as selected in the table.
HSPF_Baseline	See Table 18.0.3	Baseline HSPF or HSPF2 for the Proposed Equipment as selected in the table. For Electric Resistance Heat Baseline the HSPF will be 3.412 based on a Heating COP of 1 and does not require climate zone correction.
COP_Baseline	See Table 18.0.3	Baseline heating efficiency. A COP of 1 and does not require climate zone correction.
COP_Backup_Heat	See Table 18.0.8	Backup heating efficiency. Based on the type of backup heat selected. Condensing will be 0.95, Non-Condensing will be 0.8, and Electric Resistance will be 1.0. A COP of 1 and does not require climate zone correction.
Loss_NoQI	See Table 18.0.5	Loss Factor associated with the baseline AC.
Loss_DuctLeakage	See Table 18.0.5	Loss Factor associated with the baseline AC and Furnace.
Coincidence Factor	See Table 18.0.4	
iCoef0	See Table 18.4.1	MSHP SEER2 to EER2 Conversion Coefficient
iCoef1	See Table 18.4.1	MSHP SEER2 to EER2 Conversion Coefficient

iCoef2	See Table 18.4.1	MSHP SEER2 to EER2 Conversion Coefficient
EFLH_Cooling	See Table 18.0.1	Effective Full Load Hours for cooling load energy savings
EFLH_Heating_HP	See Table 18.0.1	Effective Full Load Hours for Heat Pump impacted energy savings
ASHP / MSHP operating temperature cutoff	35	Outdoor Ambient Temperature below which heat pump operation ceases and backup heating (either electric resistance or gas fired) begins.
~~Balance~~ No Load Pt Temp	See Table 18.0.7	Outdoor Ambient Temperature at which residential cooling and heating load profiles equal zero BTUH
Max OAT	See Table 18.0.7	Maximum Outdoor Ambient Temperature used in building ASHP load profile; TMY3 basis
Min OAT	See Table 18.0.7	Minimum Outdoor Ambient Temperature for caluclating full load heating; TMY3 Basis.
HSPF_Adj_Factor	See Table 18.0.1	Adjustment factor for correcting HSPF from published data in climate zone IV to Minnesota Climate zone V. The HSPF_Adjustment_Factor for Electric Resistance Heat will be 1.
~~Balance Pt~~ No Load Point	See Table 18.0.7	BTUH - Heating and cooling loads are zero at the ~~balance~~ No Load point outdoor ambient temperature
m_load_profile	Calculated	load profile slope (m)
b_load_profile	Calculated	load profile y intercept (b)
Full Load Heat	Calculated	calculated full load heating BTUH required to serve the home or space at the minimum Outside Air Temperature
Cost / kBTUh Heat - Baseline Furnace	$ 59.72	Average High Efficiency Furnace Cost / kBTUH; installed costs
Cost / kBTUh Heat - Baseline Boiler	$ 89.77	Average High Efficiency Boiler Cost / kBTUH; installed costs
Cost / kBTUh Heat - Baseline Electric Resistance	$ 40.00	Average Cost for air handler and electric duct heater / kBTUH; installed costs
Baseline Air Handler	$ 1,200.00	Average Cost for Baseline Air Handler for use with ER Heat or Boiler Heat associated with Air Conditioning; installed costs
Lifetime	See Table 18.0.4	Measure Lifetime for MSHPs.
Minimum Qualifying Efficiency	See Table 18.0.2	
EE-BE Cost Split	~~16.5%~~ 31.5%	The total incremental cost and the rebate for each new heat pump measure will be divided using this split into a Beneficial Electrification (BE) portion for heating and an Energy Efficiency (EE) portion for Cooling.

Customer Inputs	**M&V Verified**	
Size Cool	Yes	AHRI rated Cooling Capacity
Quantity proposed equipment	Yes	The Quantity of Outdoor Units. Only applies if the Outdoor Unit's Size AND the quantity and size of the Indoor Units served by each outdoor unit are identical.
Quantity Indoor Heads	Yes	The Quantity of Indoor Heads + Coils served by a single Outdoor Unit.
$EER\_Proposed$	Yes	AHRI rated full load Cooling Efficiency
SEER proposed	Yes	AHRI rated part load Cooling Efficiency
Home Type	Yes	Single Family, Multi-Family
County	Yes	Location of the home for determining weather zones.
Baseline Heat Type	Yes	Baseline heating type; gas furnace or electric resistance backup heat
HSPF Proposed	Yes	AHRI rated Heating HSPF

Table 18.4.1: SEER Conversion Coefficients

Equipment type	Coef0	Coef1	Coef2
MSHP - SEER2 to EER2	-0.0088000	0.8828200	-2.2811300

Table 18.4.2 Incremental Capital Costs - ~~Mini-Split~~ Ductless & Mixed Duct-Ductless Heat Pumps

Mini-Split Heat Pump	Baseline AC Cost per Cooling Ton	Cost/Efficient Indoor Head or Coil
~~Mini-Split Heat Pump (15+ SEER, 11.5+ EER, 9+ HSPF)~~	~~$ 2,507.42~~	~~$ 5,291.23~~
~~Multi-Split Heat Pump (15+ SEER, 11.5+ EER, 9+ HSPF)~~	~~$ 2,507.42~~	~~$ 4,508.69~~
~~Mini-Split Heat Pump (15.2+ SEER2, 11.5+ EER2, 7.8+ HSPF2)~~ Ductless Heat Pump - Single Head	$ 2,507.42	$ 5,291.23
~~Multi-Split Heat Pump (15.2+ SEER2, 11.5+ EER2, 7.8+ HSPF2)~~ Ductless Heat Pump - Multi-Head	$ 2,507.42	$ 4,508.69
Mixed Duct-Ductless Heat Pump - Multi-Head	$ 2,507.42	$ 4,508.69

References:

See 18.1 Residential AC references

Changes from Recent Filing:

Modified calculation of Incremental Cost to include the following items in the baseline costs: AC in lieu of MSHP, Baseline HE Furnace or Boiler or ER Heat, and Baseline air moving equipment when the baseline is electric resistance w/ AC or Boiler w/ AC.
Modified Deemed Cutover temperature to Backup Heat source from 25 F to 35 F.
Updated Proposed and Baseline Costs
Included Minimum Qualifying levels for SEER2, EER2, and HSPF2 for all AC and Heat Pump equipment based on IECC2021 where applicable. See Deemed Tables tab.

18.13 Residential Cold Climate ~~Air Source~~ Ducted Heat Pumps

Algorithms

$Customer\ kW\ Savings = ~~Customer\ kW_{EqCooling} + Customer\ kW_{QICooling}~~ Customer\ kW_{Cooling}$

$Customer\ Coincident\ kW\ Savings = Customer\ Coincident\ kW_{Equipment} + Customer\ Coincident\ kW_{QI}$

$Customer\ Rebate = Rebate/Heating\ ton\ x\ \frac{Size_{Heat\_5}}{12{,}000}$

Electric Resistance Heat Baseline:

$Customer\ kWh\ Savings = Customer\ kWh_{Cooling}\ ~~Customer\ kWh_{EqCooling} + Customer\ kWh_{QICooling}~~ + Customer\ kWh_{EQHeating} + Customer\ kWh_{QIHeating}$

Dual Fuel Gas Heat Baseline EE Savings:

$Customer\ kWh\ Cooling\ Savings = Customer\ kWh_{Cooling}\ ~~Customer\ kWh_{EqCooling} + Customer\ kWh_{QICooling}~~$

$EE\ Incremental\ Cost = EE\text{-}BE\ Cost\ Split\ x\ (Incremental\ Capital\ Cost_{Equipment} + Incremental\ Capital\ Cost_{QI})$

