Accelerated Adoption of Heat Pump Technology

Analysis of a potential point-of-sale standard for residential air conditioners in Colorado

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Executive Summary

Purpose and legislative mandate

In 2024, the Colorado General Assembly passed SB24-214 directing the Colorado Energy Office (CEO) to conduct an analysis of a potential statewide point-of-sale standard requiring new residential central air conditioners (CACs) serving one and two family dwelling units and townhouses to be configured as heat pumps (this point-of-sale standard will hereafter be referred to as the "Residential CAC Standard"). As outlined in statute, the primary objective of this directive was to assess factors likely to affect the impacts of a Residential CAC Standard in Colorado including but not limited to: assessing heat pump technical viability, examining heat pump installation and operating costs, evaluating heat pump workforce readiness, and estimating the statewide economic and greenhouse gas (GHG) emission impacts of such a standard.

To complete this analysis, CEO partnered with Apex Analytics. CEO and Apex Analytics (jointly referred to as "the team") conducted interviews with a diverse set of stakeholders including heating, ventilation, and air conditioning (HVAC) equipment manufacturers and distributors, HVAC contractors, HVAC industry experts, green homebuilders, environmental justice groups, and utilities. In addition, the team performed research on heat pump pricing and conducted engineering and economic analyses to examine heat pump operational costs under a variety of scenarios.

The findings in this white paper provide an estimate of the likely statewide and household-level impacts that would arise if a Residential CAC Standard were implemented in Colorado.

Key Findings

1. The upfront incremental cost to purchase and install a minimum efficiency heat pump (meHP) or a cold-climate heat pump (ccHP) is estimated to be $2,200 and $6,600, respectively, when compared to the cost of purchasing and installing a

like-sized minimum efficiency CAC (meCAC). ccHPs provide households with the largest annual utility bill savings and GHG emission reductions because they provide a higher heat output at very low outdoor temperatures and have higher efficiency than meHPs. That said, the higher upfront incremental cost of ccHPs currently makes them less economical than meHPs in most CAC-to-heat pump switching scenarios, especially for households that currently use natural gas for heating and do not have access to incentives that reduce the cost of ccHPs.

2. In some areas of Colorado there are currently large enough rebates and tax credits to offset much or all of the incremental cost of heat pump installations, and households with access to these incentives would realize annual total heating and cooling savings, including amortizing the upfront incremental cost of the heat pump, after installing a heat pump (even if they currently use natural gas for heating). Based on this analysis it is estimated that a $2,000 upfront incentive for meHPs and $6,000 upfront incentive for ccHPs would make heat pumps economically beneficial for most Colorado households.

3. Approximately 20% of Colorado households are expected to realize significant total heating and cooling savings after installing a meHP, saving on the order of $500 to $1,800 per year. This cohort of households primarily uses propane furnaces or electric resistance heating systems for space heating. The remaining 80% of Colorado households, which use natural gas furnaces for space heating, are expected to realize annual utility bill savings after installing a meHP, but, after the amortized incremental cost of the meHP is accounted for, these households are expected to see a small increase in total heating and cooling costs (less than $100 per year) if current energy prices persist.

4. For households with natural gas furnaces, replacing a meCAC with a meHP can result in a reduction in GHG emissions with an implied cost of roughly $100 per metric ton of CO2e. Thus, the Residential CAC Standard can induce GHG emission reductions with a cost comparable to the social cost of carbon calculated by Xcel

Energy ($92 per metric ton of CO2e).[1] For households with propane furnaces or electric resistance heating systems, the estimated cost of GHG emission reductions after installing a heat pump is negative because these households realize annual total savings and reduce their emissions.

5. Natural gas and electricity prices profoundly affect the economics of utilizing a heat pump in households that have natural gas furnaces. If natural gas prices increase at a faster rate than electricity prices going forward, the economics of heat pump operation will improve for the majority of Colorado households.

6. Interviews with HVAC contractors indicated that, in CAC-replacement scenarios, the process of installing a heat pump is similar to the process of installing a new CAC. Both processes require comparable tools and contractor skill sets, and there are likely not instances where installation of a heat pump instead of a CAC in applicable residential property types would be technically infeasible.

7. Most stakeholders interviewed (including roughly half of the HVAC contractors) were generally supportive of a Residential CAC Standard, provided cost impacts on low-income households could be mitigated. That said, stakeholders had differing reasons for supporting the standard, which ranged from wanting statewide GHG emissions to decrease to wanting their individual business revenue to increase.

Estimated Impacts on Colorado Households

The team conducted primary research via stakeholder interviews and HVAC contractor focus groups to understand how a Residential CAC Standard may affect Colorado households and the Colorado HVAC industry. In addition, the team gathered data and insights from publicly available sources, specifically in areas related to Colorado residential building stocks, heat pump operating specifications, heat pump pricing, and utility electric and gas rates. The team then created a heat pump operation model and estimated how a variety of factors including household annual heating and

[1] As directed by the Colorado Public Utility Commission, Xcel Energy estimates a social cost of carbon of $83/short ton, or $92 per metric ton. See page 5. Hearing Exhibit 102, Attachment GKJ-8

cooling costs, energy use, GHG emissions would be impacted if those households installed a heat pump instead of a CAC.

The team found that the heating and cooling savings potential of heat pumps is dependent on the existing heating system type used in each household. Households with propane furnaces or electric resistance heating systems are expected to see large total annual savings after installing a heat pump and would see their investment in a heat pump pay off within a few years in most cases, even without any upfront heat pump incentives. On the other hand, most households currently heated with natural gas furnaces are expected to see decreases in their annual utility bills but modest increases in their annual total heating and cooling costs after installing a heat pump (after the amortized incremental cost of a heat pump is accounted for). In these households, incentives reducing the upfront incremental cost of the heat pump would be required for the heat pump to pay for itself within its expected lifetime.

The utility bill savings potential of heat pumps is highly dependent on natural gas and electricity prices. With current natural gas prices, installing a heat pump does not result in total annual savings for most Colorado households that utilize natural gas furnaces for space heating. However, an increase in natural gas prices in line with current U.S. Energy Information Agency projections would significantly improve the savings potential for Colorado households. Table 1 shows the estimated impacts of a Residential CAC Standard for households that replace a CAC with a meHP, broken down by the existing space heating fuel used by the household. On average, households with natural gas furnaces see a total cost increase of $85 per year after installing a meHP, while households with propane furnaces and electric resistance heating systems see total savings of $1,000 and $1,300 per year, respectively. The GHG emission reduction impacts of the Residential CAC Standard are most significant for households that currently utilize propane and electric resistance for space heating, with the GHG emissions from these households reduced by 50%. Households that have natural gas or propane furnaces see an increase in their electricity usage and decrease in their fossil fuel usage after installing a meHP. On the other hand,

households with electric resistance heating systems see a 45% reduction in electricity usage after installing a meHP.

Table 1. Estimated average annual household impacts from a Residential CAC Standard, broken down by existing household heat system fuel type (meHP scenario).

Household Space Heating Fuel Type	Annual Household Total Savings[2]	Annual Household Electricity Consumption Change	Annual Household Fossil Fuel Consumption Change	Annual Household GHG Emission Changes
Natural Gas	-$85	+13%	-12%	-11%
Propane	$1,000	+52%	-39%	-47%
Electricity	$1,300	-45%	0%	-46%

Statewide Impacts

The Residential CAC Standard investigated would impact over 80,000 CAC installations per year, resulting in the installation of over 80,000 heat pumps per year. Table 2 breaks this estimate down by CAC installation project type and household existing heating system. Approximately 85% of impacted CAC installations are expected to occur in households that use natural gas for heating.

Implementation of the Residential CAC Standard at a statewide level would reduce overall electricity consumption by 7.0 GWh, gas consumption by 14 million therms, GHG emissions by 96,000 MT, and save a total of 8.9 million dollars in heating and cooling costs aggregated across all Colorado households each year (assuming full compliance with the standard). While the standard would result in statewide total heating and cooling savings each year, it is important to note that the economic

[2] Annual total cost accounts for both the incremental cost to install a heat pump and the annual heating and cooling utility bill savings realized when operating the heat pump, a negative number represents an added cost

benefits accrued statewide are not evenly distributed to all Colorado households and these savings primarily flow to households that have propane furnaces or electric resistance heating systems.

Table 2. Estimated annual number of CAC installations impacted by a Residential CAC Standard in Colorado

Household Space Heating Fuel Type	Annual Impacted Retrofit CAC Installations	Annual Impacted New Construction CAC Installations	Total Annual Impacted CAC Installations
Natural Gas	48,719	20,787	69,507
Electricity	5,387	2,253	7,639
Propane	3,267	1,270	4,538
Total:	57,373	24,310	81,684

Stakeholder Interviews

The team conducted interviews with 22 different stakeholders. Interviewees included national policy and market technology experts, environmental and business stakeholders, equity-focused stakeholders, and local government and utility employees. Highlighted findings from these interviews are as follows:

1. Environmental advocates, national policy experts, and some local government staff see a Residential CAC Standard as an effective means to accelerate heat pump adoption in Colorado and believe a standard is likely more enforceable and effective than decentralized local energy code advancements.
2. Complementary policies and actions, such as implementation of utility rate designs that ensure cost parity for households that use a heat pump for heating or creation of on-bill financing options for low-income households, were deemed important for preventing negative household economic impacts.

