Posting Date: September 3, 2021

➢ **Summary of 60-Day Notice:** Residential Heating & Cooling

The following 60-Day Notice summarizes Public Service Company of Colorado's (the "Company") action to update the technical assumptions and deemed savings in the Residential Heating and Cooling product, as well as, clarifying customer eligibility requirements.

The Company is including with this Notice:

- Redlined product write-up;
- Redlined Deemed Savings worksheets;
- Redlined Technical Assumptions worksheets; and
- Updated cost-benefit analyses.

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

The Company is adding a measure for natural gas boilers to increase rebate eligibility in targeted areas throughout the state and is adding an additional climate zone for deemed savings calculations in the product to more accurately calculate savings achieved in high-altitude regions. The Company is also clarifying eligibility requirements for heat pump and boiler rebates.

Natural gas boiler savings

Natural gas boilers are used in many Colorado homes for space heating. The Company included this measure in previous plans but discontinued it due to cost-effectiveness challenges. In recent years, the Company has had a renewed focus on reducing peak gas demand in certain areas to reduce constraints on the local distribution system. Some areas with such constraints have a greater prevalence of boilers than is standard for the state. High efficiency boiler rebates could be an effective strategy to address this problem.

The Company will calculate energy savings based on the difference in energy usage between the installed equipment and a baseline natural gas boiler with an Annual Fuel Utilization Efficiency ("AFUE") of 84%. The additional energy savings for the sidearm water heater are based on the difference in energy usage between the boiler and a baseline natural gas water heater.

Climate Zone IV

The Company added a fourth climate zone with associated full load cooling and heating hours to represent very high-altitude areas such as Summit County. This affects the deemed savings calculations for a variety of heating and cooling measures, including natural gas furnaces, boilers, air conditioners and heat pumps, and evaporative coolers, to more accurately forecast the savings achieved in such regions. This update does not impact the filed forecast.

Eligibility Requirements

The modification clarifies that customers who are replacing or offsetting the use of natural gas heating or water heating equipment with an electric heat pump or heat pump water heater, the customer must have residential electric and natural gas service with Xcel Energy. Additionally, an

AHRI certification is required in order to be eligible for a 90% AFUE natural gas boiler rebate. This update does not impact the filed forecast.

Table 1: Summary of Forecasted Impacts: Residential Heating & Cooling

	2021		2022	
	As Filed	*Revised per 60-day*	*As Filed*	*Revised per 60-day*
Electric Savings (kWh)	14,057,658	14,057,658	15,030,064	15,030,064
Electric Demand Reduction (kW)	11,353	11,353	11,614	11,614
Budget*	$6,162,376	$6,162,376	$6,294,442	$6,294,442
MTRC Test Ratio	1.99	1.98	2.04	2.03
Gas Savings (Dth)	177,967	180,466	170,237	172,736
Budget*	$1,957,136	$1,989,136	$1,838,670	$1,870,670
MTRC Test Ratio	0.97	0.96	1.01	0.99

*Rebates only. While the anticipated expenditure impacts are forecasted, the Company acknowledges that this Notice does not change the filed budget.

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, 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. 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 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.

As part of our strategy to increase participation in demand response products, this product will be offering AC Rewards. Further details are provided in the technical assumptions.

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

- **Standard AC or ASHP systems with Quality Installation ("QI")** - 13 to 14.99 Seasonal Energy Efficiency Ratio ("SEER") – Defined as new central Air Conditioning ("AC") or Air Source Heat Pump ("ASHP") 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 systems with Quality Installation** – Defined as new central Air Conditioning and 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 is to encourage consumers to purchase units that meet or exceed the ENERGY STAR® high efficiency standard of at least 15 SEER and 12.5 Energy Efficiency Ratio ("EER"). 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 an 18 SEER, 10.5 HSPF, and the heating BTU at 5 degrees Fahrenheit must be at least 70% of the heating BTU at 47 degrees Fahrenheit.

- **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 Heat Pumps ("MSHP")** – The mini-split heat pump equipment serves residential customers who either cannot install traditional split, central air conditioning 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 SEER, 11 EER, and 9 Heating Seasonal Performance Factor ("HSPF"). 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 certification is not a requirement. Any trade partner can offer this rebate. To be eligible for a cold climate heat pump rebate, units must have an 18 SEER, 10.5 HSPF, and the heating BTU at 5 degrees Fahrenheit must be at least 70% of the heating BTU at 47 degrees Fahrenheit.

- **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 GSHP performance criteria are a minimum of 3.3 Coefficient of Performance ("COP") and 14.1 EER. Equipment must be 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 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.

- **Natural Gas Boilers –** Boiler rebates are offered for a minimum boiler efficiency of 90% 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.

- **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 high draw standard tanks, 0.87 UEF 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 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.

- **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; NATE certification is not a requirement. 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 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" 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.

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 replacing electric resistance heat, Electric Heat Pump Water Heaters replacing electric resistance water heater, Evaporative Coolers, MSHP replacing electric resistance heat, GSHP replacing electric resistance heat, 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 participants who are replacing or offsetting the use of natural gas heating or water heating equipment with an electric heat pump or 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; for gas-only customers, participants must have central gas heating. Customers with electric and gas service must have central air conditioning and/or central gas heating.

Additional qualifications for particular types of equipment are as follows:

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

- The customer must use a registered contractor with a NATE-certified technician 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 technician's NATE certification can be used by one contractor company only, for the purpose of qualifying the company to offer these rebates. If the technician's NATE certification is in ASHP, the technician's company meets the AC NATE certification requirement automatically.
- 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 SEER rating above the nominal rating is allowed for determining rebate eligibility, provided that the overall furnace and air conditioning 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.

To be eligible for a 90% AFUE natural gas boiler rebate, an AHRI certificate must be available.

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, local municipalities within the service area, and other environmental organizations. Stakeholders are able to 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 SEER, EER, HSPF, 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 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., ~~Home Performance with ENERGY STAR®~~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.