$EE\ Rebate = EE\text{-}BE\ Cost\ Split\ x\ Customer\ Rebate$

Dual Fuel Gas Heat Baseline BE Savings:

$Customer\ kWh\ Heating\ Savings = Customer\ kWh\_Heating\ Penalty$

$Customer\ Dtherm\ Savings = Customer\ DTherms\_EQ\ Heating + Customer\ DTherm\_QI\ Heating$

$BE\ Incremental\ Cost = (Incremental\ Capital\ Cost_{Equipment} + Incremental\ Capital\ Cost_{QI}) - EE\ Incremental\ Cost$

$BE\ Rebate = Customer\ Rebate - EE\ Rebate$

Calculation Details:

$Customer\ kW_{Cooling}\ ~~Customer\ kW_{EqCooling}~~ = \frac{Full\ Load\ Cool}{12{,}000} \times \left(\left(\frac{12}{EER_{baseline} * (1 - Loss_{NoQI})}\right) - \left(\frac{12}{EER_{proposed} * (1 - Loss_{Uncorr})}\right)\right)$

$~~Customer\ kW_{QICooling} = -\frac{Full\ Load\ Cool}{12{,}000} * 12/(EER\_proposed) * ((\frac{1}{1 - Loss_{NoQI}}) - \left(\frac{1}{1 - Loss_{Uncorr}}\right))~~$

$Customer\ kWh_{Cooling}\ ~~Customer\ kWh_{EqCooling}~~ = \frac{Full\ Load\ Cool}{12{,}000} * EFLH_{cooling} * ((\frac{12}{SEER_{baseline} * (1 - Loss_{NoQI})}) - \left(\frac{12}{SEER_{proposed} * (1 - Loss_{Uncorr})}\right))$

$~~Customer\ kWh_{QICooling} = -\frac{Full\_Load\_Cool}{12{,}000} * EFLH_{cooling} * \frac{12}{SEER_{proposed}} * ((\frac{1}{1 - Loss_{NoQI}}) - \left(\frac{1}{1 - Loss_{Uncorr}}\right))~~$

$Customer\ Coincident\ kW_{Cooling}\ ~~Customer\ Coincident\ kW_{equipment}~~$
$= Coincidence\ Factor * \frac{Full\ Load\ Cool}{12{,}000} * (\left(\frac{12}{EER_{baseline} * (1 - Loss_{NoQI})}\right) - \left(\frac{12}{EER_{Proposed} * (1 - Loss_{Uncorr})}\right))$

$~~Customer\ Coincident\ kW_{QI} = -Coincidence\ Factor * \frac{12}{EER_{Cooling}} * \frac{Full\ Load\ Cool}{12{,}000} * ((\frac{1}{1 - Loss_{NoQI}}) - \left(\frac{1}{1 - Loss_{Uncorr}}\right))~~$

$Incremental\ Capital\ Cost_{Equipment} = ASHP\ Cost\ per\ Ton_{EQ} * \frac{Size\_Cool}{12{,}000} - Cost\ Per\ Ton\ Baseline * \frac{Full\_Load\_Cool}{12{,}000} - Cost\ per\ kBTUH\ heat * (Full\_Load\_Heat/COP\_Baseline)/1000 - Baseline\_Air\_Handler$

$Incremental\ Capital\ Cost_{QI}\ New\ Home = Inc\ Cost_{QI}$

$Incremental\ Capital\ Cost_{QI}\ E\ Home = MAX(75, Inc\ Cost_{QI} - \frac{Size\_Cool}{12{,}000} * (\left(\frac{1}{1 - Sizing\ Loss}\right) - 1) * Cost\ per\ Ton_{baseline}))$

Note: All formulas using SEER, EER, and HSPF are valid with SEER2, EER2, HSPF2 substitutions.

ccASHP Heating Energy Savings

*Load_Heat = -1 * Size_Heat_5 * 1/(1 + Oversize_Factor)*

m_load_profile = (~~balance pt~~ No load Point - Load_Heat) / (~~balance~~ No Load pt temp - Des_OAT)

*b_load_profile = Load_Heat - (m_load_profile * Des_OAT)*

*Full Load Cool = m_load_profile * Max_OAT + b_load_profile*

*Full_Load_Heat = m_load_profile * Min_OAT + b_load_profile*

Electric Resistance Heat Baseline:

$Customer\ kWh_{EQHeating} = -1 * Full\_Load\_Heat * EFLH\_cc\_HP\_Heat\ ~~EFLH\_Heating\_HP~~ * (1 / (HSPF\_Baseline * HSPF\_Adj\_Factor) - 1 / (HSPF\_Proposed * HSPF\_Adj\_Factor)) / 1000$

$Customer\ kWh_{QIHeating} = -1 * Full\_Load\_Heat * EFLH\_cc\_HP\_Heat\ ~~EFLH\_Heating\_HP~~ * ~~(1 / (HSPF\_Baseline * HSPF\_Adj\_Factor) * (\frac{1}{1 - Sizing_{Loss}} - 1) +~~ 1 / (HSPF\_Proposed * HSPF\_Adj\_Factor) * (1 / (1 - loss\_No\_QI) - 1/Loss\_uncorr) / 1000 ~~)~~$

Dual Fuel Gas Heat Baseline

*Customer DTherms_EQ Saved = (-1 * Full_Load_Heat * EFLH_cc_HP_Heat ~~EFLH_Heating_HP~~)/ ~~Furnace_Eff~~ COP_Baseline / 1,000,000*

*Customer kWh_Heating Penalty = Furnace_Fan_kW * EFLH_cc_HP_Heat ~~EFLH_Heating_HP~~ - Full_Load_Heat * EFLH_cc_HP_Heat * (0 - (1 / (HPSF_Proposed*HSPF_Adj_Factor))) / 1000*

*Customer DTherms_QI = (-1 * Full_Load_Heat * EFLH_cc_HP_Heat)/ COP_Baseline / 1,000,000 * (1 / 1 - Loss_DuctLeakage - 1) + -1*Full_Load_Heat * (EFLH_Heat - EFLH_cc_HP_Heat) / COP_Baseline ~~Furnace_Eff~~ * (1 / (1 - Loss_DuctLeakage) - 1 / (1 - Uncorr_Loss)) / 1,000,000*

*Customer DTherms/Hr_QI = -1*Full_Load_Heat / COP_Backup_Heat * (1 / (1 - Loss_DuctLeakage) - 1 / (1 - Uncorr_Loss)) / 1,000,000*

Customer Remaining Dtherms_Full Electrification = -1 Full_Load_Heat * (EFLH_Heat - EFLH_Heating_HP) / COP_Baseline * (1 / (1 - Uncorr_Loss)) / 1,000,000*

Customer DTherms/Hr_Full Electrification = -1 Full_Load_Heat / COP_Baseline / 1,000,000*

*Customer kWh_Heating Full Electrification = Customer kWh_Heating Penalty + Furnace_Fan_kW * (EFLH_Heat - EFLH_cc_HP_Heat) - Full_Load_Heat * (EFLH_Heat - EFLH_cc_HP_Heat) * (0 - 1 /(COP_Backup_Heat * 3.412)* (1 / (1- Uncorr_Loss))) / 1000*