3. Concerns about potential conflicts with the Energy Policy and Conservation Act's (EPCA) preemption clause surfaced in multiple stakeholder interviews, including discussions with market technology experts, policy stakeholders, environmental advocates, a distributor, and a manufacturer.
4. Stakeholders across groups emphasized the need for more HVAC contractor training opportunities to ensure heat pumps are installed in a high-quality manner and to ensure heat pumps operate efficiently and do not prematurely break down.
5. Stakeholders (specifically market technology experts and environmental advocates) predicted that a Residential CAC Standard would eventually reduce costs for heat pumps by increasing competition and contractor experience.
6. Multiple stakeholders expressed concerns about the financial burden of a Residential CAC Standard on low-income households, due to the higher cost of installing a heat pump instead of a CAC. Rebates currently play a key role in reducing heat pump upfront cost in Colorado, but not all projects qualify for rebates and there is often uncertainty around rebate program longevity.

Contractor Focus Groups

The team conducted group interviews with 15 HVAC contractors who performed heat pump installations in Colorado. The primary research objective of these contractor focus groups was assessing how a Residential CAC Standard would impact the residential HVAC market in Colorado. Key findings include:

1. Existing heat pump installers in Colorado generally focus on ccHPs and full electrification heating system projects to meet consumer needs and respond to the current structure of the incentive market. These contractors do not currently install many meHPs, which may be the most likely replacement for CACs if a Residential CAC Standard were put in place in Colorado.

2. Contractors reported that they could readily obtain heat pump equipment and were not dealing with supply chain issues at the time of the focus groups.
3. Contractors leverage utility rebates, tax credits, and local government rebates to reduce upfront heat pump installation expenses. These contractors noted that incentives play a very important role in making heat pumps an attractive option for many households.
4. Contractors noted a lack of incentives for meHPs that could be considered the most direct replacement for a CAC. Contractors reported that some customers still prefer to replace failed CACs with new CACs to minimize upfront cost.
5. For CAC-replacement scenarios, contractors reported minimal differences between installations of heat pumps and CACs, with the main difference being the need for additional wiring for heat pump controls.
6. Contractors reported that many Colorado households currently have low awareness of heat pumps and do not know the benefits of heat pump technology. The contractors noted that they usually introduce customers to heat pumps by talking about heat pump rebate programs and say customers are often receptive to the sales pitch.

Strategic Considerations

Based on the findings in this white paper, the team has identified the following areas as important strategic considerations for the effective implementation of a Residential CAC Standard in Colorado.

Identify opportunities to create incentives for meHPs

The most affordable heat pumps (meHPs) are not currently eligible for rebates or tax credits at the state or federal level and determining which heat pump equipment is eligible for rebates is time consuming and confusing for both homeowners and HVAC contractors. Providing a $2,000 incentive to each household that installs a heat pump would ensure that almost all households in Colorado benefit economically from the

heat pump and making meHPs eligible for incentives would reduce prices for consumers and make it easier for homeowners and HVAC contractors to utilize incentive programs.

Set an effective date for the standard that allows the market to prepare

The HVAC contractors that were interviewed during this research effort primarily installed high performance heat pumps or ccHPs. Colorado utility rebate program usage data and market share data from Heating Air-Conditioning Refrigeration Distributors International (HARDI) support that most of the existing heat pump customer base in Colorado are choosing to install heat pumps with high or moderately high performance (i.e. not meHPs). If a Residential CAC Standard goes into effect, the residential heat pump market would likely expand significantly beyond this current customer base. Data from HARDI shows that approximately 70% of residential CACs sold in Colorado are low efficiency units, so most equipment that would be affected by the Residential CAC Standard would be low cost meCACs. To reduce upfront costs, households may prefer to install meHPs after CAC failures. An ample planning period would allow Colorado distributors to ensure meHPs and other low-cost heat pump options are in stock prior to any Residential CAC Standard implementation.

EPCA preemption may pose legal hurdles for a Residential CAC Standard

Multiple stakeholders indicated that a Residential CAC Standard is likely to receive legal challenges based on existing federal air conditioner efficiency standards. Such legal challenges could potentially prevent implementation of the standard or could delay implementation and create market confusion during protracted legal proceedings. Developing a legal strategy to prevent EPCA challenges could be important in case the state sees a legal challenge related to a Residential CAC Standard.

Examine utility electric rate structures that are beneficial for households with heat pumps

Utilities could improve heat pump economics for households by offering electric rate structures that reduce the cost of operating heat pumps for space heating in the winter. Such rate structures have been shown to improve heat pump economics in other regions of the United States. SB24-214, passed by Colorado General Assembly in 2024, requires that investor-owned utilities in Colorado develop proposals for electric rate structures that are designed to lower the average monthly energy bill for residential households that utilize heat pumps as their primary heating source. Examining the advantages and disadvantages of these rate structures will be important if heat pump adoption accelerates in the coming years.

Structure the Residential CAC Standard to apply to all residential CACs

The Residential CAC Standard examined in this analysis would only apply to CACs utilized in one and two family dwelling units and townhouses. Thus, it would still be legal to sell CACs for use in residential building types that are not covered by the standard, potentially creating confusion for HVAC equipment distributors and retailers. It may be more effective to design a Residential CAC Standard to apply to all residential CACs below a nominal cooling output threshold. For example, the standard could apply to all CACs with rated capacity below 65,000 Btu per hour, regardless of the building type or size that the CAC will be installed in.

Develop low-cost financing options for households that install heat pumps

The incremental cost estimated for a meHP installation is $2,200, which can be a significant added financial burden for many households after they experience a CAC failure. Low-cost financing options would reduce this burden and would allow households to better manage the financial impacts of a Residential CAC Standard.

Introduction

Colorado has established statewide emission targets to reduce greenhouse gas (GHG) emissions based on the levels that existed in 2005, including a 50% reduction by 2030, a 65% reduction by 2035, and net zero emissions by 2050. In 2021, the Colorado Greenhouse Gas Pollution Reduction Roadmap[3] identified that electrification and decarbonization of space heating in residential buildings will be important for Colorado to meet its 2050 climate goal. Increased adoption of electric heat pump technology is likely to be a key contributor to the residential building electrification effort because heat pumps operate at much higher efficiency than electric resistance heating technologies.

In Colorado, a variety of strategies are currently being used to accelerate the adoption of heat pump technology for space heating in the residential building sector. Examples include the Colorado State Heat Pump Tax Credit, heat pump rebates from utility programs, heat pump rebates from local governments, and federal tax credits and Inflation Reduction Act rebates. These incentive-based strategies encourage homeowners and heating, ventilation, and air conditioning (HVAC) contractors to install heat pumps by reducing the upfront cost for heat pump installations.

This white paper examines the potential effects of a statewide point-of-sale standard that would require new residential central air conditioners (CACs) serving one and two family dwelling units and townhouses to be configured as heat pumps (this point-of-sale standard will hereafter be referred to as the "Residential CAC Standard"). Such a standard would effectively mandate that heat pumps be installed instead of new CACs in the applicable residential building types. The potential impacts if a Residential CAC Standard was implemented in Colorado have not been investigated to date.

To analyze the impacts of a Residential CAC Standard in Colorado, the Colorado Energy Office (CEO) and Apex Analytics (jointly referred to as "the team") conducted

[3] Colorado Greenhouse Gas Pollution Reduction Roadmap, 2021

research interviews with stakeholders including HVAC equipment manufacturers and distributors, HVAC contractors, heat pump experts, green homebuilders, environmental justice groups, and utilities. Using the data collected through this primary research, the team conducted engineering and economic analyses to assess upfront heat pump installation costs and operational costs under a variety of scenarios. The primary objective of this analysis was to assess factors that are likely to affect the impacts of a Residential CAC Standard. These factors include, assessing heat pump technical viability, examining heat pump installation and operating costs, evaluating HVAC workforce readiness, and estimating the statewide economic and greenhouse gas (GHG) emission impacts of a Residential CAC Standard.

Analysis Methodology

This analysis was performed to determine how a Residential CAC Standard would impact the following:

- Household and statewide energy consumption, including changes in natural gas, propane, and electricity usage
- Household and statewide GHG emissions from space heating and cooling
- Household-level utility bills and total heating and cooling costs, and the associated statewide costs when aggregated across all impacted households

The team also examined the following factors specific to CAC-to-heat pump replacements:

- The presumed payback period (if any) based on annual utility bill savings and the incremental cost of a heat pump installation vs. a CAC installation
- The influence of natural gas or propane and electricity prices on heat pump economics and GHG emission reduction potential
- The influence of climate zones and geographically defined analysis regions on heat pump economics and GHG emission reduction potential
- How heat pump economics and GHG emission reduction potential depend on heat pump equipment efficiency

Estimating the Reach of a Residential CAC Standard

To start the analysis, the team utilized the NREL Restock Database[4] and subdivided the Colorado data to estimate the number of households that would be impacted by the Residential CAC Standard. The population impacted by the standard includes residential one and two family dwelling units and townhouses with CAC installed or future new construction projects that are expected to install CAC. Out of the existing

[4] NREL ResStock Dataset

2,377,943 households in Colorado, 1,147,720 households are expected to be impacted by the standard. The team subdivided Colorado into 16 Geographic Analysis Regions, which were selected to capture variability in climate, housing, energy consumption patterns, fuel prices and electricity prices. When placing counties in the respective Geographic Analysis Regions, all counties in climate zone 4B were grouped in one region named Southeast Colorado and all counties in climate zones 6B and 7B were similarly grouped into the 6B Mountain and 7B High Mountain analysis regions, respectively. Climate zone 5B, where 91% of impacted households are located, was split into 13 more granular regions to better capture the variability of housing stock and electricity and fuel rates within this climate zone. Appendix Table 32 shows the estimated number of impacted households in each Colorado county and shows the relationship between county, climate zone, and the Geographic Analysis Regions.