18.5 Residential Furnaces & Boilers

Algorithms

$$Customer\ DTh = Qty\_Prop\_Equip * \left(\left(Size_{Heat} \times \frac{EFF_{proposed}}{EFF_{baseline}}\right) - Size_{Heat}\right) \times 1/(1 + Oversize\ Factor) \times (1 - Altitude\ Factor) \times \frac{EFLH_{heating}}{1{,}000{,}000}$$

Variables

EFLH Heating	See Table 18.0.1	Equivalent Full Load Heating Hours assumed for installed high efficiency furnace and boiler equipment
Incremental Cost	See Table 18.5.1	Incremental costs of efficient equipment
Baseline Efficiency	See Table 18.5.2	Efficiency of baseline code minimum boiler (Reference 10) or furnace (Reference 1) Efficiency of Existing Equipment receiving Tune-up.
Proposed Efficiency	See Table 18.5.2	Proposed Efficiency of existing equipment after Tune-up.
Altitude_Factor	See Table 18.0.1	Deemed Altitude adjustment factor for derating sea level rated equipment (4% / 1000 Feet above sea level)
Boiler Oversize Factor	25%	Deemed Oversize Safety Factor for all new boiler heating equipment and all Income Qualified Single Family Weatherization Boiler Tune-up products
Furnace Oversize Factor	20%	Deemed Oversize Safety Factor for all new furnace heating equipment and all Income Qualified Single Family Weatherization Furnace Tune-up products
Lifetime	See Table 18.5.1	
Conversion from Btu to Dth	1,000,000	1 Dth = 1,000,000 Btuh
Conversion from Btu to Therms	100,000	1 Therm = 100,000 Btuh

Customer Inputs	**M&V Verified**	
Qty Prop Equip	Yes	Quantity of units of the same size
$Size\_Heat$	Yes	For new furnace or boiler AHRI rated Input BTUH. Provide data on customer rebate form. For Tune-up Measure on existing furnace or boiler Nameplate Input BTUH rating for existing equipment getting the tune-up measure. Provided data on customer rebate form.
Proposed Efficiency	Yes	AHRI rated efficiency of the proposed new equipment.
County	Yes	County where the new equipment is installed or Tune-up is being performed.

Table 18.5.1	**Measure Life (Reference 2)**	**Incremental Cost (Reference 4 for Furnaces, IQ Boilers and Tune-ups) (Reference 7 for all other High Efficiency Boilers)**
High Efficiency Furnace	18	$1,138.00
IQ-SFW Boiler	20	$1,446.00
IQ-SFW Boiler/Furnace Tune-up	2	$250.00
High Efficiency Boiler 90%	20	$817.48
High Efficiency Boiler 95%	20	$1,330.61

Table 18.5.2	Baseline EFF	Proposed EFF	Lifetime
High Efficiency Furnace	80%	Customer Input	18
High Efficiency Boiler	84%	Customer Input	20
IQ SFW - Furnace Tune-up	75%	80%	2
IQ SFW - Boiler Tune-up	75%	80%	2

References:

1. US Department of Energy; Residential Furnaces and Boilers; http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/72
2. 2015 ASHRAE Handbook - HVAC Applications; Comparison of Service Life Estimates; Page 37.3, Table 4
3. ECM Furnace Impact Assessment Report https://focusonenergy.com/sites/default/files/emcfurnaceimpactassessment_evaluationreport.pdf
4. Xcel program data from 2017 program year
5. Cost information from "2010 - 2012 W0017 Ex Ante Measure Cost Study Final Report.", Itron, May 2014.
6. DOE incremental cost for EC motors https://www.regulations.gov/document?D=EERE-2010-BT-STD-0011-0117
7. Xcel Minnesota Program Cost Data

Changes from Recent Filing:

1. Updated format of the deemed sheet to be able to reference the variables in the rest of the document
2. Changed Reference 2 to be IECC 2015 because ASHRAE 2015 does not exist
3. Updated costs for EC motors
4. Updated Program data to include the furnaces rebated in 2017
5. Split climate zone 3 into two climate zones to better represent the very high altitude mountain communities
6. added high efficinecy boilers.

18.13 Residential Cold Climate Air Source Heat Pumps

Algorithms

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

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

ASHP Baseline Cooling Only:

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

Electric Resistance Heat Baseline:

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

Dual Fuel Gas Heat Baseline

Customer kWh Savings = Customer $kWh_{EqCooling}$ *+ Customer* $kWh_{QICooling}$ *+ Customer kWh_Heating Penalty*

Customer Dtherm Savings = Customer DTherms_EQ Heating + Customer DTherm_QI Heating

$$EER_{baseline} = iCoef0 * (SEER^2_{baaseline}) + iCoef1 * SEER_{baseline}$$

$$Customer\ kW_{EqCooling} = Qty_{prop} \times \frac{\frac{Full\ Load\ Cool}{12{,}000}}{(1 - Sizing\ Loss)} \times \left(\left(\frac{12}{EER_{baseline}}\right) - \left(\frac{12}{EER_{proposed}}\right)\right)$$

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

$$Customer\ kWh_{EqCooling} = Qty_{Prop} * \frac{\left(\frac{Full\ Load\ Cool}{12{,}000}\right)}{1 - Sizing\ Loss} * EFLH_{cooling} * ((\frac{12}{SEER_{baseline}}) - \left(\frac{12}{SEER_{proposed}}\right))$$

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

$$Customer\ Coincident\ kW_{equipment} = Qty_{Prop} * Coincidence\ Factor * \frac{Full\ Load\ Cool}{12{,}000} * \frac{1}{1 - Sizing\ Loss} * ((\left(\frac{12}{EER_{baseline}}\right) - \left(\frac{12}{EER_{Proposed}}\right))$$

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

$$Incremental\ Capital\ Cost_{Equipment} = ASHP\ Cost\ per\ Ton_{EQ} * \frac{\sout{Size\_Heat_5}Size\_Heat\_47}{12{,}000} - \text{Cost Per Ton Baseline} * \frac{Size\_Cool}{12{,}000}$$

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

$$Incremental\ Capital\ Cost_{QI}\ E\ Home = MAX(75, Inc\ Cost_{QI} - \frac{\sout{Size\_Heat_5}Size\_Heat\_47}{12{,}000} * (\left(\frac{1}{1 - Sizing\ Loss}\right) - 1) * Cost\ per\ Ton_{baseline}))$$

ccASHP Heating Energy Savings

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

m_load_profile = (balance pt load - Load_Heat) / (balance 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_Heating_HP * (1 / (HSPF_Baseline * HSPF_Adj_Factor) - 1 / (HSPF_Proposed * HSPF_Adj_Factor)) / 1000*