*Customer Winter Peak kW = -1 * Full_Load_Heat / 3412*

Variables

ASHP Cost per Ton_EQ	See Table 18.13.1	Capital Cost per Ton of new ccASHP.
Cost per Ton_baseline	See Table 18.13.1	Baseline capital cost per ton for new AC equipment.
EER baseline	See Table 18.0.3	Baseline EER as calculated for residential equipment from the code required SEER baseline AC unit.
SEER baseline	See Table 18.0.3	IECC 2021 identified code minimum AC unit SEER
COP_Baseline	~~See Table 18.0.3~~ See Table 18.0.8	Baseline heating efficiency. Based on the type of backup heat selected. Condensing will be 0.95, Non-Condensing will be 0.8, and Electric Resistance will be 1.0. A COP of 1 and does not require climate zone correction.
COP_Backup_Heat	See Table 18.0.8	Backup heating efficiency. Based on the type of backup heat selected. Condensing will be 0.95, Non-Condensing will be 0.8, and Electric Resistance will be 1.0. A COP of 1 and does not require climate zone correction.
Sizing Loss	See Table 18.0.5	
Loss_NoQI	See Table 18.0.5	
Loss_Uncorr	See Table 18.0.5	
Inc Cost_QI	See Table 18.0.5	
Coincidence Factor_EQ	See Table 18.0.4	
Coincidence Factor_QI	See Table 18.0.4	
Oversize_Factor__c	~~20%~~ 0%	Deemed Oversize Safety Factor for heating equipment. - there is no oversize factor for the heat pump. A backup heating system will provide the supplemental of backup heat required on the extreme days.
EFLH cooling	See Table 18.0.1	Effective Full Load Hours for cooling load energy savings
EFLH_Heat	See Table 18.0.1	Effective Full Load Hours for heating load QI energy savings
EFLH_ccHP_Heat	See Table 18.0.1a	Effective Full Load Hours for Cold Climate Heat Pump at and above customer provided Operating Cutover Temperature.
~~Balance~~ No Load Pt Temp	See Table 18.0.7	Outdoor Ambient Temperature at which residential cooling and heating load profiles equal ~~s are~~ zero BTUH
Max_OAT	See Table 18.0.7	Maximum Outdoor Ambient Temperature used in building load profile
Min_OAT	See Table 18.0.7	Minimum Outdoor Ambient Temperature used in building load profile
Des OAT	5	Low Outdoor Ambient Temperature for caluclating heating load Profile. Based on Low Temp Rating from NEEP QPL Data Sheets. Deemed to be 5 F.
Electric Resistance Heat HSPF	3.412	Electric resistance heat assumed heating season performance factor based on a COP of 1. no climate zone correction required.
~~Balance Pt~~ No Load Point	See Table 18.0.7	BTUH - Heating and cooling loads are zero at the ~~balance~~ No Load point outdoor ambient temperature
Furnace_Fan_kW	~~0.357~~ 0.257	Furnace Fan EC Motor kW demand for baseline energy calculations for ASHP.
~~Furnace Eff~~	~~95%~~	~~This is the assumed furnace efficiency for the backup gas fired heat (Baseline Heat Type equals Gas Furnace) in a dual fuel ASHP system application.~~
Cost / kBTUh Heat - Baseline Furnace	$ 59.72	Average High Efficiency Furnace Cost / kBTUH; installed costs
Cost / kBTUh Heat - Baseline Boiler	$ 89.77	Average High Efficiency Boiler Cost / kBTUH; installed costs
Cost / kBTUh Heat - Baseline Electric Resistance	$ 40.00	Average Cost for air handler and electric duct heater / kBTUH; installed costs
Baseline Air Handler	$ 1,200.00	Average Cost for Baseline Air Handler for use with ER Heat or Boiler Heat associated with Air Conditioning; installed costs
HSPF_Adj_Factor	See Table 18.0.1	Adjustment factor for correcting HSPF from published data in AHRI's Climate Zone IV to AHRI's Climate Zone V. The HSPF_Adjustment_Factor for Electric Resistance Heat will be 1.
HSPF_Basline	See Table 18.0.3	Heating season performance factor of baseline equipment. For electric resistance heat baseline, a COP of 1 is assumed with no climate zone correction required.
Measure Life - Matched Split-System Air -Source Heat Pump	See Table 18.0.3	Reference 16
Measure Life - Quality Installation	18	Reference 16
Conversion Factors	See Table 18.0.6	
EE-BE Cost Split	~~20.0%~~ 4.4%	The total incremental cost and the rebate for each new heat pump measure will be divided using this split into a Beneficial Electrification (BE) portion for heating and an Energy Efficiency (EE) portion for Cooling.

Customer Inputs	M&V Verified	
Size_Cool	Yes	NEEP QPL Data Sheet Rated Cooling Capacity at 95 F
Size_Heat_5	Yes	NEEP QPL Data Sheet Max Heating Capacity at 5 F
Size_Heat_47	Yes	NEEP QPL Data Sheet Rated Heating Capacity at 47 F
~~EER proposed~~	~~Yes~~	~~NEEP QPL Data Sheet rated full load Cooling Efficiency~~
~~SEER proposed~~	~~Yes~~	~~NEEP QPL Data Sheet rated part load Cooling Efficiency~~
~~HSPF Proposed~~	~~Yes~~	~~NEEP QPL Data Sheet rated Heating HSPF~~
EER2 proposed	Yes	AHRI Certification for units manufactured after 1/1/2023
SEER2 proposed	Yes	AHRI Certification for units manufactured after 1/1/2023
HSPF2 Proposed	Yes	AHRI Certification for units manufactured after 1/1/2023
Home Type	Yes	Single Family or Multi-Family home
~~County~~	~~Yes~~	~~Location of the home for determining weather zones.~~
~~Baseline Heat Type~~	~~Yes~~	~~baseline heating type; gas furnace or electric resistance backup heat~~
Baseline Heat Efficiency	Yes	baseline heating Eff; Condensing, Non-Condensing, Electric Resistance
Backup Heat Efficiency	Yes	backup heating Eff; Condensing, Non-Condensing, Electric Resistance
Home Category	Yes	New Home or Existing Home
Operating Cutover Temperature	Yes	Outdoor Ambient Temperature below which heat pump operation ceases and Gas Backup or electric resistance heating begins. If the system is arranged for supplemental heating in place of full backup, this is the temperature where supplemental heating is called.

Table 18.13.1. Incremental Capital Costs ~~- Reference 28 - New Construction (Plan A) - Reference 6~~

SEER	ccASHP Cost per Ton	Baseline Cost per Ton (Res AC) Installed
~~13 SEER~~ 13.4 SEER2 Baseline Air Conditioner	N/A	$ 2,507.42
~~18+ SEER~~	~~$ 3,500.00~~	~~N/A~~
15.2+ SEER2 Cold Climate Heat Pump w/ Furnace	$ 8,717.48	N/A
15.2+ SEER2 Cold Climate Heat Pump w/out Furnace	$ 5,912.94	N/A

References:

1. Building America, Research Benchmark Definitions, 2010. (see p. 10) http://www.nrel.gov/docs/fy10osti/47246.pdf
2. ASHRAE, 2019, Applications Handbook, Ch. 38, table 4, Comparison of Service Life Estimates
3. DOE Appliance Standards Website, Residential Central Air Conditioners and Heat Pumps. https://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75
4. Neme, Proctor, Nadel, ACEEE, 1999. Energy Savings Potential From Addressing Residential Air Conditioner and Heat Pump Installation Problems, http://aceee.org/research-report/a992
5. State of Minnesota Technical reference Manual For Energy Conservation Improvement Programs, Version 3.1 https://mn.gov/commerce/industries/energy/utilities/cip/technical-
6 ENERGY STAR Quality Installation standards (ESVI). https://www.energystar.gov/index.cfm?c=hvac_install.hvac_install_index
7. NREL 2011 Measure Guideline Sealing and Insulating Ducts in Existing Homes. http://www.nrel.gov/docs/fy12osti/53494.pdf
8. State of Illinois Technical Reference Manual Version 8, dated 2020
9. For explanation of duct sealing requirements for new homes see "Significant Changes to the 2015 Minnesota Residential Codes (MR 1303, 1309 and 1322)". http://www.ci.minneapolis.mn.us/www/groups/public/@regservices/documents/webcontent/wcms1p-142763.pdf
10. Incremental costs for MSHPs were determined from the NEEP Incremental Cost Study Phase 2 Report
11. MSHP equipment life is from Measure Life Report Residential and Commercial/Industrial Lighting and HVAC Measures; http://library.cee1.org/content/measure-life-report-residential-and-commercialindustrial-lighting-and-hvac-measures
12. For estimated life of GSHP see http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12640 (indoor components up to 25 years; ground loop =50 years)
13. Costs obtained from "2010-2012 WO017 Ex Ante Measure Cost Study Final Report", by Itron, May 2014. These are used in the DEER 2016 database.
14.For assumptions on losses related to overcharge or undercharge on refrigerant see "Sensitivity Analysis of Installation Faults on Heat Pump Performance", by P. Domanski, et. al., Sept 2014, http://www.acca.org/HigherLogic/System/DownloadDocumentFile.ashx?DocumentFileKey=f02c1f61-4d1d-4a24-971d-cc9ea3e626b2&forceDialog=0
15. ENERGY STAR Connected Thermostat Key Product Criteria, Version 1.0, Rev. Jan 2017 -
16. Code of Federal Regulations Title 10: Energy PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS Subpart C—Energy and Water
17: "Measure Life Report - Residential and Commercial/Industrial Lighting and HVAC Measures", dated June 2007 for The New England State Program Working Group prepared
18. Assumptions on EC fan operating modes. Center for Energy and Environment Comments to Docket Number EERE-2010-BT-STD-0011-0022, July 27, 2010
19. ECM Furnace Impact Assessment Report https://focusonenergy.com/sites/default/files/emcfurnaceimpactassessment_evaluationreport.pdf
20. Xcel Energy, January 2019. Typical MN Residential Smart Switch Load Relief 2011-2015.
21. Xcel Energy, January 2019. Saver's Switch Control History.
22. Xcel Energy. January 2006. Residential Saver's Switch 2005 Impact Evaluation.
23. http://wpb-radon.com/radon_fan_performance.html33:5032:50A33:50
24. Information from manufacturer and contractors (Radonaway)
25. https://www.radonaway.com/products/radon-fans/rp140-pro.php
26. Energy Information Administration's (EIA) 2009 Residential Energy Consumption Survey (RECS)
27. Bin analysis using RECS data for thermostat operation and typical CO home cooling and heating conditions.
28 Analysis of Invoices from Xcel Energy Rebated systems in 2022

Changes from Recent Filing:

Modified calculation of Incremental Cost to include the following items in the baseline costs: AC in lieu of ASHP, Baseline HE Furnace or Boiler or ER Heat, and Baseline air moving equipment when the baseline is electric resistance w/ AC or Boiler w/ AC.
Updated Proposed and Baseline Costs
Included Minimum Qualifying levels for SEER2, EER2, and HSPF2 for all AC and Heat Pump equipment based on IECC2021 where applicable. See Deemed Tables tab.
Removed QI Sizing Loss factors from full load cooling. Sizing should have been heating load basis.

18.14 Cold Climate Mini-Split Heat Pumps

Algorithms

$Customer\ kW\ Savings = Customer\ kW_{EqCooling}$

$Customer\ Coincident\ kW\ Savings = Customer\ Coincident\ kW_{Equipment}$

$Customer\ Rebate = Rebate/Heating\ ton\ x\ \frac{Size_{Heat\_5}}{12{,}000}$

Electric Resistance Heat Baseline:

$Customer\ kWh\ Savings = Customer\ kWh_{EqCooling} + Customer\ kWh_{EQHeating}$

Dual Fuel Gas Heat Baseline EE Savings:

$Customer\ kWh\ Cooling\ Savings = Customer\ kWh_{EqCooling}$

$Incremental\ EE\ Captial\ Cost = \ EE\text{-}BE\ Cost\ Split\ x\ Incremental\ Capital\ Cost_{Equipment}$

EE Rebate = Customer Rebate x EE-BE Cost Split

Dual Fuel Gas Heat Baseline BE Savings:

Customer kWh Heating Savings = Customer kWh_Heating Penalty

Customer Dtherm Savings = Customer DTherms_EQ Heating

$Incremental\ BE\ Capital\ Cost = Incremental\ Capital\ Cost_{Equipment}$ *- Incremental EE Captial Cost*

BE Rebate = Customer Rebate - EE Rebate

Caluclation Details:

$$Customer\ kW_{EqCooling} = Qty_{prop} * \frac{Full\_Load\_Cool}{12{,}000} * \left(\left(\frac{12}{EER_{baseline} * (1 - Loss_{NoQI})}\right) - \left(\frac{12}{EER_{proposed}}\right)\right)$$

$$Customer\ kWh_{EqCooling} = Qty_{Prop} * \frac{Full\_Load\_Cool}{12{,}000} * EFLH_{cooling} * \left(\left(\frac{12}{SEER_{baseline} * (1 - Loss_{NoQI})}\right) - \left(\frac{12}{SEER_{proposed}}\right)\right)$$

$$Customer\ Coincident\ kW_{equipment} = Qty_{Prop} * Coincidence\ Factor * \frac{Full\_Load\_Cool}{12{,}000} * \left(\left(\frac{12}{EER_{baseline} * (1 - Loss_{NoQI})}\right) - \left(\frac{12}{EER_{Proposed}}\right)\right)$$

$Incremental\ Capital\ Cost_{Equipment} = Qty\_Indoor\_Heads * Cost/Eff\_Indoor\_Head$ *- Cost Per Ton Baseline* $* \frac{Size\_Cool}{12{,}000}$ *- Cost per kBTUh heat * (Full_Load_Heat/COP_Baseline)/1000 - Baseline_Air_Handler*

cc$MSHP\ Heating\ Energy\ Savings$

*Load_Heat = -1 * Size_Heat_5 * 1/(1 + Oversize_Factor)*

m_load_profile = (~~balance pt~~ No load Point - Load_Heat) / (~~balance~~ No Load pt temp - Des_OAT)

*b_load_profile = Load_Heat - (m_load_profile * Des_OAT)*

*Full Load Heat = m_load_profile * Min OAT + b_load_profile*

*Full Load Cool = m_load_profile * Max OAT + b_load_profile*

*HSPF_Baseline_Adj = HSPF_Baseline * HSPF_Adjustment_Factor*

*HSPF_Proposed_Adj = HSPF_Proposed * HSPF_Adjustment_Factor*

Electric Resistance Heating Baseline:

$Customer\ kWh_{EQHeating}$ *= Qty_{Prop} * (-1 * Full_Load_Heat * EFLH_ccHP_Heat * (1 / HSPF_Baseline_Adj - 1 / HSPF_Proposed_Adj) / 1000*

Gas Heating Baseline:

*Customer DTherms_EQ Saved = (-1 * Full_Load_Heat * EFLH_ccHP_Heat * (1 /* $(1 - Loss_{DuctLeakage})$*)) / COP_Baseline ~~Furnace_Eff~~ / 1,000,000*

*Customer kWh_Heating Penalty = Furnace_Fan_kW * EFLH_cc_HP_Heat + (- 1 * Full_Load_Heat) * EFLH_ccHP_Heat * (0 - (1 / (HPSF_Proposed*HSPF_Adj_Factor))) / 1000*

*Customer Dtherm/Hr Full Electrification = -1 * Full_Load_Heat / COP_Baseline / 1,000,000*

*Customer Remaining DTherm Full Electrification = -1 * Full_Load_Heat * (EFLH_Heat - EFLH_Heating_HP) / COP_Baseline * (1 / (1 -* $Loss_{DuctLeakage}$*)) / 1,000,000*

*Customer kWh_Heating Full Electrificaiton = Customer kWh_Heating Penalty + Furnace_Fan_kW * (EFLH_Heat - EFLH_cc_HP_Heat) - Full_Load_Heat * (EFLH_Heat - EFLH_cc_HP_Heat) * (0 - 1 /(HPSF_Proposed*HSPF_Adj_Factor)) / 1000*

Note: All formulas using SEER, EER, and HSPF are valid with SEER2, EER2, HSPF2 substitutions.