While the total potential population that could be impacted by the Residential CAC Standard is 1,147,720 households, only those households that are purchasing new CACs in any given year are impacted each year. The number of CAC installations in retrofit scenarios that happen each year is estimated by multiplying the total impacted population by the estimated yearly turnover rate of residential CAC equipment, 5%.[5] In addition to retrofit installations, residential new construction projects that will include space cooling equipment are also impacted by the standard. To estimate the number of new construction units that will be impacted each year, the team added the forecasted county level increase in housing units from the Colorado Department of Local Affairs (DOLA)[6] to the estimated demolition rate from the Hud User Office of Policy Development and Research[7] to produce an estimate of total new constructed housing units. The team then multiplied total new construction housing units by the percent of homes with CACs per county from the 2000-2020 vintage from the ResStock database to estimate the number of newly constructed

[5] Updated Buildings Sector Appliance and Equipment Costs and Efficiencies, This source provides a lifetime range of 11 to 25 years; the team used professional judgment to select an average CAC lifetime of 20 years to estimate the number of annual CAC failures that lead to replacement.

[6] Excel file download link: DOLA forecasted county level increase in housing units

[7] Estimated housing demolition rates from HUD

homes with CAC installed each year. The team estimates 81,696 households and 81,696 CAC installation projects will be impacted by the Residential CAC Standard each year.[8] Assuming full compliance with the standard, these impacted CAC projects would result in the installation of 81,696 heat pumps each year.

Table 3 shows the estimated number of households and CAC installation projects impacted by the Residential CAC Standard in each Geographic Analysis Region, broken down by project type. Table 4 breaks down the estimated number of annual CAC installation projects by household existing primary heating fuel based on data from ResStock. Overall, 85%, 5.6%, and 9.4% of impacted CAC installations will occur in households with natural gas furnaces, propane furnaces, and electric resistance heating systems, respectively.

Table 3. Estimated number of CAC installations impacted by the Residential CAC Standard, by project type

Geographic Analysis Region	Annual Retrofit CAC Installations	Annual New Construction CAC Installations	Total Annual CAC Installations
Southeastern Colorado	429	23	452
6B Mountain	2,018	703	2,721
7B High Mountain	2,561	848	3,409
Adams County	4,630	2,459	7,088
Arapahoe County	5,816	2,301	8,117
Boulder_Broomfield_Gilpin	4,176	1,729	5,905
Denver County	4,806	2,216	7,022

[8] Assuming one CAC unit is installed in each impacted household

Geographic Analysis Region	Annual Retrofit CAC Installations	Annual New Construction CAC Installations	Total Annual CAC Installations
Douglas_Elbert	4,453	1,940	6,393
El Paso_Fremont_Teller	8,553	3,662	12,215
Jefferson County	5,879	1,663	7,542
La Plata_Montezuma	870	356	1,227
Larimer County	3,797	1,758	5,556
Mesa Area	3,179	1,775	4,954
Morgan Area	770	124	893
Pueblo Area	2,523	768	3,291
Weld County	2,914	1,986	4,900
Total:	57,373	24,310	81,684

Table 4. Estimated number of impacted CAC installations broken down by existing household heating system type

Geographic Analysis Region	Annual CAC Installations, Natural Gas Furnace	Annual CAC Installations, Propane Furnace	Annual CAC Installations, Electric Resistance Heating Systems
Southeastern Colorado	319	106	27
6B Mountain	1,905	561	255
7B High Mountain	2,468	521	420

Geographic Analysis Region	Annual CAC Installations, Natural Gas Furnace	Annual CAC Installations, Propane Furnace	Annual CAC Installations, Electric Resistance Heating Systems
Adams County	6,258	58	773
Arapahoe County	7,025	123	968
Boulder_Broomfield_Gilpin	5,352	250	303
Denver County	6,359	18	645
Douglas_Elbert	5,415	380	598
El Paso_Fremont_Teller	10,233	667	1,315
Jefferson County	6,700	81	761
La Plata_Montezuma	747	356	124
Larimer County	5,002	240	314
Mesa Area	4,148	472	334
Morgan Area	527	234	132
Pueblo Area	2,764	280	247
Weld County	4,285	191	424
Total:	69,507	4,538	7,639

Estimating Heat Pump Cost, Energy, and Carbon Impacts

Determining electric and fossil fuel prices

After designating the Geographic Analysis Regions, a representative electric and gas utility was chosen for each region by identifying the utility that serves the most households in each region. The team then gathered the electric and gas rates for each utility (retrieved between December 2024 and January 2025). When multiple electric rates were available to households, the team analyzed the two most common rate options and utilized results from the rate structure that provided the lowest heating and cooling bills after heat pump installation. The rates were constructed into 8760 volumetric rates based on utility time of use (TOU) programs, as applicable. For natural gas rates, the team assumed a flat volumetric rate based on the latest available retail price data. For propane rates, the team used the statewide propane rate estimate assumed in the ResStock database. Table 5 shows each Geographic Analysis Region's primary electric and gas utility, and Table 6 shows the volumetric rates for electricity, gas, and propane used for the economic analysis of each region. Due to the uncertainty in energy prices over 10+ year time spans, these rates were assumed to be constant over time when comparing the operational economics of heat pumps and CACs over time.

Table 5. Geographic Analysis Region with the primary electric and gas utility

Geographic Analysis Region	Primary Electric Utility	Primary Gas Utility
Southeast Colorado	Southeast Colorado Power Association	Atmos Energy
6B Mountain	Holy Cross Electric Association	Black Hills Energy
7B High Mountain	Xcel Energy	Xcel Energy
Adams County	Xcel Energy	Xcel Energy

Geographic Analysis Region	Primary Electric Utility	Primary Gas Utility
Arapahoe County	Xcel Energy	Xcel Energy
Boulder_Broomfield_Gilpin	Xcel Energy	Xcel Energy
Denver County	Xcel Energy	Xcel Energy
Douglas_Elbert	Core Electric Coop	Black Hills Energy
El Paso_Fremont_Teller	City of Colorado Springs	City of Colorado Springs
Jefferson County	Xcel Energy	Xcel Energy
La Plata_Montezuma	La Plata Electric Assn, Inc	Atmos Energy
Larimer County	City Of Fort Collins	Xcel Energy
Mesa Area	Xcel Energy	Xcel Energy
Morgan Area	Highline Electric Association	Xcel Energy
Pueblo Area	Black Hills Utility Holdings	Xcel Energy
Weld County	Xcel Energy	Atmos Energy

Table 6. Geographic Analysis Region primary electric and gas rates used for the economic analysis (rates gathered between December 2024 and January 2025)

Geographic Analysis Region	Electricity Price #1 ($/kWh)	Electricity Price #2 ($/kWh)	Natural Gas Price ($/Therm)	Propane Price ($/Gallon)
Southeast Colorado	$0.13	$0.13 first 1,000 kWh, $0.11 over 1,000 kWh	$0.71	$2.32
6B Mountain	$0.11	Holy Cross Electric Association[9]	$1.34	$2.32
7B High Mountain	$0.13	Xcel TOU	$0.87	$2.32
Adams County	$0.13	Xcel TOU[10]	$0.87	$2.32
Arapahoe County	$0.13	Xcel TOU	$0.87	$2.32
Boulder_Broomfield_Gilpin	$0.13	Xcel TOU	$0.87	$2.32
Denver County	$0.13	Xcel TOU	$0.87	$2.32
Douglas_Elbert	$0.11	Core Electric Coop TOU[11]	$0.70	$2.32
El Paso_Fremont_Teller	$0.12	CO Springs	$0.50	$2.32
Jefferson County	$0.13	Xcel TOU	$0.87	$2.32
La Plata_Montezuma	$0.12	La Plata Electric Assn,	$0.62	$2.32

[9] Holy Cross Energy Electric Service Tariff, Rules and Regulations
[10] Xcel Energy Colorado TOU rate information
[11] CORE Electric Cooperative Rates and Regulations

Geographic Analysis Region	Electricity Price #1 ($/kWh)	Electricity Price #2 ($/kWh)	Natural Gas Price ($/Therm)	Propane Price ($/Gallon)
		Inc[12]		
Larimer County	Electric Heat TOU[13]	Gas Heat TOU	$0.87	$2.32
Mesa Area	$0.13	Xcel TOU	$0.87	$2.32
Morgan Area	$0.09	Highline Electric Association TOU[14]	$0.87	$2.32
Pueblo Area	$0.13[15]	N/A	$0.87	$2.32
Weld County	$0.13	Xcel TOU	$0.94	$2.32

[12] LPEA electric rate information

[13] Fort Collins electric rate information

[14] Highline Electric Association Tariff information

[15] Shortly after the economic analysis for this white paper was performed, the electric rate for Black Hills customers was increased from $0.13/kWh to $0.16/kWh, PUC info on Black Hills rate case

Heating system operation modeling

The team aggregated 15 min interval data from ResStock into hourly heating and cooling loadshapes for each region.[16] These loadshapes include data on energy usage and GHG impacts. GHG impacts in ResStock are derived from the NREL Cambium dataset.[17] The electric grid emissions used are marginal emissions averaged over a 15-year time horizon under cambium's mid-case forecast scenario. The hourly emission values in this dataset are provided at the month-hour level, i.e., the forecasted emissions in each month are averaged for each hour of the day in that month. This methodology captures monthly and diurnal changes in electric grid GHG emissions but does not allow for a direct comparison between temperature and emission rates.[18] Emission intensity for natural gas and propane was sourced from ResStock and includes methane leakage from the natural gas system, expressed in CO2e.