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*

Dual Fuel Gas Heat Baseline

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

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

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

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.
SEER baseline	See Table 18.0.3	IECC 2012 identified code minimum SEER
Sizing Loss	See Table 18.0.4	
$Loss\_NoQI$	See Table 18.0.4	
$Loss\_Uncorr$	See Table 18.0.4	
$Inc\ Cost\_QI$	See Table 18.0.4	
Coincidence Factor_EQ	See Table 18.0.3	
Coincidence Factor_QI	See Table 18.0.3	
$iCoef0$	-0.02	coefficient used in polynomial conversion for AC or ASHP EER derived from known SEER.
$iCoef1$	1.12	coefficient used in polynomial conversion for AC or ASHP EER derived from known SEER.
Oversize_Factor__c	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_ccHP_Heat	See Table 18.0.1	Effective Full Load Hours for Cold Climate Heat Pump at and above cutoff temperature
Balance Pt Temp	See Table 18.0.6	Outdoor Ambient Temperature at which residential cooling and heating loads are zero BTUH
Max_OAT	See Table 18.0.6	Maximum Outdoor Ambient Temperature used in building load profile
Min_OAT	See Table 18.0.6	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 Load	See Table 18.0.6	Heating and cooling loads are zero at the balance point outdoor ambient temperature
Furnace_Fan_kW	0.357	Furnace Fan EC Motor kW demand for baseline energy calculations for ASHP.
ASHP operating temperature cutoff	5	Outdoor Ambient Temperature below which heat pump operation ceases and gas furnace or electric resistance backup heating begins.
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.
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.
NTG	100.0%	Net-to-gross for ccASHP units
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	

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
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
Home Category	Yes	New Home or Existing Home

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

SEER	ASHP Cost per Ton	ccASHP Incremental Cost per Ton (compared to Res AC at 14 SEER)	Baseline Cost per Ton (Res AC)
13 SEER	N/A	N/A	N/A
14/14.5 SEER	$ 777.64	N/A	$ 514.98
15 SEER	$ 960.40	$ 445.42	N/A
16 SEER	$ 1,143.16	$ 628.18	N/A
17/18+ SEER	$ 1,325.93	$ 810.95	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.

Changes from Recent Filing:

added dual fuel heating baseline
modified heating savings methodology to incorporate cut-off temperature for both dual fuel and electric resistance baselines
incorporated HSPF addjustments based on AHRI climate zones

18.14 Cold Climate Mini-Split Heat Pumps

Algorithms

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

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

Electric Resistance Heat Baseline:

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

Dual Fuel Gas Heat Baseline:

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

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

$$EER_{baseline} = (\ iCoef0\_c * (SEER\_Base / \frac{Size_{Cool}}{12{,}000})\ \hat{}3 + iCoef1\_c * (SEER\_Base / \frac{Size_{Cool}}{12{,}000})\ \hat{}2 + iCoef2\_c * (SEER\_Base / \frac{Size_{Cool}}{12{,}000}) + iCoef3\_c\ ) * (\frac{Size_{Cool}}{12{,}000})$$

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

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

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

$$Incremental\ Capital\ Cost_{Equipment} = Qty_{Prop} * Inc\ Cost\ per\ Ton_{EQ} * \frac{\sout{Size_{Cool}}Size\_Heat\_47}{12{,}000}$$

cc$MSHP\ Heating\ Energy\ Savings$

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

m_load_profile = (balance pt load - Load_Heat) / (balance 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*

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

$Customer\ DTherms\_EQ\ Saved = (-1 * Full\_Load\_Heat * EFLH\_ccHP\_Heat) / Furnace\_Eff / 1{,}000{,}000$

$Customer\ \ kWh\_Heating\ Penalty = - 1 * Full\_Load\_Heat * EFLH\_ccHP\_Heat * (0 - (1 / (HPSF\_Proposed * HSPF\_Adj\_Factor))) / 1000$

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 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.
Coincidence Factor	See Table 18.0.3	
iCoef0	See Table 18.4.1	MSHP SEER to EER Conversion Coefficient
iCoef1	See Table 18.4.1	MSHP SEER to EER Conversion Coefficient
iCoef2	See Table 18.4.1	MSHP SEER to EER Conversion Coefficient
iCoef3	See Table 18.4.1	MSHP SEER to EER 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
EFLH_ccHP_Heat	See Table 18.0.1a	Effective Full Load Hours for Cold Climate Heat Pump impacted energy savings
ASHP / MSHP operating temperature cutoff	5	Outdoor Ambient Temperature below which heat pump operation ceases and electric resistance heating begins
Balance Pt Temp	See Table 18.0.6	Outdoor Ambient Temperature at which residential cooling and heating load profiles equal zero BTUH
Max OAT	See Table 18.0.6	Maximum Outdoor Ambient Temperature used in building ASHP load profile; TMY3 basis
Min OAT	See Table 18.0.6	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 Point Load	See Table 18.0.6	BTUH - Heating and cooling loads are zero at the balance point outdoor ambient
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.
Furnace Eff	95%	Furnace efficiency for backup heating deemed to be condensing type furnace with 95% efficiency
Oversize_Factor__c	20%	Deemed Oversize Safety Factor for heating equipment.
Lifetime	See Table 18.0.3	Measure Lifetime for ccMSHPs are the same as for MSHPs found in referenced table.
Minimum Qualifying Efficiency	See Table 18.0.2	

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
Quantity proposed equipment	Yes	
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

Table 18.14.1: SEER Conversion Coefficients

Equipment type	Coef0	Coef1	Coef2	Coef3	Notes
MSHP - SEER to EER	-0.0002600	0.0101270	0.5263880	-0.0233300	Xcel Derivation

Table 18.14.2 Incremental Capital Costs - Cold Climate Mini-Split Heat Pump (Reference 8)

Mini-Split Heat Pump	Baseline Cost per ton Heating	Incremental cost per ton ~~Cooling~~ Heating
ccMSHP (18+ SEER, 11+ EER, 10.5 HSPF)	$ 3,266.64	$ 555.94

References:

See 18.1 Residential AC references

Changes from Recent Filing:

added dual fuel heating baseline
modified heating savings methodology to incorporate cut-off temperature for both dual fuel and electric resistance baselines
incorporated HSPF addjustments based on AHRI climate zones

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 Factor
Zone 1 - CO Front Range *	590	699	1,825	1,409	1,409	1,088	0.177 ~~0.212~~	100%
Zone 2 - CO Western Slope **	837	992	1,971 ~~1,739~~	1,522 ~~1,343~~	1,495 ~~668~~	1,154 ~~516~~	0.163 ~~0.194~~	100%
Zone 3 - CO Mountain Areas ***	210	249	2,104	1,625	920	710	0.244 ~~0.301~~	85%
Zone 4 - CO Very High Altitude Areas *****	0	0	2,739	2,115	1,360	1,050	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~~ 25 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	EFLH_ccHP_Heat (Cold Climate Heat Pump Impacted heating hours) *****	
	Single Family	Multi-Family
Zone 1 - CO Front Range	1,809	1,397
Zone 2 - CO Western Slope	1,971	1,522
Zone 3 - CO Mountain Areas	1,748	1,349
Zone 4 - CO Very High Altitude Areas	2,521	1,946