Variables

$Cost/Eff\_Indoor\_Head$	See Table 18.4.1	Deemed Cost per Indoor Head or Coil, Based On Mini-Split vs. Multi-Split
$Cost\ per\ Ton\_baseline$	See Table 18.4.1	Baseline capital cost per ton for new AC equipment
EER baseline	See Table 18.0.3	Baseline EER as calculated for residential equipment from the code required SEER.
SEER baseline	See Table 18.0.3	IECC 2012 identified code minimum SEER
HSPF_Baseline	See Table 18.0.3	Baseline heating season performance factor for code minimum MSHP. For Electric Resistance Heat Baseline the HSPF will be 3.412 based on a COP of 1 and does not require climate zone correction.
COP_Baseline	~~See Table 18.0.3~~ See Table 18.0.8	Baseline heating efficiency. Based on the type of backup heat selected. Condensing will be 0.95, Non-Condensing will be 0.8, and Electric Resistance will be 1.0. A COP of 1 and does not require climate zone correction.
COP_Backup_Heat	See Table 18.0.8	Backup heating efficiency. Based on the type of backup heat selected. Condensing will be 0.95, Non-Condensing will be 0.8, and Electric Resistance will be 1.0. A COP of 1 and does not require climate zone correction.
Coincidence Factor	See Table 18.0.3	
EFLH_Cooling	See Table 18.0.1	Effective Full Load Hours for cooling load energy savings
EFLH_Heating_HP	See Table 18.0.1	Effective Full Load Hours for Heat Pump impacted energy savings
EFLH_ccHP_Heat	See Table 18.0.1a	Effective Full Load Hours for Cold Climate Heat Pump at and above customer provided cutover temperature.
Loss_DuctLeakage	See Table 18.0.5	The loss factor associated with leaky ductwok for the baseline system
~~Balance~~ No Load Pt Temp	See Table 18.0.7	Outdoor Ambient Temperature at which residential cooling and heating load profiles equal ~~s are~~ zero BTUH
Max OAT	See Table 18.0.7	Maximum Outdoor Ambient Temperature used in building ASHP load profile; TMY3 basis
Min OAT	See Table 18.0.7	Minimum Outdoor Ambient Temperature for caluclating full load heating; TMY3 Basis.
Des OAT	5	Low Outdoor Ambient Temperature for caluclating heating load Profile. Based on Low Temp Rating from NEEP QPL Data Sheets. Deemed to be 5 F.
HSPF_Adj_Factor	See Table 18.0.1	Adjustment factor for correcting HSPF from published data in climate zone IV to Minnesota Climate zone V. The HSPF_Adjustment_Factor for Electric Resistance Heat will be 1.
~~Balance Pt~~ No Load Point	See Table 18.0.7	BTUH - Heating and cooling loads are zero at the ~~balance~~ No Load point outdoor ambient temperature
m_load_profile	Calculated	load profile slope (m)
b_load_profile	Calculated	load profile y intercept (b)
Full Load Heat	Calculated	Calculated full load heating BTUH based on the calculated load profile using the minimum Outside Air Temperature for the selected ccMSHP equipment. The load served is assumed to not be the whole load for the home.
Full Load Cool	Calculated	Calculated full load cooling BTUH based on the calculated load profile using the maximum Outside Air Temperature for the selected ccMSHP equipment. The load served is assumed to not be the whole load for the home.
Cold Climate Heat Maintenace Ratio	70%	The Max Heating Capacity at 5 ºF must be at least 70% of the Rated Heating Capacity at 47 ºF
Furnace_Fan_kW	0.257	Furnace Fan EC Motor kW demand for baseline energy calculations for ASHP.
~~Furnace Eff~~	~~95%~~	~~Furnace efficiency for backup heating deemed to be condensing type furnace with 95% efficiency~~
Oversize_Factor__c	~~20%~~ 10%	Deemed Oversize Safety Factor for heating equipment.
Cost / kBTUh Heat - Baseline Furnace	$ 59.72	Average High Efficiency Furnace Cost / kBTUH; installed costs
Cost / kBTUh Heat - Baseline Boiler	$ 89.77	Average High Efficiency Boiler Cost / kBTUH; installed costs
Cost / kBTUh Heat - Baseline Electric Resistance	$ 40.00	Average Cost for air handler and electric duct heater / kBTUH; installed costs
Baseline Air Handler	$ 1,200.00	Average Cost for Baseline Air Handler for use with ER Heat or Boiler Heat associated with
Lifetime	See Table 18.0.4	Measure Lifetime for ccMSHPs are the same as for MSHPs found in referenced table.
Minimum Qualifying Efficiency	See Table 18.0.2	
EE-BE Cost Split	~~8.9%~~ 3.7%	The total incremental cost and the rebate for each new heat pump measure will be divided using this split into a Beneficial Electrification (BE) portion for heating and an Energy Efficiency (EE) portion for Cooling.

Customer Inputs	**M&V Verified**	
Size_Cool	Yes	NEEP QPL Data Sheet Rated Cooling Capacity at 95 ºF
Size_Heat_5	Yes	NEEP QPL Data Sheet Max Heating Capacity at 5 ºF
Size_Heat_47	Yes	NEEP QPL Data Sheet Rated Heating Capacity at 47 ºF
~~EER proposed~~	~~Yes~~	~~NEEP QPL Data Sheet rated full load Cooling Efficiency~~
~~SEER proposed~~	~~Yes~~	~~NEEP QPL Data Sheet rated part load Cooling Efficiency~~
~~HSPF Proposed~~	~~Yes~~	~~NEEP QPL Data Sheet rated Heating HSPF~~
EER2 proposed	Yes	AHRI Certification for units manufactured after 1/1/2023
SEER2 proposed	Yes	AHRI Certification for units manufactured after 1/1/2023
HSPF2 Proposed	Yes	AHRI Certification for units manufactured after 1/1/2023
Quantity proposed equipment	Yes	The Quantity of Outdoor Units. Only applies if the Outdoor Unit's Size AND the quantity and size of the Indoor Units served by each outdoor unit are identical.
Quantity Indoor Heads	Yes	The Quantity of Indoor Heads + Coils served by a single Outdoor Unit.
Home Type	Yes	Single Family or Multi-Family home
~~County~~	~~Yes~~	~~Location of the home for determining weather zones.~~
~~Baseline Heat Type~~	~~Yes~~	~~Baseline heating type; gas furnace or electric resistance backup heat~~
Baseline Heat Efficiency	Yes	baseline heating Eff; Condensing, Non-Condensing, Electric Resistance
Backup Heat Efficiency	Yes	backup heating Eff; Condensing, Non-Condensing, Electric Resistance
Operating Cutover Temperature	Yes	Outdoor Ambient Temperature below which heat pump operation ceases and Gas Backup or electric resistance heating begins. If the system is arranged for supplemental heating in place of full backup, this is the temperature where supplemental heating is called.