For all modeling, heat pumps were sized to cover cooling design loads typical of the Front Range region of Colorado (e.g. 2 to 3 tons cooling capacity). For households in climate zones 6B and 7, sizing for design cooling load according to standard sizing procedures (Manual J and Manual S) often results in the selection of very small heat pumps (smaller than is typically available for purchase). The number of households with CAC systems that are located in climate zones 6B and 7 is not very high, and the team assumes these homes are likely large in size, with above average cooling load requirements. Thus, the team assumed households with CACs in climate zones 6B and 7 would also utilize heat pumps sized to cover typical Front Range cooling loads. Note that sizing a heat pump to cover cooling load will typically result in a heat pump installation that is not capable of meeting the home's full heating requirements.

[16] ResStock includes a file for each model that contains 15 min interval data. The team assembled a database of each of these files, totaling 15-minute interval data for 4,549 models that represent the housing of all impacted residents. This data was summarized by region to create regional loadshapes that account for the housing stock and weather of each region.

[17] NREL Cambium dataset

[18] It is the authors opinion that this may result in a slight overestimate of emission benefits at lower switchover temperatures and a slight underestimate of emission benefits at higher switchover temperatures due to the expected relationship between the grid's fraction of clean energy and ambient air temperature.

Thus, we assume all households retain their existing heating systems and use them for backup or supplemental heat in dual fuel configurations (in homes with natural gas or propane furnaces) or all-electric heating systems (in homes with electric resistance heating systems).

The regional 8760 energy and emission loadshapes were paired with a minimum efficiency heat pump (meHP) and cold-climate heat pump (ccHP) performance models[19] to estimate energy consumption, annual heating costs, and GHG emissions of the heat pumps when operated in dual fuel systems with differing switchover temperatures. The switchover temperature is the temperature at which the thermostat is programmed to switch from heating with the heat pump to heating with the natural gas or propane furnace in dual fuel heating systems. Heat pump performance and economics in households with existing electric resistance space heating systems were modeled without any heat pump switchover temperature and without setback-induced increases in electric resistance heating. As a result, in these all-electric heating systems, the heat pump was assumed to operate whenever it was capable of outputting heat (down to -5 degrees F for meHPs and -15 degrees F for ccHPs). The electric resistance heating system was modeled to supplement the heat pump when the heat pump heating output was lower than the building heat load.

For meHPs, the range of switchover temperature examined was 20 to 50 degrees F. For ccHPs, switchover temperatures between 5 and 50 degrees F were examined. Below these minimum temperatures, a heat pump installed in a CAC-replacement scenario with no ductwork modifications or electrical infrastructure upgrades will likely have insufficient heating capacity to meet the building heating load. Thus, the team assumed the existing gas or propane furnace supplies all heating when the outdoor temperature is below the switchover temperature. At switchover

[19] Equipment performance maps for modeled meHPs (Carrier 25SPA5) and ccHPs (Carrier 25VNA8) were used to develop an equipment performance model. Carrier publishes expanded product performance maps in a way that most other manufacturers do not.

temperatures of 50 degrees F, the heat pump is only supplying a marginal amount of the annual heating load for the residential building.

The team then determined the economically optimal switchover temperature for each heating system type in each Geographic Analysis Region, where the economically optimal switchover temperature is defined as the switchover temperature within the allowed range that provided the lowest annual heating utility bill. For the economic and GHG emission reduction impact analysis, the team assumed that households in each region would utilize the economically optimal switchover temperature when operating their heating system over the lifetime of the heat pump. The Residential CAC Standard analyzed does not require that households operate their heat pump heating systems with any particular switchover temperature and does not even explicitly require that the household utilize the heat pump for heating. The standard simply requires that a heat pump is installed instead of a CAC. That said, the team believes it is fair to assume that households will operate their heat pump system in an economically optimal manner that reduces heating utility bills.

Figure 1 below shows the estimated annual heating cost for a dual fuel heating system composed of a meHP and 80% annual fuel utilization efficiency (AFUE) natural gas furnace for a range of switchover temperatures for various Geographic Analysis Regions. Regions with high natural gas costs (e.g. climate zone 6B-Mountains, Morgan County Area) have lower heating costs at lower switchover temperatures, while regions with low natural gas costs (e.g. El Paso County) have lower heating costs with higher switchover temperatures.

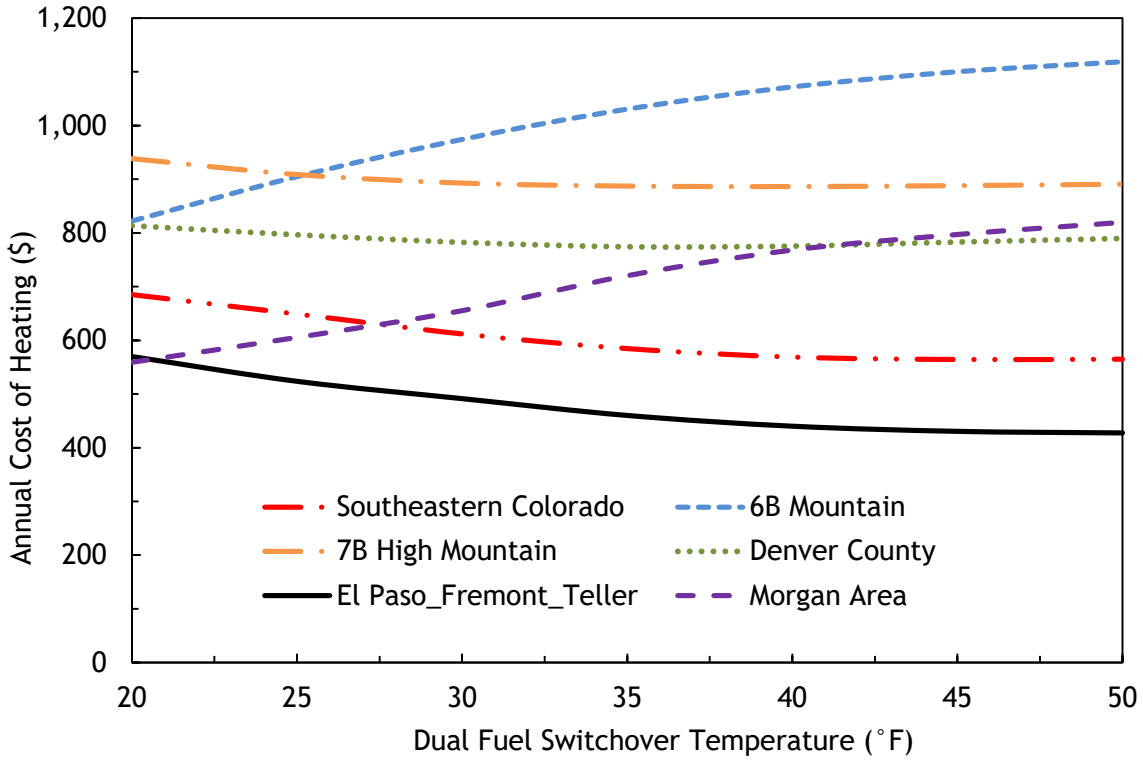


Figure 1. Annual heating cost as a function of switchover temperature. The Dual fuel heating system is composed of a meHP and 80% AFUE natural gas furnace.

Table 7 and Appendix Table 33 summarize the economically optimal switchover temperature for dual fuel heating system combinations in each Geographic Analysis Region, for natural gas and propane heating systems, respectively. The switchover temperature for natural gas dual fuel heating systems varies significantly between Geographic Analysis Region, showing that there is geographic variation for when it is more economical to operate a heat pump or a natural gas furnace. On the other hand, propane dual fuel systems have switchover temperatures of 20 degrees F and 5 degrees F for meHPs and ccHPs, respectively, in 15 out of 16 regions showing that it is nearly always economically optimal to operate a heat pump instead of a propane furnace. ccHPs generally have lower economically optimal switchover temperatures when compared to meHPs, because ccHPs are frequently more efficient than meHPs, especially at temperatures below 20 degrees F. In addition, homes with 80% efficient furnaces have lower switchover temperatures, because the heat pump provides higher natural gas savings when paired with lower efficiency furnaces.

Table 7. Calculated economically optimal switchover temperatures for dual fuel heating systems utilizing natural gas as the heating fuel

Geographic Analysis Region	meHP + 80% AFUE Nat. Gas Furnace	meHP + 96% AFUE Nat. Gas Furnace	ccHP + 80% AFUE Nat. Gas Furnace	ccHP + 96% AFUE Nat. Gas Furnace
Southeastern Colorado	45	50	40	45
6B Mountain	20	20	5	5
7B High Mountain	40	50	25	40
Adams County	35	45	30	35
Arapahoe County	35	45	30	35
Boulder_Broomfield_Gilpin	35	45	30	40
Denver County	35	45	30	35
Douglas_Elbert	35	50	25	35
El Paso_Fremont_Teller	50	50	45	50
Jefferson County	35	45	30	40
La Plata_Montezuma	45	50	40	45
Larimer County	30	45	25	30
Mesa Area	35	45	25	35
Morgan Area	20	20	10	15
Pueblo Area	35	45	30	40
Weld County	30	40	25	30

In addition to the impacts on heating utility bills, the team calculated cooling utility bill savings based on the higher federal minimum efficiency standard for heat pumps compared to air conditioners. A minimum seasonal energy efficiency ratio (SEER2) value of 14.3 was used for heat pumps and a minimum SEER2 value of 13.4[20] was used for CACs.

After calculating the economics and GHG emission impacts for each CAC installation type at the Geographic Analysis Region level, the team used the distribution of households with each heating system efficiency level and fuel type from ResStock to weigh the average per household impacts for each region to a statewide level.

[20] EIA, Efficiency requirements for residential central AC and heat pumps to rise in 2023

Estimated Household-Level Impacts

To estimate the household impacts of a Residential CAC Standard in Colorado, the team examined the upfront incremental cost of heat pumps, modeled operating costs for heat pumps for space heating and cooling, estimated changes in overall electricity and natural gas or propane use after heat pump installation, and estimated changes in GHG emissions per household.