**** the cold climate heat pump impacted hours are determined at a cutoff temperature of 5 F.

Table 18.0.2: Minimum Qualifying Efficiency	Code Minimum						
Measure	SEER	EER	HSPF	Heating COP	Minimum Qualifying SEER	Minimum Qualifying EER	Minimum qualifying HSPF / Full Load COP
High Efficiency Air Conditioner - Split System	13.00	11.18	N/A	N/A	15.00		N/A
High Efficiency Air Conditioner - Packaged System	14.00	11.76	N/A	N/A	15.00		N/A
Air Source Heat Pump - Split System	14.00	11.76	8.20	N/A	15.00		9.00
Air Source Heat Pump - Packaged System	14.00	11.76	8.00	N/A	15.00		9.00
Mini-Split & Multi-Split Heat Pumps	14.00	11.76	8.20	N/A	16.00		9.00
Cold Climate Air Source Heat Pumps	14.00	11.76	8.00	N/A	18.00		10.50
Cold Climate Mini-Split & Multi-Split Heat Pumps	14.00	11.76	8.20	N/A	18.00		10.50
Gorund Source Heat Pump **	14.10	14.10	N/A	3.20	~~16.00~~	16.00	3.30 ~~4.00~~

** Ground Loop Brine to Air with entering temperatures of 77 F cooling mode and 32 F heating mode

Table 18.0.3: Coincidence Factors, Baseline Efficiencies and Lifetimes

Equipment Type	Deemed Equipment Coincidence Factor	Deemed QI Coincidence Factor	SEER Baseline	EER Baseline	HSPF Baseline	Baseline Heating COP (Gas Fired)	Lifetime	Notes
High Efficiency Air Conditioner - Split System *	90%	100%	13.00	11.18	N/A	N/A	18	(Reference 17)
Air Source Heat Pump - Split System	90%	100%	14.00	11.76	8.20	0.80	18	(Reference 17)
Mini-Split & Multi-Split Heat Pumps	90%	N/A	14.00	Varies	8.20	0.80	15	
Cold Climate Air Source Heat Pump - Split System	90%	100%	14.00	11.76	8.20	0.80	18	(Reference 17)
Cold Climate Mini-Split & Multi-Split Heat Pumps	90%	N/A	14.00	Varies	8.20	0.80	15	
Gorund Source Heat Pump **	90%	100%	13.00	11.18	N/A	0.80	20	

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

Table 18.0.4: 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 - 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	0.0%	0.0%	0.0%	0.0%	0.00%	0.0%
Existing Home MSHP	0.0%	0.0%	0.0%	0.0%	0.00%	0.0%

Table 18.0.5: 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 18.0.6: Cooling & Heating Weather Data for Load Estimates	Maximum Outside Air Temperature (F)	Mimimum Outside Air Temperature (F)	Balance Point OSA Temperature (F)	Balance Point Load (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		

20.1 Gas Water Heaters

Algorithms

$Customer\_Dth = Baseline\_Dth - Proposed\_Dth$

$Baseline\_Dth = Hot\_Water\_Energy / Baseline\_Eff\_Gas / 1{,}000{,}000$

$Proposed\_Dth = Hot\_Water\_Energy / Proposed\_Eff / 1{,}000{,}000$

$Hot\_Water\_Energy = Qty \times Hot\_Water\_Consumption \times Water\_Heater\_Delta\_T \times Days\_Per\_Year \times Water\_Density$

$Water\ Heater\ Delta\ T = Water\_Heater\_Temperature - City\_Mains\_Temperature$

For Storage Water Heaters:

$Baseline\_Efficiency\_Gas = coef1 - (coef2 \times Proposed\_Tank\_Size)$

For Instantaneous and Indirect Water Heaters:

$Baseline\_Efficiency\_Gas = coef1 - (coef2 \times Baseline\_Tank\_Size)$

For Indirect Water Heaters:

$$Proposed\_Dth = \left(Hot\_Water\_Energy / Eff_{P,Boiler} + \frac{UA_{P,DHW}}{Eff_{P,Boiler}} \times Ambient\_dT \times HoursPerYear \right) / 1{,}000{,}000$$

$$Ambient\_dT = Water\_Heater\_Temperature - Ambient\_Temperature$$

$$UA_{P,DHW} = \frac{SL_{P,DHW}}{70} \times Proposed\ Tank\ Size \times Water\_Density \times SpecificHeat_{Water}$$

$Incremental\ Cost = Proposed\ Cost - Baseline\ Cost$

Variables

Hot_Water_Consumption	See Table 20.1.4	Gallons of Water per day based on number of Bedrooms and Home Type
Water Heater Temperature	120.0	Water Heater Tank Temperature
City Mains Temperature	51.4	Water Main temperature average over the year
Conversion from Btu to Dth	1,000,000	1 Dth = 1,000,000 Btuh
Conversion from Btu to Therm	100,000	1 Therm = 100,000 Btuh
Conversion from kW to Watts	1,000	1 kW = 1,000 Watts
Conversion from Btu to kWh	3,412	1 kW = 3,412 Btuh
Specific Heat of Water	1	Btu/lb/°F
Water_Density	8.34	lb/gal H20
Days_Per_Year	365	Days per Year
HoursPerYear	8,760	Hours per Year
Coef1	See Table 20.1.1 See Table 20.1.2	Code based forumula for calculation of Baseline efficiency based on water heater type and Proposed Tank Size
Coef2	See Table 20.1.1 See Table 20.1.2	Code based forumula for calculation of Baseline efficiency based on water heater type and draw pattern
Baseline_Tank_Size	See Table 20.1.3	For Instantaneous Water Heaters the baseline tank size will be based on the deemed First Hour Rating and the number of bedrooms.
Water Heater Self-Installation Rate	52%	Percent of Water Heaters that self-installed after retail purchase (Reference 9). Zero percent for heat pump water heaters.
Ambient_Temperature	70	Deemed ambient air temperature of the space where the Indirect Water Heater is installed.
SL_P,DHW	See Table 20.1.7	Standby loss factor for the proposed Indirect Water Heater, in °F/h. Deemed from Averages of AHRI database.
Indirect Water Heater Baseline Cost	See Table 20.1.6	Baseline cost of Indirect Water Heater, based on number of bedrooms
Indirect Water Heater Draw Pattern	See Table 20.1.6	Draw Pattern of baseline water heater for Indirect Water Heater measure based on number of bedrooms
Indirect Water Heater Proposed Cost	See Table 20.1.7	Proposed cost of Indirect Water Heater based on the proposed nominal tank size.
Measure Life for Indirect Water Heater	13	Indirect Water Heater measure life is equivalent to a gas fired storage water heater.