Table 18.14.1: Baseline and Proposed Capital Costs - Cold Climate Mini-Split Heat Pump (Reference 8)

	Baseline AC cost / ton	**Cost/Efficient Indoor Head or Coil**
~~ccMSHP~~ Ductless Cold Climate Single Head System Costs	$ 2,507.42	$ 6,670.00
~~ccMSHP~~ Ductless Cold Climate Multi-Head System Costs	$ 2,507.42	$ 6,010.00

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

References:

See 18.1 Residential AC references

Changes from Recent Filing:

Modified calculation of Incremental Cost to include the following items in the baseline costs: AC in lieu of MSHP, Baseline HE Furnace or Boiler or ER Heat, and Baseline air moving equipment when the baseline is electric resistance w/ AC or Boiler w/ AC.
Updated Proposed and Baseline Costs
Included Minimum Qualifying levels for SEER2, EER2, and HSPF2 for all AC and Heat Pump equipment based on IECC2021 where applicable. See Deemed Tables tab.

Program	Measure Group	Measure Lifetime (years)	Rebate Amount ($)	Incremental Cost ($)	Annual Customer kWh Savings (kWh/yr)	Annual Customer Peak Coincident Demand Savings (PCkW)	Gas Savings (Dth)	Non-Energy O&M Savings ($)	Electric NTG (%)	Gas NTG (%)	Install Rate (%)	2023 Electric Units	2023 Gas Units
Residential HVAC - CO	Standard Efficiency AC with QI	18	$200	$128	260	0.531	0.0	$0.00	73%	73%	100%	600	0
Residential HVAC - CO	High Efficiency AC with QI	18	$400	$860	481	0.736	0.0	$0.00	73%	73%	100%	334	0
Residential HVAC - CO	Standard Efficiency AC with QI and associated furnace	18	$200	$137	246	0.492	4.8	$0.00	73%	73%	100%	1,600	1,600
Residential HVAC - CO	High Efficiency AC without QI and associated furnace	18	$200	$369	152	0.188	0.0	$0.00	73%	73%	100%	4,600	0
Residential HVAC - CO	Quality Install of High Efficiency AC with associated furnace	18	$200	$150	179	0.371	4.8	$0.00	73%	73%	100%	4,600	4,600
Residential HVAC - CO	BE-High Efficiency Dual Fuel ASHP with QI	18	$678	$2,729	-1,785	0.303	20.0	$0.00	97%	97%	100%	210	210
Residential HVAC - CO	High Efficiency ASHP and Electric Resistance Heat Backup with QI	18	$1,198	$1,948	4,860	0.309	0.0	$0.00	98%	98%	100%	60	0
Residential HVAC - CO	High Efficiency Mini-Split Heat Pump	18	$500	$2,973	4,897	0.249	0.0	$0.00	57%	57%	100%	220	0
Residential HVAC - CO	BE-High Efficiency Dual Fuel Mini-Split Heat Pump	18	$656	$1,798	-844	0.107	8.5	$0.00	69%	69%	100%	934	934
Residential HVAC - CO	BE-High Efficiency Dual Fuel ccASHP with QI	18	$1,028	$4,765	-2,399	0.124	27.3	$0.00	98%	98%	100%	90	90
Residential HVAC - CO	High Efficiency ccASHP with QI with Electric Resistance Backup	18	$1,911	$6,896	9,870	0.276	0.0	$0.00	98%	98%	100%	3	0
Residential HVAC - CO	BE-High Efficiency Dual Fuel Cold Climate Mini-Split Heat Pump	15	$910	$5,784	-1,402	0.022	15.5	$0.00	69%	69%	100%	630	630
Residential HVAC - CO	High Efficiency Cold Climate Mini-Split Heat Pump with Electric Resistance Backup	15	$1,642	$500	5,002	0.070	0.0	$0.00	69%	69%	100%	21	0
Residential HVAC - CO	High Efficiency Boiler	20	$225	$1,331	0	0.000	20.6	$0.00	100%	100%	100%	0	300
Residential HVAC - CO	High Efficiency GSHP with QI	20	$2,500	$22,519	24,929	1.482	0.0	$0.00	100%	100%	100%	3	0
Residential HVAC - CO	BE-High Efficiency GSHP with QI - AC & Gas Baseline	20	$2,125	$11,608	-3,802	0.723	74.6	$0.00	97%	97%	100%	20	20
Residential HVAC - CO	Enhanced Fan Time Delay for Retrofit	1	$0	$0	0	0.000	0.0	$0.00	100%	100%	100%	0	0
Residential HVAC - CO	Standard evaporative cooler	15	$300	-$5,118	768	1.550	0.0	-$14.28	70%	70%	100%	1,134	0
Residential HVAC - CO	Premium evaporative cooler	15	$675	$547	1,165	1.477	0.0	-$19.89	70%	70%	100%	464	0
Residential HVAC - CO	Multi-ducted premium evaporative cooler	15	$1,200	$1,534	890	1.297	0.0	-$18.81	88%	88%	100%	818	0
Residential HVAC - CO	High Efficiency Furnace	18	$225	$1,294	0	0.000	21.3	$0.00	86%	86%	100%	0	5,369
Residential HVAC - CO	AC Rewards-EE	1	$0	$0	0	0.000	0.0	$0.00	100%	100%	100%	0	0
Residential HVAC - CO	Energy Star Smart Thermostat	10	$50	$215	142	0.215	8.1	$0.00	100%	100%	100%	3,395	3,820
Residential HVAC - CO	Smart Thermostat Optimization	1	$0	$0	45	0.054	0.0	$0.00	100%	100%	100%	5,600	5,600
Residential HVAC - CO	Heat Pump Water Heater	12	$643	$3,110	2,725	0.354	0.0	-$8.57	100%	100%	100%	56	0
Residential HVAC - CO	Gas-Fired Storage Water Heater	13	$50	$354	0	0.000	2.3	$0.00	100%	90%	100%	0	170
Residential HVAC - CO	Tankless Water Heater	20	$100	$1,049	0	0.000	7.6	$0.00	100%	90%	100%	0	670
Residential HVAC - CO	BE-Heat Pump Water Heater - Gas WH Baseline	12	$606	$3,033	-944	0.000	16.0	$0.00	100%	100%	100%	31	31
Residential HVAC - CO	Indirect Water Heater	13	$100	$576	0	0.000	5.2	$0.00	100%	100%	100%	0	15
Residential HVAC - CO	BE-High Efficiency Mini-Split Heat Pump - Full Electrification	18	$270	$1,798	-3,462	0.006	32.4	$0.00	93%	93%	100%	50	25
Residential HVAC - CO	BE-High Efficiency ccASHP with QI - Full Electrification	18	$884	$7,648	-3,364	0.021	33.9	$0.00	93%	93%	100%	50	25
Residential HVAC - CO	BE-High Efficiency Cold Climate Mini-Split Heat Pump - Full Electrification	15	$529	$2,949	-2,399	0.105	18.5	$0.00	93%	93%	100%	270	135
Residential HVAC - CO	High Efficiency GSHP with QI - ER Baseline	20	$5,500	$22,519	25,055	1.410	0.0	$0.00	93%	93%	100%	3	0
Residential HVAC - CO	BE-High Efficiency ASHP with QI Full Electrification	18	$399	$5,371	-9,207	0.281	56.8	$0.00	93%	93%	100%	50	25