Heat pump upfront incremental cost

The team relied on a secondary literature review, interviews with market experts, and contractor focus groups to estimate heat pump costs. The team estimates the total installed cost of a 3-ton ducted meHP (SEER2 = 14.3) to be $2,200 higher than the cost of a 3-ton minimum efficiency central air conditioner (meCAC) installed alongside the existing heating system.[21] This estimate was determined by averaging incremental cost estimates from a variety of sources as shown in Table 8. The average incremental cost was determined to be roughly $2,200 (rounded down from $2,232). The higher costs for the heat pump reflect higher equipment efficiency (SEER2 of 14.3 vs. 13.4), additional components to allow heat pump operation (e.g. reversing valve and defrost controls), and slightly higher installation costs. HVAC contractors were asked to compare the installation process for a heat pump and an CAC, and they responded that the primary difference was the potential need for a new thermostat and/or need for a different control wire between the heat pump outdoor condenser and indoor unit (or from the thermostat to the indoor unit). Thus, the team expects the labor cost differences between a meHP and a meCAC to be small but non-zero in many cases.

[21] Costs are expected to vary depending on local labor conditions and home and heating system type, but it was beyond the scope of this study to develop individual cost models for all 16 analysis regions

Table 8. Data and sources used to estimate the incremental cost of a meHP

Source	meCAC Cost 13-14 SEER2	meHP Cost 14-15 SEER2	Incremental Cost of meHP
Heat Pumps in the Northeast and Mid-Atlantic: Costs and Market Trends, 2024	$4,140	$7,200	$3,060
TECH Clean California Incremental Cost Study, 2024	$9,777	$11,201	$1,424
Cool Way to Heat Homes, 2024	$6,546	$8,503	$1,957
Heat pumps for all? Distributions of the costs and benefits of residential air-source heat pumps in the United States, 2024	$5,891	$8,562	$2,671
Xcel 2024-2026 Demand-Side Management & Beneficial Electrification Plan, 2023	$7,522	$9,195	$1,673
Investigation of Air Source Heat Pumps as a Replacement of Central Air Conditioning, 2022	N/A	N/A	$1,350[22]
EIA – Technology Forecast Updates – Residential and Commercial Building Technologies – Advanced Case, 2023	$5,310	$6,810	$1,500
The Cost of Decarbonization and Energy Upgrade Retrofits for US Homes, 2021	$6,000	$7,443	$1,443
2023 Illinois Statewide Technical Reference Manual, V11.0, 2023	$2,960	$8,485	$5,525
Wholesale equipment price data from RMI	$4,301.60[23]	$6,018.75	$1,717.16

[22] Determined using the average of the wholesale price and project bid methods
[23] Full installation cost estimated by adding a 40% margin on top of equipment cost

For ccHPs, the team estimates the incremental cost of a 3-ton ccHP over a 3-ton meCAC is $6,600. There is significant diversity in ccHP equipment price and capability so estimating a single incremental price is difficult. That said, when possible, the team tried to identify price estimates for heat pumps that met the ENERGY STAR cold-climate heat pump specification and had SEER2 between 15.2 and 20. The team also tried to identify price data that did not include the cost of supplemental heating systems, ductwork modifications, or electrical upgrades. The price data used to determine the $6,600 incremental price is shown in Table 9. The incremental cost for a ccHP is expected to be higher than that of a meHP because ccHPs typically have inverter compressor technology and higher SEER2. Based on conversations with HVAC contractors, ccHP systems in Colorado are currently used primarily in full heating system electrification projects or new dual fuel heating systems as opposed to scenarios where a CAC is replaced with a ccHP. That said, ccHPs were still modeled herein because there is likely no technical factor that would prevent a household from installing a ccHP and using it alongside their existing heating system.

Table 9. Data and sources used to estimate the incremental cost of installing a ccHP

Source	meCAC Cost 13-14 SEER2	ccHP Cost 15-20 SEER2	Incremental Cost of ccHP
Xcel 2024-2026 Demand-Side Management & Beneficial Electrification Plan, 2023	$7,522	$17,739	$10,217
Heat pumps for all? Distributions of the costs and benefits of residential air-source heat pumps in the United States, 2024	$5,891	$12,900[24]	$7,009
Heat Pumps Pay Off, Unlocking lower-cost heating and cooling in Canada, 2023	$4,913	$13,200	$8,287
Investigation of Air Source Heat Pumps as a	N/A	N/A	$7,860[25]

[24] Price estimate taken from Figure 7, assuming a heating seasonal performance factor of 11.0
[25] Determined using the average of the wholesale price and project bid methods

Source	meCAC Cost 13-14 SEER2	ccHP Cost 15-20 SEER2	Incremental Cost of ccHP
Replacement of Central Air Conditioning, 2022			
EIA – Technology Forecast Updates – Residential and Commercial Building Technologies – Advanced Case, 2023	$5,310	$6,940	$1,630
Wholesale equipment price data from RMI	$4,301.60[26]	$8,901.47	$4,599.87

When modeling the economics of meHPs and ccHPs, the team assumed no rebates or tax credits were used to offset incremental installation and equipment costs for heat pumps. This assumption was made because there is uncertainty in incentive levels over the 18-year time frame examined in this analysis. Utility and local government rebate levels frequently change from year to year and equipment efficiency requirements tend to change over time. However, rebates and tax credits are currently an important piece of the HVAC ecosystem in Colorado with significant incentives available for many households that install heat pumps. Thus, their impact on heat pump economics is discussed in a later section of this white paper.

Economic impacts after heat pump installation

Space heating and cooling system operating costs, energy use, and GHG emissions were calculated for each equipment scenario in each Geographic Analysis Region. All households in Colorado are found to realize annual heating and cooling bill savings after installation of a meHP or ccHP instead of a meCAC (when the meHP is operated in an economically optimal manner). That said, the specific amount of utility bill savings is not evenly distributed across households. An estimated 82% of households realize annual utility bill savings of $50 or less after installing a meHP, as shown in

[26] Full installation cost estimated by adding a 40% margin on top of equipment cost

Figure 2. The other 18% of Colorado households see much more significant utility bill savings after installing a meHP, with 3% of households saving between $50 and $500 per year, 2% of households saving between $500 and $1,000 per year, and 13% of households saving over $1,000 per year.

When the annualized incremental meHP cost of $122/year is added to the annual utility bill savings, the resulting annual total savings are negative (an added cost) for 82% of households and positive (savings) for the other 18% of households. The primary conclusion from this data is that the annual total savings potential after a heat pump installation is divided into two primary cohorts. One cohort of Colorado households (≈80% of households) sees a modest annual total cost increase after installing a meHP instead of a meCAC and the other cohort (≈20% of households) sees large annual savings after installing a meHP. Decreasing the upfront incremental cost of installing a heat pump would play a large role in improving heat pump economics and making installation of a meHP economically positive for all Colorado households.

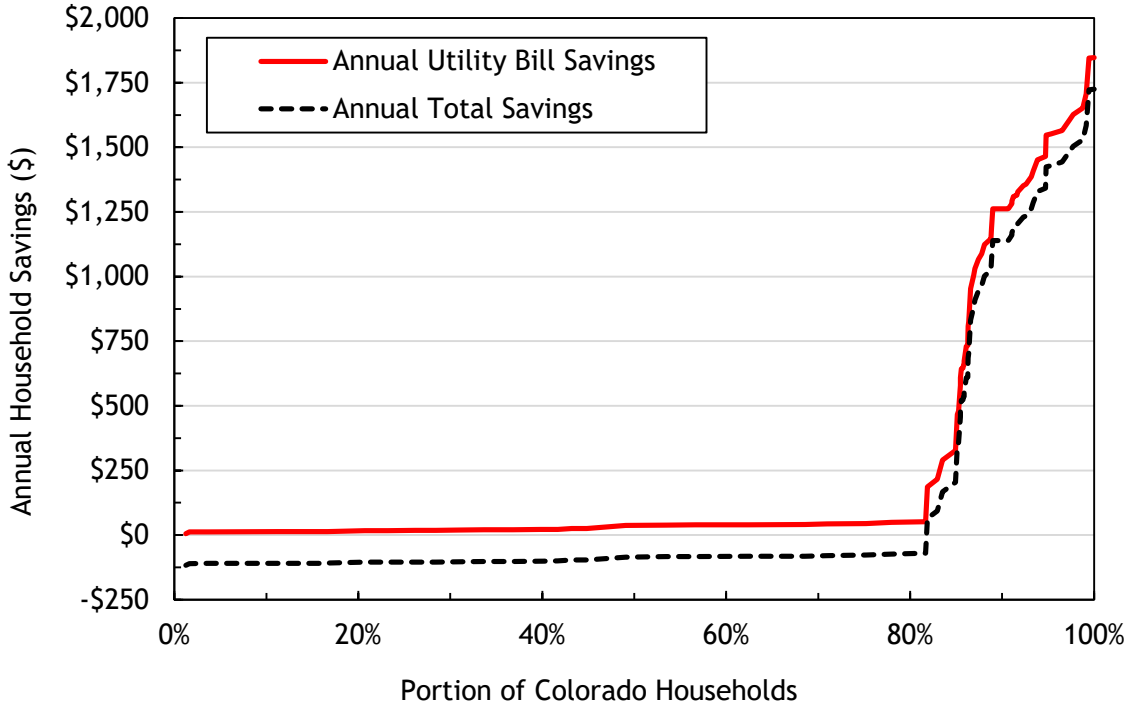


Figure 2. Distribution of annual heating and cooling utility bill savings and annual total savings for Colorado households that install a meHP instead of a meCAC

The key driver behind this uneven distribution of savings is the fuel used by the existing heating systems in each household. Figure 3 breaks down the economic impacts of the Residential CAC Standard by the number of households with each heating fuel type (either natural gas, propane, or electricity). The household economic impacts of the Residential CAC Standard depend strongly on household existing heating fuel. Most Colorado households use natural gas furnaces for space heating, and these households see a modest increase in annual total costs ($0 to $100) after installing a meHP instead of a meCAC. Households with existing propane furnace heating systems realize significant annual total savings ($375 to $1,500) after installing a meHP and the incremental cost of the heat pump is paid back within only a few years. The economic value of installing a meHP is even stronger for households with existing electric resistance space heating systems. These households see annual total savings of $750 to $2,000 and would have their investments in a meHP recovered within 1 or 2 two years. Thus, households with a CAC and propane furnace or electric resistance heating system should install a heat pump when their existing CAC reaches end life if they aim to optimize for the lowest annual total heating and cooling costs. These households would see significant savings over the expected 18-year lifetime of the installed heat pump.