Customer Inputs	**M&V Verified**	
Number of Bedrooms	Yes	total number of bedrooms in the home where a new water heater is being installed
Proposed Eff	Yes	Proposed water heater AHRI Certified Uniform Energy Factor (UEF)
First Hour Rating	Yes	AHRI certified First Hour Rating in gallons per hour (GPH)
Quantity Proposed Equipment	Yes	
Instantaneous Water Heater Max GPM Rating	Yes	AHRI Certified GPM Rating
Proposed Tank Size	Yes	DOE Rated Storage Volume for tank type water heaters
Type of Proposed Water Heater	No	Type of proposed water heater. (i.e. Storage, Tankless, Heat Pump)
Water Heater Draw Pattern	No	Usage Bin identified on AHRI Certificate
$Eff\_P,Boiler$	Yes	Proposed Boiler Percent AFUE for boiler equipment associated with operation of the indirect water heater.

Table 20.1.1 Gas Fired Storage Water Heater and Heat Pump Water Heater Baseline Efficiency Calculation Parameters (Reference 8)

	First Hour Rating to Define Draw Pattern		Electric Storage Water Heater >=20 Gallon and <=55 Gallon Baseline Efficiency Coefficients		Gas Storage WH >20 Gallon and <=55 Gallon Baseline Efficiency Coefficients		Gas Storage WH >55 Gallon and <=100 Gallon Baseline Efficiency Coefficients	
Draw Pattern	min (>=Gallons)	max (< Gallons)	coef1	coef2	coef1	coef2	coef1	coef2
Very Small	1	18	0.8808	0.0008	0.3456	0.0020	0.6470	0.0006
Low	18	51	0.9254	0.0003	0.5982	0.0019	0.7689	0.0005
Medium	51	75	0.9307	0.0002	0.6483	0.0017	0.7897	0.0004
High	75	No Upper Limit	0.9349	0.0001	0.6920	0.0013	0.8072	0.0003

Table 20.1.2 Instantaneous Gas Fired Water Heater baseline Efficiency calculation parameters (Reference 8)

	Instantaneous Gas-Fired Water Heater <2 gal and >50,000 Btu/h GPM Drawn	
Draw Pattern	Minimum (>=GPM)	Maximum (< GPM)
Very Small	0	1.7
Low	1.7	2.8
Medium	2.8	4
High	4	No Upper Limit

Table 20.1.3 Estimated Baseline Gas Storage Water Heater Tank Size for Instantaneous and Indirect Water Heaters - 2019 ASHRAE HVAC Applications Chapter 51 Service Water Heating: Table 4 HUD-FHA Minimum Water Heater Capacities for One- and Two-Family Living Units (Reference 12)

Water Heater Type \ Number of Bedrooms	1	2	3	4	5	6
Average Gas Storage First Hour Draw (Reference 12)	43	60	67	77	90	92
Instantaneous Water Heater Baseline Tank Size	20	30	35	40	50	50
Indirect Water Heater Baseline Tank Size	20	30	35	40	50	50

Table 20.1.4 Water Usage per Day by Number of Bedrooms

Home Type \ Number of Bedrooms	1	2	3	4	5	6
Single Family total HW usage per day	34	48	60	72	84	96
Multi-Family total HW usage per day	41	53	63	73	83	92

Table 20.1.5: Inc Costs for Income Qualifed Single Family Weatherization Program

	Incrmental Cost
High Efficiency Tank-Type Gas Fired Water Heater	$374.00
High Efficiency Tankless Gas Fired Water Heater	$1,100.27

Table 20.1.6: Baseline Water Heater Deemed Information for Indirect Water Heaters

No. of Bedrooms \ Cost & Draw Pattern	Baseline Cost	Deemed Draw Pattern
1	$719.04	Low
2	$719.04	Medium
3	$719.04	Medium
4	$719.04	High
5	$773.07	High

Table 20.1.7: Proposed Indirect Water Heater Standby Loss Factor (Reference 7), Equipment Cost

Indirect Nominal Tank Size (Proposed Tank Size)	Standby Loss, °F/h	Indirect WH Equip Cost	Minimum Tank Size	Maximum Tank Size
30	1.1286	$1,130.14	25	33
35	0.9538	$1,192.44	33	38
40	0.9957	$1,361.20	38	45
50	0.7304	$1,497.25	45	55

References:

1. Energy Conservation Program for Consumer Products: Test Procedure for Water Heaters; United States Department of Energy; http://www.gpo.gov/fdsys/pkg/FR-1998-05-11/pdf/98-12296.pdf
2. Denver Water's 2006 Treated Water Quality Summary Report; http://www.denverwater.org/docs/assets/9A12FBC5-BCDF-1B42-D1BC5F0B1CE3B115/TreatedWQSummaryReport20061.pdf
3. Energy Star Residential Water Heaters -Final Criterial Analysis, April 2008. http://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/WaterHeaterAnalysis_Final.pdf
4. New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs; https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/TRM%20Version%206%20-%20January%202019.pdf
5. US Department of Energy; Residential Heat Pump Water Heaters; http://energy.gov/eere/femp/covered-product-category-residential-heat-pump-water-heaters
6. US Department of Energy; Consumer Water Heaters; https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=32
7. AHRI Directory of Certified Product Performance for Indirect Water Heaters; https://www.ahridirectory.org/NewSearch?programId=28&searchTypeId=3
8.US Department of Energy,Energy and water conservation standards and their compliance dates: 10 CFR 430.32(d): https://www.ecfr.gov/cgi-bin/text-idx?SID=80dfa785ea350ebeee184bb0ae03e7f0&mc=true&node=se10.3.430_132&rgn=div8

9. EnergyStar - http://aceee.org/sites/default/files/files/pdf/conferences/hwf/2016/Ryan_Session1C_HWF16_2.22.16_0.pdf
10. Equipment Manufacturer Retail Price Information Request (Q4 - 2017)
11. NREL - National Residential Efficiency Measure Database, https://remdb.nrel.gov/measures.php?gld=6&ctld=270
12. 2019 ASHRAE HVAC Applications manual Chapter 51 Service Water Heating
13 Florida Solar Energy Center paper "Estimating Daily Domestic Hot Water Use in North American Homes.
https://fsec.ucf.edu/en/publications/pdf/FSEC-PF-464-15.pdf Table 5 on Page 11.