Program	Measure Group	Measure Lifetime (years)	Rebate Amount ($)	Incremental Cost ($)	Annual Customer kWh Savings (kWh/yr)	Annual Customer Peak Coincident Demand Savings (PCkW)	Gas Savings (Dth)	Non-Energy O&M Savings ($)	Electric NTG (%)	Gas NTG (%)	Install Rate (%)	2023 Electric Units	2023 Gas Units
Whole Home Efficiency - CO	ENERGY STAR Clothes Dryer	16	$30	$75	160	0.022	0.0	$0.00	79%	79%	100%	75	0
Whole Home Efficiency - CO	ENERGY STAR Clothes Washer	11	$30	$121	78	0.011	2.8	$12.57	91%	91%	100%	85	100
Whole Home Efficiency - CO	Attic Insulation - Electric Heating and Cooling	20	$346	$2,500	706	0.157	0.0	$0.00	79%	79%	100%	12	0
Whole Home Efficiency - CO	Attic Insulation - Electric Heating Only	20	$322	$1,514	2,083	0.000	0.0	$0.00	79%	79%	100%	12	0
Whole Home Efficiency - CO	Attic Insulation - Gas Heating / Electric Cooling	20	$386	$1,626	106	0.180	9.8	$0.00	90%	99%	100%	82	75
Whole Home Efficiency - CO	Attic Insulation - Gas Heating Only	20	$410	$1,796	0	0.000	11.6	$0.00	100%	79%	100%	0	19
Whole Home Efficiency - CO	Wall Insulation - Electric Heating and Cooling	20	$308	$2,570	3,593	0.595	0.0	$0.00	79%	79%	100%	6	0
Whole Home Efficiency - CO	Wall Insulation - Electric Heating Only	20	$350	$3,541	5,637	0.000	0.0	$0.00	79%	79%	100%	6	0
Whole Home Efficiency - CO	Wall Insulation - Gas Heating / Electric Cooling	20	$112	$2,696	285	0.483	26.4	$0.00	88%	79%	100%	54	60
Whole Home Efficiency - CO	Wall Insulation - Gas Heating Only	20	$310	$1,897	0	0.000	31.1	$0.00	100%	79%	100%	0	8
Whole Home Efficiency - CO	Air Sealing - Electric Heating and Cooling	10	$200	$1,137	2,619	0.191	0.0	$0.00	79%	79%	100%	24	0
Whole Home Efficiency - CO	Air Sealing - Electric Heating Only	10	$190	$1,708	3,405	0.000	0.0	$0.00	79%	79%	100%	39	0
Whole Home Efficiency - CO	Air Sealing - Gas Heating / Electric Cooling	10	$142	$934	113	0.191	15.1	$0.00	107%	107%	100%	69	69
Whole Home Efficiency - CO	Air Sealing - Gas Heating Only	10	$184	$816	0	0.000	13.6	$0.00	100%	79%	100%	0	29
Whole Home Efficiency - CO	High Efficiency Furnace	18	$225	$1,294	0	0.000	21.3	$0.00	100%	79%	100%	0	40
Whole Home Efficiency - CO	Standard Efficiency AC with QI	18	$200	$128	260	0.531	0.0	$0.00	79%	79%	100%	30	0
Whole Home Efficiency - CO	High Efficiency AC with QI	18	$400	$877	470	0.694	0.0	$0.00	79%	79%	100%	80	0
Whole Home Efficiency - CO	Standard Efficiency AC with QI and associated furnace	18	$200	$137	247	0.492	4.8	$0.00	79%	79%	100%	15	15
Whole Home Efficiency - CO	High Efficiency AC without QI and associated furnace	18	$200	$369	152	0.188	0.0	$0.00	79%	79%	100%	2	0
Whole Home Efficiency - CO	Quality Install of High Efficiency AC with associated furnace	18	$200	$150	179	0.371	4.8	$0.00	79%	79%	100%	20	20
Whole Home Efficiency - CO	BE-High Efficiency Dual Fuel ASHP with QI	18	$850	$704	-1,674	0.330	19.4	$0.00	100%	100%	100%	40	40
Whole Home Efficiency - CO	High Efficiency ASHP and Electric Resistance Heat Backup with QI	18	$1,198	$1,948	4,826	0.309	0.0	$0.00	79%	79%	100%	3	0
Whole Home Efficiency - CO	High Efficiency Mini-Split Heat Pump	18	$500	$2,973	4,897	0.249	0.0	$0.00	79%	79%	100%	1	0
Whole Home Efficiency - CO	BE-High Efficiency Dual Fuel Mini-Split Heat Pump	18	$676	$1,798	-1,197	0.108	12.5	$0.00	100%	100%	100%	20	20
Whole Home Efficiency - CO	BE-High Efficiency Dual Fuel ccASHP with QI	18	$1,028	$4,765	-2,399	0.124	27.3	$0.00	100%	100%	100%	6	6
Whole Home Efficiency - CO	High Efficiency ccASHP with QI with Electric Resistance Backup	18	$1,911	$6,895	9,871	0.276	0.0	$0.00	79%	79%	100%	3	0
Whole Home Efficiency - CO	BE-High Efficiency Dual Fuel Cold Climate Mini-Split Heat Pump	15	$910	$5,784	-1,402	0.022	15.5	$0.00	100%	100%	100%	6	6
Whole Home Efficiency - CO	High Efficiency Cold Climate Mini-Split Heat Pump with Electric Resistance Backup	15	$1,642	$11,259	5,002	0.070	0.0	$0.00	79%	79%	100%	3	0
Whole Home Efficiency - CO	High Efficiency GSHP with QI	20	$2,500	$22,519	24,929	1.482	0.0	$0.00	79%	79%	100%	1	0
Whole Home Efficiency - CO	BE-High Efficiency GSHP with QI - AC & Gas Baseline	20	$2,125	$11,608	-3,802	0.723	74.6	$0.00	100%	100%	100%	4	4
Whole Home Efficiency - CO	Premium evaporative cooler	15	$675	$782	1,049	1.408	0.0	-$17.91	79%	79%	100%	17	0
Whole Home Efficiency - CO	Energy Star Smart Thermostat	10	$50	$215	142	0.215	5.4	$0.00	90%	90%	100%	105	80
Whole Home Efficiency - CO	Smart Thermostat Optimization	1	$0	$0	45	0.054	0.0	$0.00	79%	79%	100%	12	12
Whole Home Efficiency - CO	Heat Pump Water Heater	12	$705	$3,110	2,687	0.354	0.0	-$11.38	79%	79%	100%	44	0
Whole Home Efficiency - CO	Tankless Water Heater	20	$100	$960	0	0.000	7.4	$0.00	100%	79%	100%	0	175
Whole Home Efficiency - CO	BE-Heat Pump Water Heater - Gas WH Baseline	12	$800	$3,033	-931	0.000	16.0	$0.00	100%	100%	100%	15	15
Whole Home Efficiency - CO	High Efficiency GSHP with QI - ER Baseline	20	$5,500	$22,519	25,055	1.410	0.0	$0.00	79%	79%	100%	1	0