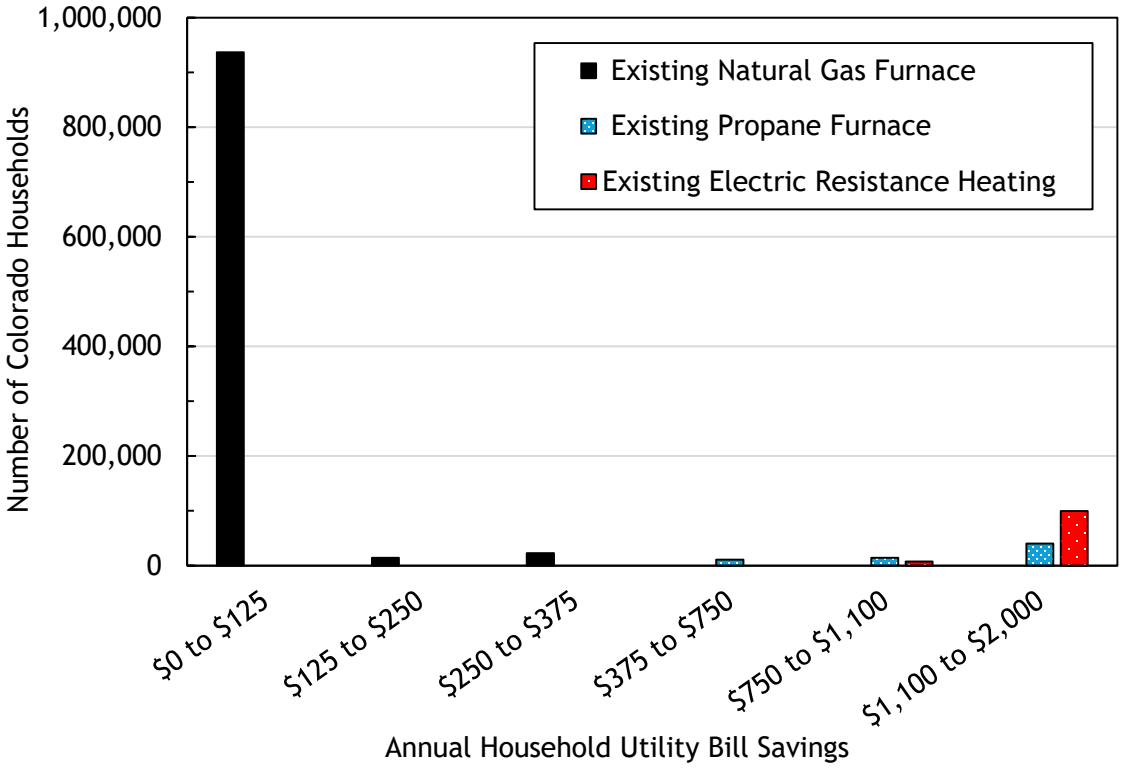


Figure 3. Number of Colorado households, organized by existing heating fuel, as a function of annual utility bill savings after a meHP is installed instead of a meCAC

Regional breakdown: annual utility bill savings

Using the electricity and fuel prices as laid out in Table 6, the annual utility bill savings per household associated with installing a heat pump alongside different existing heating equipment were calculated for all 16 Geographic Analysis Regions. Heating and cooling utility bill savings for Colorado households that install a meHP and ccHP are shown in Table 10 and Table 11, respectively. Note that these utility bill savings metrics do not account for the incremental cost of a heat pump vs. a meCAC. For both meHPs and ccHPs, heating utility bill savings are highly variable across different regions, primarily because of variability in natural gas prices and secondarily because annual heating loads vary across regions. The cooling utility bill savings are less variable given that electricity rates are fairly stable across the different regions

examined. Regions with very low cooling loads (6B Mountain and 7B High Mountain) have smaller cooling savings as expected. A key finding is that all households realize heating and cooling utility bill savings after installing a meHP or ccHP. The level of savings, however, is highly dependent on existing heating system type and local electricity and fossil fuel prices.

Table 10. Annual heating and cooling utility bill savings from using a dual fuel or all electric heating system with the meHP (instead of a meCAC), does not account for the $2,200 incremental cost of a meHP vs. a meCAC

Geographic Analysis Region	80% AFUE Nat. Gas Furnace, Heating Savings	96% AFUE Nat. Gas Furnace, Heating Savings	80% AFUE Propane Furnace, Heating Savings	96% AFUE Propane Furnace, Heating Savings	Electric Resistance, Heating Savings	Cooling Savings
Southeastern Colorado	$4	$0	$1,098	$816	$1,525	$22
6B Mountain	$317	$207	$904	$695	$1,078	$9
7B High Mountain	$7	$0	$867	$635	$1,841	$5
Adams County	$19	$2	$916	$679	$1,447	$18
Arapahoe County	$21	$3	$988	$732	$1,547	$19
Boulder_Broomfield_Gilpin	$28	$3	$1,165	$866	$1,690	$16
Denver County	$21	$3	$1,016	$753	$1,587	$18
Douglas_Elbert	$0	$0	$1,052	$811	$1,129	$17
El Paso_Fremont_Teller	$0	$0	$1,046	$798	$1,248	$13
Jefferson County	$26	$3	$1,096	$813	$1,637	$15

Geographic Analysis Region	80% AFUE Nat. Gas Furnace, Heating Savings	96% AFUE Nat. Gas Furnace, Heating Savings	80% AFUE Propane Furnace, Heating Savings	96% AFUE Propane Furnace, Heating Savings	Electric Resistance, Heating Savings	Cooling Savings
La Plata_Montezuma	$2	$0	$710	$533	$1,019	$12
Larimer County	$38	$4	$1,037	$792	$1,301	$15
Mesa Area	$16	$2	$880	$651	$1,259	$24
Morgan Area	$278	$175	$1,447	$1,149	$941	$12
Pueblo Area	$21	$4	$917	$679	$1,364	$22
Weld County	$33	$6	$934	$690	$1,607	$16

Table 11. Annual heating and cooling utility bill savings from using a dual fuel or all electric heating system with the ccHP (instead of a meCAC), does not account for the $6,600 incremental cost of a ccHP vs. a meCAC

Geographic Analysis Region	80% AFUE Nat. Gas Furnace, Heating Savings	96% AFUE Nat. Gas Furnace, Heating Savings	80% AFUE Propane Furnace, Heating Savings	96% AFUE Propane Furnace, Heating Savings	Electric Resistance, Heating Savings	Cooling Savings
Southeastern Colorado	$29	$10	$1,240	$927	$1,578	$101
6B Mountain	$582	$402	$1,534	$1,196	$1,141	$43
7B High Mountain	$57	$9	$1,435	$1,041	$1,929	$25
Adams County	$66	$20	$1,140	$846	$1,522	$83
Arapahoe County	$67	$21	$1,210	$893	$1,617	$88
Boulder_Broomfield_Gilpin	$82	$29	$1,350	$998	$1,755	$77
Denver County	$68	$21	$1,239	$913	$1,657	$83
Douglas_Elbert	$23	$0	$1,311	$1,012	$1,186	$80
El Paso_Fremont_Teller	$6	$0	$1,332	$1,014	$1,296	$61

Geographic Analysis Region	80% AFUE Nat. Gas Furnace, Heating Savings	96% AFUE Nat. Gas Furnace, Heating Savings	80% AFUE Propane Furnace, Heating Savings	96% AFUE Propane Furnace, Heating Savings	Electric Resistance, Heating Savings	Cooling Savings
Jefferson County	$74	$25	$1,301	$957	$1,702	$69
La Plata_Montezuma	$9	$3	$992	$753	$1,094	$56
Larimer County	$98	$35	$1,320	$1,000	$1,391	$68
Mesa Area	$65	$18	$1,042	$783	$1,329	$111
Morgan Area	$331	$214	$1,824	$1,443	$974	$57
Pueblo Area	$63	$22	$1,091	$807	$1,424	$101
Weld County	$90	$29	$1,262	$923	$1,685	$74

Regional breakdown: annual total savings

The annual total savings for households is calculated by combining the annual heating and cooling utility bill savings and the annualized incremental cost of the heat pump installation. A $2,200 incremental cost for a meHP divided across an 18-year equipment life yields an incremental heat pump cost of $122 per year. A $6,600 incremental cost for a ccHP corresponds to an incremental cost of $367 per year. These incremental costs were assumed to be the same in all Geographic Analysis Regions, but prices may differ slightly due to local labor conditions and regional equipment availability.