Changes from Recent Filing:

changed method for determining baseline tank size for instantaneous water heaters
changed method for determining hot water consumption
Added Indirect Water Heaters installed with a high efficiency boiler
Added Tankless Water Heater cost for Income Qualified Single Family Weatherization

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 (%)	2021 Electric Units	2022 Electric Units	2021 Gas Units	2022 Gas Units
Residential HVAC	AC Rewards	10	$104	$104	132	0.199	4.9	$0.00	100%	100%	100%	3,750	3,750	2,500	2,500
Residential HVAC	Energy Star Smart Thermostat	10	$50	$215	142	0.215	8.1	$0.00	100%	100%	100%	5,500	5,500	5,800	5,800
Residential HVAC	Enhanced Fan Time Delay for Retrofit	1	$0	$0	0	0.000	0.0	$0.00	100%	100%	100%	0	0	0	0
Residential HVAC	Gas-Fired Storage Water Heater	13	$50	$345	0	0.000	2.4	$0.00	90%	90%	100%	0	0	342	342
Residential HVAC	Heat Pump Water Heater	10	$719	$1,059	2,787	0.353	0.0	-$11.66	100%	100%	100%	590	552	0	0
Residential HVAC	Heat Pump Water Heater - Gas WH Baseline	12	$800	$982	27	0.000	16.0	$0.00	100%	100%	100%	10	48	0	0
Residential HVAC	High Efficiency AC with QI	18	$500	$956	480	0.550	0.0	$0.00	68%	68%	100%	1,700	1,700	0	0
Residential HVAC	High Efficiency AC without QI and associated furnace	18	$300	$369	199	0.208	0.0	$0.00	68%	68%	100%	3,500	3,500	0	0
Residential HVAC	High Efficiency ASHP and Electric Resistance Heat Backup with QI	18	$800	$583	9,892	0.403	0.0	$0.00	100%	100%	100%	150	150	0	0
Residential HVAC	High Efficiency Boiler	20	$245	$1,284	0	0.000	20.4	$0.00	100%	100%	100%	0	0	110	110
Residential HVAC	High Efficiency ccASHP with QI with Electric Resistance Backup	18	$1,000	$3,521	13,073	0.355	0.0	$0.00	100%	100%	100%	10	10	10	10
Residential HVAC	High Efficiency Cold Climate Mini-Split Heat Pump with Electric Resistance Backup	15	$600	$8,563	7,537	0.572	0.0	$0.00	100%	100%	100%	10	10	10	10
Residential HVAC	High Efficiency Dual Fuel ASHP with QI and associated furnace	18	$800	$938	302	0.459	56.1	$0.00	100%	100%	100%	250	250	250	250
Residential HVAC	High Efficiency Dual Fuel ccASHP with QI and associated furnace	18	$1,000	$3,521	426	0.355	67.6	$0.00	100%	100%	100%	100	100	100	100
Residential HVAC	High Efficiency Dual Fuel Cold Climate Mini-Split Heat Pump	15	$600	$8,563	157	0.572	39.3	$0.00	100%	100%	100%	100	100	100	100
Residential HVAC	High Efficiency Dual Fuel Mini-Split Heat Pump	18	$500	$6,855	242	0.881	46.9	$0.00	100%	100%	100%	200	200	200	200
Residential HVAC	High Efficiency Furnace	18	$300	$1,138	0	0.000	21.3	$0.00	86%	86%	100%	0	0	2,740	2,318
Residential HVAC	High Efficiency GSHP with QI	20	$945	$10,107	11,734	1.472	0.0	$0.00	100%	100%	100%	100	100	0	0
Residential HVAC	High Efficiency GSHP with QI - AC & Gas Baseline	20	$1,259	$4,853	686	1.472	60.1	$0.00	100%	100%	100%	150	150	150	150
Residential HVAC	High Efficiency Mini-Split Heat Pump	18	$500	$6,855	8,933	0.881	0.0	$0.00	100%	100%	100%	284	284	0	0
Residential HVAC	Indirect Water Heater	15	$100	$578	0	0.000	5.1	$0.00	100%	100%	100%	0	0	50	50
Residential HVAC	Multi-ducted premium evaporative cooler	15	$1,200	$443	944	1.319	0.0	-$18.29	85%	85%	100%	634	665	0	0
Residential HVAC	Premium evaporative cooler	15	$675	-$774	1,227	1.530	0.0	-$19.23	70%	70%	100%	358	374	0	0
Residential HVAC	Quality Install of High Efficiency AC with associated furnace	18	$200	$235	153	0.143	4.5	$0.00	68%	68%	100%	3,500	3,500	3,500	3,500
Residential HVAC	Smart Thermostat Optimization	1	$0	$0	45	0.054	0.0	$0.00	100%	100%	100%	3,000	3,000	0	0
Residential HVAC	Standard Efficiency AC with QI	18	$200	$238	230	0.189	0.0	$0.00	68%	68%	100%	450	450	0	0
Residential HVAC	Standard Efficiency AC with QI and associated furnace	18	$200	$237	248	0.201	5.5	$0.00	68%	68%	100%	1,100	1,100	1,100	1,100
Residential HVAC	Standard evaporative cooler	15	$300	-$2,889	712	1.533	0.0	-$13.30	70%	70%	100%	3,885	4,071	0	0
Residential HVAC	Tankless Water Heater	20	$100	$1,060	0	0.000	7.6	$0.00	90%	90%	100%	0	0	558	558

RESIDENTIAL HEATING & COOLING

2021 Net Present Cost Benefit Summary Analysis For All Participants

	Participant Test ($Total)	Utility Test ($Total)	Rate Impact Test ($Total)	Modified Total Resource Test ($Total)
Benefits				
Avoided Revenue Requirements				
Generation Capacity	N/A	$11,397,813	$11,397,813	$11,397,813
Trans. & Dist. Capacity	N/A	$1,427,426	$1,427,426	$1,427,426
Marginal Energy	N/A	$3,545,056	$3,545,056	$3,545,056
Avoided Emissions (CO2)	N/A	N/A	N/A	$2,690,990
Subtotal				$19,061,284
Non-Energy Benefits Adder (20.0%)				$3,274,059
Subtotal	N/A	$16,370,294	$16,370,294	$22,335,342
Participant Benefits				
Bill Reduction - Electric	$19,619,973	N/A	N/A	N/A
Participant Rebates and Incentives	$6,162,376	N/A	N/A	$6,162,376
Incremental Capital Savings	$11,499,147	N/A	N/A	$8,049,403
Incremental O&M Savings	$0	N/A	N/A	$0
Subtotal	$37,281,496	N/A	N/A	$14,211,779
Total Benefits	$37,281,496	$16,370,294	$16,370,294	$36,547,121
Costs				
Utility Project Costs				
Program Planning & Design	N/A	$0	$0	$0
Administration & Program Delivery	N/A	$1,495,162	$1,495,162	$1,495,162
Advertising/Promotion/Customer Ed	N/A	$1,280,780	$1,280,780	$1,280,780
Participant Rebates and Incentives	N/A	$6,162,376	$6,162,376	$6,162,376
Equipment & Installation	N/A	$0	$0	$0
Measurement and Verification	N/A	$50,000	$50,000	$50,000
Subtotal	N/A	$8,988,318	$8,988,318	$8,988,318
Utility Revenue Reduction				
Revenue Reduction - Electric	N/A	N/A	$19,475,442	N/A
Subtotal	N/A	N/A	$19,475,442	N/A
Participant Costs				
Incremental Capital Costs	$10,115,035	N/A	N/A	$8,848,581
Incremental O&M Costs	$852,119	N/A	N/A	$634,292
Subtotal	$10,967,154	N/A	N/A	$9,482,873
Total Costs	$10,967,154	$8,988,318	$28,463,759	$18,471,191
Net Benefit (Cost)	$26,314,342	$7,381,976	($12,093,466)	**$18,075,931**
Benefit/Cost Ratio	3.40	1.82	0.58	**1.98**