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Income Qualified SF Weatherization - CO	Refrigerator Replacement	14	$900	$900	422	0.031	0.0	$0.00	100%	100%	100%	500	0
Income Qualified SF Weatherization - CO	Attic Insulation - Electric Heating Only	20	$2,005	$2,005	2,413	0.000	0.0	$0.00	100%	100%	100%	15	0
Income Qualified SF Weatherization - CO	Attic Insulation - Gas Heating Only	20	$1,680	$1,681	0	0.000	11.6	$0.00	100%	100%	100%	0	650
Income Qualified SF Weatherization - CO	Wall Insulation - Electric Heating Only	20	$1,873	$1,873	5,346	0.000	0.0	$0.00	100%	100%	100%	3	0
Income Qualified SF Weatherization - CO	Wall Insulation - Gas Heating Only	20	$1,241	$1,092	0	0.000	19.7	$0.00	100%	100%	100%	0	190
Income Qualified SF Weatherization - CO	Crawl Space Wall Insulation - Electric Heating Only	20	$1,875	$1,875	7,306	0.000	0.0	$0.00	100%	100%	100%	5	0
Income Qualified SF Weatherization - CO	Crawl Space Wall Insulation - Gas Heating Only	20	$1,205	$1,103	0	0.000	12.6	$0.00	100%	100%	100%	0	250
Income Qualified SF Weatherization - CO	Air Sealing - Electric Heating Only	10	$908	$938	1,533	0.000	0.0	$0.00	100%	100%	100%	20	0
Income Qualified SF Weatherization - CO	Air Sealing - Gas Heating Only	10	$472	$480	0	0.000	8.8	$0.00	100%	100%	100%	0	850
Income Qualified SF Weatherization - CO	Storm Windows - Electric Heating Only	20	$451	$451	853	0.000	0.0	$0.00	100%	100%	100%	5	0
Income Qualified SF Weatherization - CO	Storm Windows - Gas Heating Only	20	$809	$821	0	0.000	5.7	$0.00	100%	100%	100%	0	200
Income Qualified SF Weatherization - CO	Home Lighting - Direct Install	17	$1	$1	34	0.004	0.0	$0.00	100%	100%	99%	642,250	0
Income Qualified SF Weatherization - CO	High Efficiency Mini-Split Heat Pump	17	$7,750	$2,973	4,897	0.249	0.0	$0.00	100%	100%	100%	2	0
Income Qualified SF Weatherization - CO	BE-High Efficiency Dual Fuel Mini-Split Heat Pump	18	$4,250	$1,798	-1,221	0.107	12.6	$0.00	100%	100%	100%	12	12
Income Qualified SF Weatherization - CO	High Efficiency Furnace Tier 1	18	$1,000	$1,294	0	0.000	14.6	$0.00	100%	100%	100%	0	375
Income Qualified SF Weatherization - CO	High Efficiency Furnace Tier 2	18	$3,760	$1,294	0	0.000	14.6	$0.00	100%	100%	100%	0	90
Income Qualified SF Weatherization - CO	High Efficiency Boiler Tier 1	20	$1,000	$1,446	0	0.000	10.1	$0.00	100%	100%	100%	0	15
Income Qualified SF Weatherization - CO	High Efficiency Boiler Tier 2	20	$4,000	$1,446	0	0.000	10.1	$0.00	100%	100%	100%	0	5
Income Qualified SF Weatherization - CO	IQ-SFW Boiler/Furnace Tune-up	2	$319	$250	0	0.000	5.2	$0.00	100%	100%	100%	0	105
Income Qualified SF Weatherization - CO	Energy Star Smart Thermostat	10	$150	$100	0	0.000	6.5	$0.00	100%	100%	100%	0	250
Income Qualified SF Weatherization - CO	T-Stat Install & Programming	10	$100	$29	0	0.000	11.6	$0.00	100%	100%	100%	0	600
Income Qualified SF Weatherization - CO	BE-High Efficiency Dual Fuel ASHP with QI	18	$4,250	$2,429	-1,769	0.282	19.9	$0.00	100%	100%	100%	12	12
Income Qualified SF Weatherization - CO	High Efficiency ASHP and Electric Resistance Heat Backup with QI	18	$7,750	$1,948	5,186	0.295	0.0	$0.00	100%	100%	100%	6	0
Income Qualified SF Weatherization - CO	Standard evaporative cooler	15	$1,200	-$5,119	685	1.551	0.0	-$12.64	100%	100%	100%	71	0
Income Qualified SF Weatherization - CO	High Efficiency Cold Climate Mini-Split Heat Pump with Electric Resistance Backup	15	$9,250	$11,259	4,903	0.070	0.0	$0.00	100%	100%	100%	6	0
Income Qualified SF Weatherization - CO	BE-High Efficiency Dual Fuel Cold Climate Mini-Split Heat Pump	15	$5,500	$2,980	-1,402	0.022	15.5	$0.00	100%	100%	100%	24	24
Income Qualified SF Weatherization - CO	High Efficiency ccASHP with QI with Electric Resistance Backup	18	$10,429	$6,386	9,558	0.283	0.0	$0.00	100%	100%	100%	7	0
Income Qualified SF Weatherization - CO	BE-High Efficiency Dual Fuel ccASHP with QI	18	$5,500	$4,536	-2,267	0.118	26.0	$0.00	100%	100%	100%	24	24
Income Qualified SF Weatherization - CO	Single-Family Audit	1	$200	$200	0	0.000	0.0	$0.00	100%	100%	100%	400	400
Income Qualified SF Weatherization - CO	Aerators - EWH	10	$5	$1	60	0.008	0.0	$4.04	100%	100%	100%	50	0
Income Qualified SF Weatherization - CO	Aerators - GWH	10	$4	$1	0	0.000	0.3	$4.12	100%	100%	100%	0	603
Income Qualified SF Weatherization - CO	Showerheads - EWH	10	$10	$3	476	0.035	0.0	$33.50	100%	100%	100%	20	0
Income Qualified SF Weatherization - CO	Showerheads - GWH	10	$10	$3	0	0.000	2.0	$33.50	100%	100%	100%	0	3,189
Income Qualified SF Weatherization - CO	Water Heater Blanket Gas	8	$75	$75	0	0.000	1.0	$0.00	100%	100%	100%	0	400
Income Qualified SF Weatherization - CO	Water Heater Blanket Electric	8	$75	$75	226	0.026	0.0	$0.00	100%	100%	100%	1	0
Income Qualified SF Weatherization - CO	Gas-Fired Storage Water Heater	13	$970	$374	0	0.000	2.5	$0.00	100%	100%	100%	0	150
Income Qualified SF Weatherization - CO	Heat Pump Water Heater	12	$2,450	$3,110	2,641	0.350	0.0	-$8.94	100%	100%	100%	14	0
Income Qualified SF Weatherization - CO	BE-Heat Pump Water Heater - Gas WH Baseline	12	$4,057	$3,033	-958	0.000	16.0	$0.00	100%	100%	100%	7	7
Income Qualified SF Weatherization - CO	Tankless Water Heater	20	$1,104	$1,100	0	0.000	6.1	$0.00	100%	100%	100%	0	100

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Income Qualified MF Weatherization - CO	IQMF Project	19	$23,397	$29,597	24,954	3.016	180.4	$301.49	100%	100%	100%	40	41
Income Qualified MF Weatherization - CO	BE-Custom Beneficial Electrification Project	15	$5,548	$5,548	-844	0.141	10.2	$0.00	100%	100%	100%	115	115

Program	Measure Group	Measure Lifetime (years)	Rebate Amount ($)	Incremental Cost ($)	Annual Customer kWh Savings (kWh/yr)	Annual Customer Peak Coincident Demand Savings (PCkW)	Gas Savings (Dth)	Non-Energy O&M Savings ($)	Electric NTG (%)	Gas NTG (%)	Install Rate (%)	2023 Electric Units	2023 Gas Units
Whole Home Efficiency - CO	NEEP Project	18	$15,985	$20,146	16,976	3.724	81.3	$174.79	100%	100%	100%	37	53
Whole Home Efficiency - CO	BE-Custom Beneficial Electrification Project	14	$6,276	$6,276	-816	0.115	10.8	$0.00	100%	100%	100%	33	33