When examining household annual total savings, a positive number represents annual savings for the households and a negative number represents an added cost (compared to if the household had just installed a meCAC instead of a meHP). These annual total savings estimates are shown in Table 12 and Table 13 for meHPs and ccHPs, respectively.

Natural gas households only realize annual total savings after installing a meHP or ccHP in the 6B Mountain and Morgan Area regions. The 6B Mountain region has relatively high natural gas prices and the Morgan Area has relatively low electricity prices. Natural gas households in the other 14 Geographic Analysis Regions realize an added annual total cost after installing a meHP instead of a meCAC. Households with existing electric resistance or propane heating systems are found to always have annual total savings when they install a heat pump instead of a meCAC, regardless of region, and these savings generally are between $500 and $2,000 per year.

ccHPs provide greater annual heating and cooling utility bill savings than meHPs. On net, however, the higher incremental cost of a ccHP outweighs the increased utility bill savings and makes the household annual total savings for ccHPs less favorable than that of meHPs in all regions, especially when households use natural gas for space heating. If the price of ccHPs were to decrease in future years as the technology matures, the economics for households installing ccHPs would improve.

Table 12. Estimated household annual total savings after installing a meHP instead of a meCAC (positive numbers represent savings, negative numbers are added cost)

Geographic Analysis Region	80% AFUE Nat. Gas Furnace	96% AFUE Nat. Gas Furnace	80% AFUE Propane Furnace	96% AFUE Propane Furnace	Electric Resistance
Southeastern Colorado	-$97	-$101	$998	$716	$1,424
6B Mountain	$204	$94	$790	$582	$965
7B High Mountain	-$110	-$117	$750	$518	$1,724
Adams County	-$85	-$102	$812	$574	$1,342
Arapahoe County	-$83	-$101	$884	$628	$1,443
Boulder_Broomfield_Gilpin	-$77	-$103	$1,059	$760	$1,584
Denver County	-$83	-$102	$912	$648	$1,483
Douglas_Elbert	-$105	-$105	$947	$706	$1,024
El Paso_Fremont_Teller	-$109	-$109	$937	$689	$1,139
Jefferson County	-$82	-$104	$988	$705	$1,529
La Plata_Montezuma	-$108	-$110	$599	$423	$908
Larimer County	-$70	-$104	$929	$685	$1,193
Mesa Area	-$83	-$97	$782	$552	$1,160
Morgan Area	$167	$64	$1,337	$1,039	$831
Pueblo Area	-$79	-$97	$816	$578	$1,264
Weld County	-$73	-$100	$828	$584	$1,501

Table 13. Estimated household annual total savings after installing a ccHP instead of a meCAC (positive numbers represent savings, negative numbers are added cost)

Geographic Analysis Region	80% AFUE Nat. Gas Furnace	96% AFUE Nat. Gas Furnace	80% AFUE Propane Furnace	96% AFUE Propane Furnace	Electric Resistance
Southeastern Colorado	-$237	-$256	$974	$661	$1,312
6B Mountain	$258	$78	$1,210	$872	$817
7B High Mountain	-$285	-$333	$1,093	$699	$1,587
Adams County	-$218	-$264	$856	$562	$1,238
Arapahoe County	-$212	-$258	$931	$614	$1,338
Boulder_Broomfield_Gilpin	-$208	-$261	$1,060	$708	$1,465
Denver County	-$216	-$263	$955	$629	$1,373
Douglas_Elbert	-$264	-$287	$1,024	$725	$899
El Paso_Fremont_Teller	-$300	-$306	$1,026	$708	$990
Jefferson County	-$224	-$273	$1,003	$659	$1,404
La Plata_Montezuma	-$302	-$308	$681	$442	$783
Larimer County	-$201	-$264	$1,021	$701	$1,092
Mesa Area	-$191	-$238	$786	$527	$1,073
Morgan Area	$21	-$96	$1,514	$1,133	$664
Pueblo Area	-$203	-$244	$825	$541	$1,158
Weld County	-$203	-$264	$969	$630	$1,392

Impacts of electricity and fossil fuel price

Electricity to fossil fuel price ratio

The annual total savings potential per household is directly related to the price of heating fuel and electricity. When the electricity price (in $/kWh) to natural gas or propane price (in $/therm) ratio is less than ≈0.1, heat pumps provide large utility bill savings for households, and it is economically optimal to install a meHP instead of a meCAC. When the electricity-to-fuel price ratio is between 0.1 and 0.12, heat pumps provide annual utility bill savings, but the savings may or may not be large enough to offset the incremental cost paid to install a heat pump instead of a CAC (it will depend on the exact incremental cost and the household heating and cooling needs). When the electricity-to-fuel price ratio is above 0.12, the utility bill savings generated by the heat pump are generally not large enough to offset the incremental cost of installing the heat pump (assuming no upfront incentives are available for installing the heat pump).

With current propane prices in Colorado the electricity-to-propane price ratio is below 0.10 in all Geographic Analysis Regions. Thus, households with propane heating systems in all regions were found to have very favorable heat pump operating economics and short payback periods after investing in heat pumps. The story is more mixed for Colorado households that use natural gas for heating in 2025. As an example, households utilizing Xcel Energy for both gas and electricity service pay approximately $0.87/therm for natural gas and $0.13/kWh for electricity in 2025. The resulting price ratio is 0.15, providing less attractive heat pump operating economics. A household with Xcel Energy service would still realize annual heating and cooling bill savings if they installed a meHP instead of a meCAC, but the savings are not large enough to offset the incremental cost of the heat pump within its 18-year lifetime.

Table 14 shows the current electricity-to-fuel price ratio for all 16 Geographic Analysis Regions. Three regions (6B Mountain, Morgan Area, and Larimer County) have highly favorable heat pump economics at current price levels for households with

natural gas heating systems. The 6B Mountain region currently has higher than average natural gas prices and the Morgan Area and Larimer County have lower than average electricity prices.

In contrast, in Colorado Springs (El Paso_Fremont_Teller), the electricity-to-natural gas price ratio is currently 0.24, resulting in very poor heat pump operating economics (hence why the economically optimal switchover temperatures are high for this region). In most other regions, the ratio sits between 0.14 and 0.20, resulting in situations where the heat pump does not provide large enough annual heating and cooling savings to pay off the upfront incremental cost of the heat pump.

Table 14. Comparison of electricity and natural gas prices for January 2025 prices and a scenario where natural gas prices are 50% higher than the January 2025 price

Geographic Analysis Region	Electricity Price ($/kWh)	Natural Gas Price ($/therm)	Ratio of Electricity to Nat. Gas Price	Ratio With 50% Higher Nat. Gas Price
Southeastern Colorado	0.13	0.71	0.18	0.12
6B Mountain	0.11	1.34	0.08	0.05
7B High Mountain	0.13	0.87	0.15	0.10
Adams County	0.13	0.87	0.15	0.10
Arapahoe County	0.13	0.87	0.15	0.10
Boulder_Broomfield_Gilpin	0.13	0.87	0.15	0.10
Denver County	0.13	0.87	0.15	0.10
Douglas_Elbert	0.11	0.70	0.16	0.10
El Paso_Fremont_Teller	0.12	0.50	0.24	0.16
Jefferson County	0.13	0.87	0.15	0.10

Geographic Analysis Region	Electricity Price ($/kWh)	Natural Gas Price ($/therm)	Ratio of Electricity to Nat. Gas Price	Ratio With 50% Higher Nat. Gas Price
La Plata_Montezuma	0.12	0.62	0.19	0.13
Larimer County	0.093	0.87	0.11	0.07
Mesa Area	0.13	0.87	0.15	0.10
Morgan Area	0.090	0.87	0.10	0.07
Pueblo Area	0.13	0.87	0.15	0.10
Weld County	0.13	0.94	0.14	0.09

Impacts of higher natural gas prices

The U.S. Energy Information Agency (EIA) is currently projecting spot natural gas prices will increase through 2026, potentially by more than 50% (see Figure 4 below). If this projected natural gas price increase results in a significant increase in natural gas retail prices for Coloradans, the economics of installing and operating a heat pump in Colorado will likely significantly improve. Table 14 shows how the electricity-to-fuel price ratio would change if natural gas prices in each region were increased by 50% (and electricity price was held constant). Increasing natural gas prices by 50% reduces the electricity-to-fuel price ratio to ≈0.10 in 13 out of 16 Geographic Analysis Regions. Figure 5 shows that in the scenario of 50% higher natural gas prices in Colorado, roughly 80% of Colorado households would realize positive annual total savings after installing a meHP instead of a meCAC and Figure 6 shows that an increased number of natural gas households see utility bill savings over $125 per year when gas prices are increased by 50% (compared to what is shown in Figure 3).