Note: Dollar values represent present value of impacts accumulated over the lifetime of the measures.

2021 ELECTRIC GOAL

Input Summary and Totals

Program "Inputs" per Customer kW and per Participant		
Lifetime (Weighted on Generator kWh)	A	15.7 years
T & D Loss Factor (Energy)	B	6.38%
T & D Loss Factor (Demand)	C	9.13%
Net-to-Gross (Energy)	D	87.81%
Net-to-Gross (Demand)	E	78.25%
Installation Rate (Energy)	F	**100.00%**
Installation Rate (Demand)	G	**100.00%**
Net coincident kW Saved at Generator	H	0.39 kW
Gross Annual kWh Saved at Customer	I	510.97 kWh
Net Annual kWh Saved at Generator	J	479.28 kWh

Program Summary All Participants		
Total Budget	K	**$8,988,318**
Net coincident kW Saved at Generator	L	**11,353 kW**
Gross Annual kWh Saved at Customer	M	14,987,321 kWh
Net Annual kWh Saved at Generator	N	**14,057,658 kWh**
Total MTRC Net Benefits with Adder	O	**$18,075,931**
Total MTRC Net Benefits without Adder	P	**$14,801,872**

Utility Program Cost per kWh Lifetime	K/(A x N)	**$0.0408**
Utility Program Cost per kW at Gen	K/ L	**$792**

Avoided Lifetime CO2 Emissions, Total Program (tons CO2)	**69,372**

RESIDENTIAL HEATING & COOLING

2022 Net Present Cost Benefit Summary Analysis For All Participants

	Participant Test ($Total)	Utility Test ($Total)	Rate Impact Test ($Total)	Modified Total Resource Test ($Total)
Benefits				
Avoided Revenue Requirements				
Generation Capacity	N/A	$11,906,509	$11,906,509	$11,906,509
Trans. & Dist. Capacity	N/A	$1,491,142	$1,491,142	$1,491,142
Marginal Energy	N/A	$3,660,375	$3,660,375	$3,660,375
Avoided Emissions (CO2)	N/A	N/A	N/A	$2,613,946
Subtotal				$19,671,973
Non-Energy Benefits Adder (20.0%)				$3,411,605
Subtotal	N/A	$17,058,027	$17,058,027	$23,083,578
Participant Benefits				
Bill Reduction - Electric	$20,205,699	N/A	N/A	N/A
Participant Rebates and Incentives	$6,294,442	N/A	N/A	$6,294,442
Incremental Capital Savings	$12,048,784	N/A	N/A	$8,434,149
Incremental O&M Savings	$0	N/A	N/A	$0
Subtotal	$38,548,925	N/A	N/A	$14,728,591
Total Benefits	$38,548,925	$17,058,027	$17,058,027	$37,812,169
Costs				
Utility Project Costs				
Program Planning & Design	N/A	$0	$0	$0
Administration & Program Delivery	N/A	$1,544,002	$1,544,002	$1,544,002
Advertising/Promotion/Customer Ed	N/A	$1,244,610	$1,244,610	$1,244,610
Participant Rebates and Incentives	N/A	$6,294,442	$6,294,442	$6,294,442
Equipment & Installation	N/A	$0	$0	$0
Measurement and Verification	N/A	$52,000	$52,000	$52,000
Subtotal	N/A	$9,135,054	$9,135,054	$9,135,054
Utility Revenue Reduction				
Revenue Reduction - Electric	N/A	N/A	$20,057,916	N/A
Subtotal	N/A	N/A	$20,057,916	N/A
Participant Costs				
Incremental Capital Costs	$10,102,451	N/A	N/A	$8,834,802
Incremental O&M Costs	$879,809	N/A	N/A	$651,637
Subtotal	$10,982,260	N/A	N/A	$9,486,439
Total Costs	$10,982,260	$9,135,054	$29,192,970	$18,621,493
Net Benefit (Cost)	$27,566,665	$7,922,973	($12,134,943)	**$19,190,677**
Benefit/Cost Ratio	3.51	1.87	0.58	**2.03**

Note: Dollar values represent present value of impacts accumulated over the lifetime of the measures.

2022 ELECTRIC GOAL

Input Summary and Totals

Program "Inputs" per Customer kW and per Participant		
Lifetime (Weighted on Generator kWh)	A	15.7 years
T & D Loss Factor (Energy)	B	6.38%
T & D Loss Factor (Demand)	C	9.13%
Net-to-Gross (Energy)	D	87.52%
Net-to-Gross (Demand)	E	78.06%
Installation Rate (Energy)	F	**100.00%**
Installation Rate (Demand)	G	**100.00%**
Net coincident kW Saved at Generator	H	0.39 kW
Gross Annual kWh Saved at Customer	I	508.39 kWh
Net Annual kWh Saved at Generator	J	475.24 kWh

Program Summary All Participants		
Total Budget	K	**$9,135,054**
Net coincident kW Saved at Generator	L	**11,614 kW**
Gross Annual kWh Saved at Customer	M	15,030,064 kWh
Net Annual kWh Saved at Generator	N	**14,050,068 kWh**
Total MTRC Net Benefits with Adder	O	**$19,190,677**
Total MTRC Net Benefits without Adder	P	**$15,779,071**

Utility Program Cost per kWh Lifetime	K/(A x N)	**$0.0414**
Utility Program Cost per kW at Gen	K/ L	**$787**

Avoided Lifetime CO2 Emissions, Total Program (tons CO2)	**64,808**

RESIDENTIAL HEATING & COOLING

2021 Net Present Cost Benefit Summary Analysis For All Participants

	Participant Test ($Total)	Utility Test ($Total)	Rate Impact Test ($Total)	Modified Total Resource Test ($Total)
Benefits				
Avoided Revenue Requirements				
Commodity Cost Reduction	N/A	$5,343,776	$5,343,776	$5,343,776
Variable O&M Savings	N/A	$89,609	$89,609	$89,609
Demand Savings	N/A	$627,659	$627,659	$627,659
Subtotal				$6,061,044
Non-Energy Benefits Adder (20.0%)				$1,212,209
Subtotal	N/A	$6,061,044	$6,061,044	$7,273,253
Participant Benefits				
Bill Reduction - Gas	$9,672,032	N/A	N/A	N/A
Participant Rebates and Incentives	$1,989,136	N/A	N/A	$1,989,136
Incremental Capital Savings	$0	N/A	N/A	$0
Incremental O&M Savings	$0	N/A	N/A	$0
Subtotal	$11,661,168	N/A	N/A	$1,989,136
Total Benefits	$11,661,168	$6,061,044	$6,061,044	$9,262,389
Costs				
Utility Project Costs				
Program Planning & Design	N/A	$0	$0	$0
Administration & Program Delivery	N/A	$737,986	$737,986	$737,986
Advertising/Promotion/Customer Ed	N/A	$292,020	$292,020	$292,020
Participant Rebates and Incentives	N/A	$1,989,136	$1,989,136	$1,989,136
Equipment & Installation	N/A	$0	$0	$0
Measurement and Verification	N/A	$19,500	$19,500	$19,500
Subtotal	N/A	$3,038,642	$3,038,642	$3,038,642
Utility Revenue Reduction				
Revenue Reduction - Gas	N/A	N/A	$9,524,975	N/A
Subtotal	N/A	N/A	$9,524,975	N/A
Participant Costs				
Incremental Capital Costs	$7,355,601	N/A	N/A	$6,616,073
Incremental O&M Costs	$0	N/A	N/A	$0
Subtotal	$7,355,601	N/A	N/A	$6,616,073
Total Costs	$7,355,601	$3,038,642	$12,563,617	$9,654,715
Net Benefit (Cost)	$4,305,567	$3,022,402	($6,502,573)	**($392,326)**
Benefit/Cost Ratio	1.59	1.99	0.48	**0.96**

Note: Dollar values represent present value of impacts accumulated over the lifetime of the measures.

2021 GAS **GOAL**

Input Summary and Totals

Program "Inputs" per Dth		
Lifetime (Weighted on Dth)	A	15.4 years
Net-to-Gross (Weighted on Dth)	B	92.00%
Install Rate (Weighted on Dth)	C	100.00%

Program Summary per Participant		
Gross Annual Dth Saved	D	11.2
Net Annual Dth Saved	E	10.3

Program Summary All Participants		
Total Budget	F	**$3,038,642**
Gross Annual Dth Saved	G	**196,162 Dth**
Net Annual Dth Saved	H	**180,466 Dth**
Total MTRC Net Benefits with Adder	I	**($392,326)**
Total MTRC Net Benefits without Adder	J	**($1,604,535)**
Utility Program Cost per Dth Lifetime	F /(A x H)	**$1.0926**

RESIDENTIAL HEATING & COOLING

2022 Net Present Cost Benefit Summary Analysis For All Participants

	Participant Test ($Total)	Utility Test ($Total)	Rate Impact Test ($Total)	Modified Total Resource Test ($Total)
Benefits				
Avoided Revenue Requirements				
Commodity Cost Reduction	N/A	$5,291,252	$5,291,252	$5,291,252
Variable O&M Savings	N/A	$85,290	$85,290	$85,290
Demand Savings	N/A	$597,405	$597,405	$597,405
Subtotal				$5,973,946
Non-Energy Benefits Adder (20.0%)				$1,194,789
Subtotal	N/A	$5,973,946	$5,973,946	$7,168,735
Participant Benefits				
Bill Reduction - Gas	$9,584,836	N/A	N/A	N/A
Participant Rebates and Incentives	$1,870,670	N/A	N/A	$1,870,670
Incremental Capital Savings	$0	N/A	N/A	$0
Incremental O&M Savings	$0	N/A	N/A	$0
Subtotal	$11,455,506	N/A	N/A	$1,870,670
Total Benefits	$11,455,506	$5,973,946	$5,973,946	$9,039,405
Costs				
Utility Project Costs				
Program Planning & Design	N/A	$0	$0	$0
Administration & Program Delivery	N/A	$706,741	$706,741	$706,741
Advertising/Promotion/Customer Ed	N/A	$297,040	$297,040	$297,040
Participant Rebates and Incentives	N/A	$1,870,670	$1,870,670	$1,870,670
Equipment & Installation	N/A	$0	$0	$0
Measurement and Verification	N/A	$20,000	$20,000	$20,000
Subtotal	N/A	$2,894,451	$2,894,451	$2,894,451
Utility Revenue Reduction				
Revenue Reduction - Gas	N/A	N/A	$9,431,353	N/A
Subtotal	N/A	N/A	$9,431,353	N/A
Participant Costs				
Incremental Capital Costs	$6,898,721	N/A	N/A	$6,225,867
Incremental O&M Costs	$0	N/A	N/A	$0
Subtotal	$6,898,721	N/A	N/A	$6,225,867
Total Costs	$6,898,721	$2,894,451	$12,325,804	$9,120,318
Net Benefit (Cost)	$4,556,785	$3,079,495	($6,351,858)	**($80,913)**
Benefit/Cost Ratio	1.66	2.06	0.48	**0.99**

Note: Dollar values represent present value of impacts accumulated over the lifetime of the measures.

2022 GAS **GOAL**

Input Summary and Totals

Program "Inputs" per Dth		
Lifetime (Weighted on Dth)	A	15.3 years
Net-to-Gross (Weighted on Dth)	B	92.29%
Install Rate (Weighted on Dth)	C	100.00%

Program Summary per Participant		
Gross Annual Dth Saved	D	10.9
Net Annual Dth Saved	E	10.1

Program Summary All Participants		
Total Budget	F	**$2,894,451**
Gross Annual Dth Saved	G	**187,173 Dth**
Net Annual Dth Saved	H	**172,736 Dth**
Total MTRC Net Benefits with Adder	I	**($80,913)**
Total MTRC Net Benefits without Adder	J	**($1,275,702)**
Utility Program Cost per Dth Lifetime	F /(A x H)	**$1.0961**