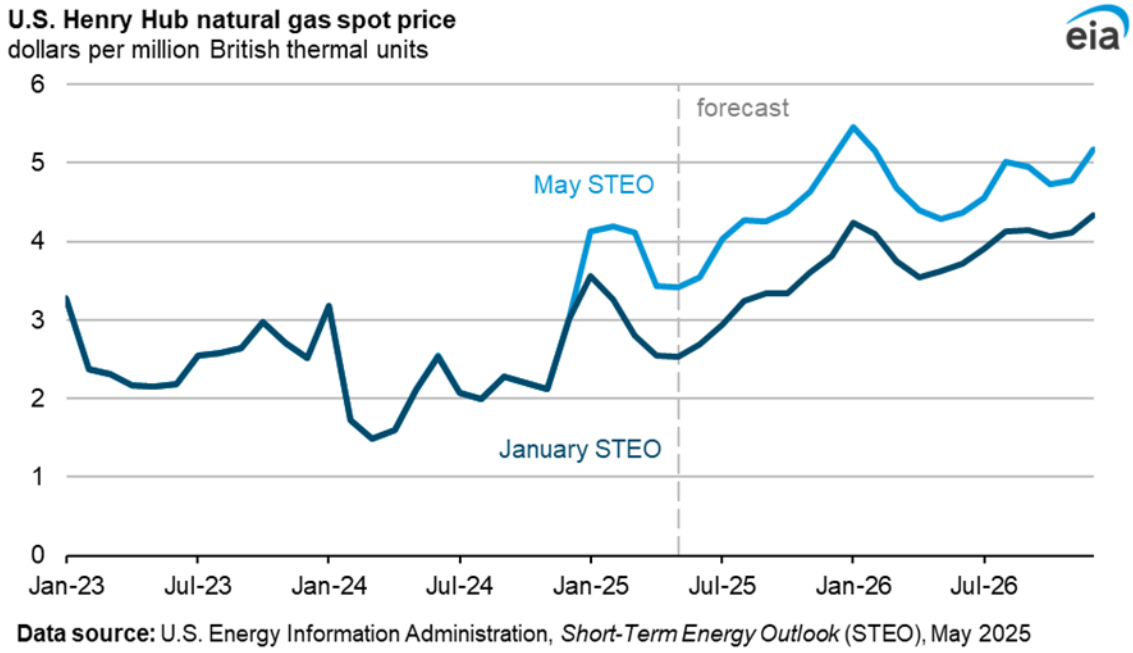


Figure 4. Natural gas spot price projections produced by the U.S. EIA, retrieved May 2025

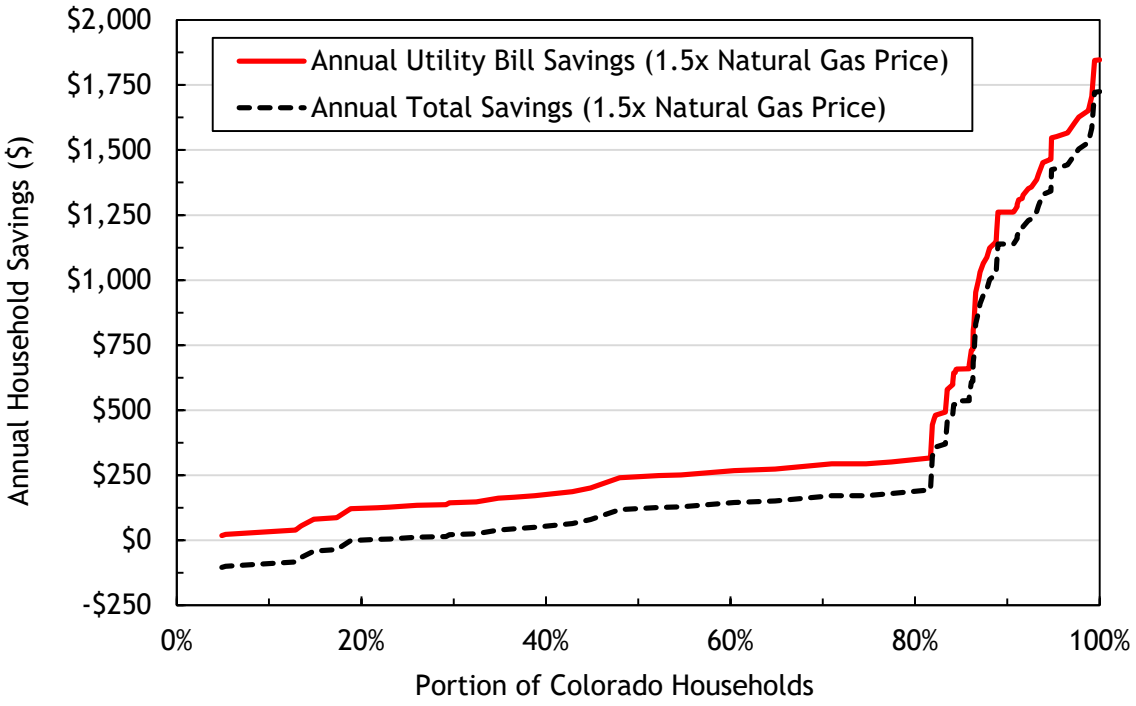


Figure 5. Distribution of annual utility bill savings and annual total savings for households that install a meHP instead of a meCAC (1.5x natural gas price scenario)

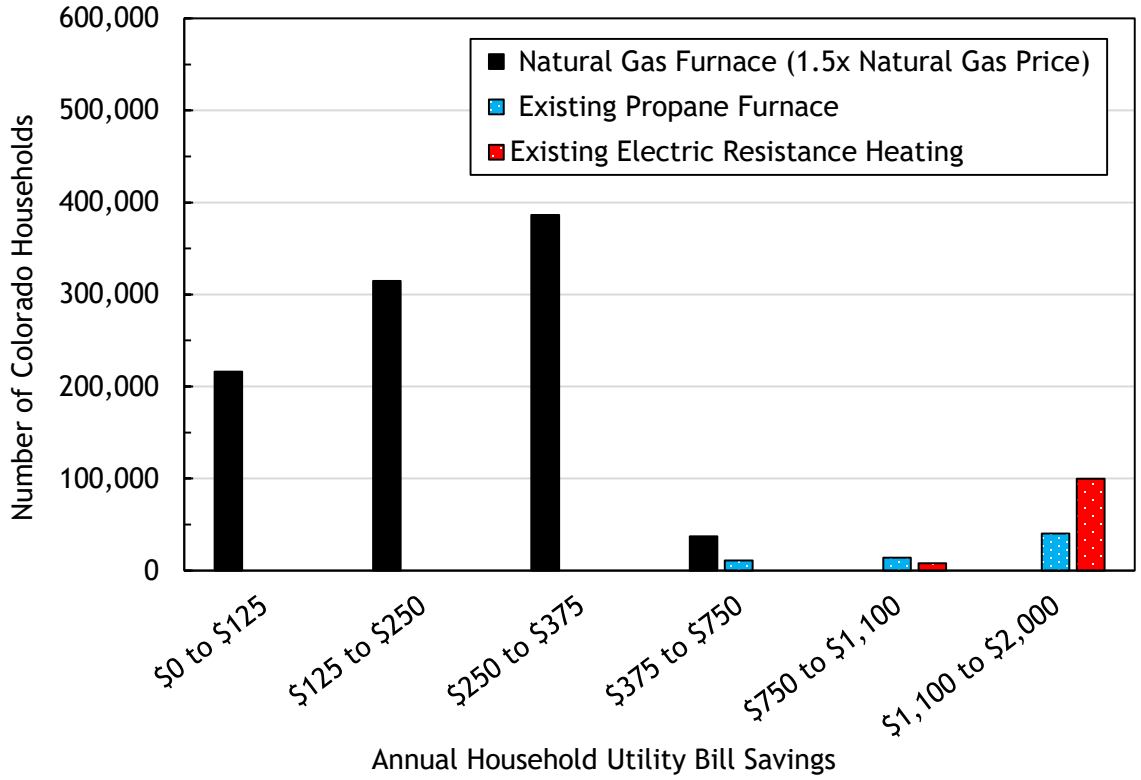


Figure 6. Number of Colorado households, organized by existing heating fuel, as a function of annual utility bill savings after a meHP is installed instead of a meCAC

Electric rate structures favorable to heat pumps

Specialized electric rate structures can be offered to encourage the adoption of heat pumps for space heating. The goal of these rate structures is to reduce heat pump operating costs, specifically by reducing bills in the winter. Example rate structures beneficial to heat pump users are seasonally adjusted rate structures (e.g. differing summer and winter rates) and specialized time of use rate structures that are only available to households that have electric resistance heating systems or heat pumps installed. An analysis by the Rocky Mountain Institute found that heat pump users save an average of 10% on their electric utility bill after switching from a standard rate structure to an electrified heat rate structure, with potential for savings up to 50% in

some cases.[27] Other studies have also identified that rate structures play a significant role in decreasing the operating costs for heat pumps.[28,29,30]

SB24-214, passed by Colorado General Assembly in 2024, requires that investor-owned utilities in Colorado develop proposals for electric rate structures that are designed to lower the average monthly energy bill for residential households that utilize heat pumps as their primary heating source. These proposed rate structures must be submitted to the Colorado Public Utilities Commission by August 1, 2027. In Colorado, the largest utility by number of customers is Xcel Energy. Xcel Energy currently provides a decreased electricity price to residential customers in the winter when heat pump usage is highest but does not offer a specialized residential electric heat rate structure. The municipal utility in Fort Collins and Wheatland Electric Cooperative, located in Eastern Colorado, currently offer electric heat rate structures in Colorado. However, the number of households receiving electric services from these two entities is small (less than 5% of households in Colorado). If more Colorado utilities and cooperatives begin to offer electric heat rate structures, the operating costs for heat pumps would be reduced and heat pumps would become more attractive to many households.

Heat pump rebates and tax credit Incentives

Rebates and tax credits are currently an important piece of the HVAC ecosystem in Colorado with significant incentives available for many households that install heat pumps. Exact incentive levels vary depending on household location, what heat pump equipment is installed, and household income level and tax liability. Due to this variability, the team modeled the economic effects of general upfront incentive amounts as opposed to modeling specific scenarios where current utility and local government rebates are stacked with federal and state tax credits.

[27] It's time to stop overcharging heat pump customers. Electrified Heating Rates Can Help.
[28] Massachusetts Study on Time-Varying Rate Design to Enable Electrification
[29] Electricity Rates that Keep Bills Down after Electrification of Home Heating
[30] Heat Pump–Friendly Cost-Based Rate Designs

As shown previously, the economics for heat pump installations in households with existing propane furnace or electric resistance heating systems are highly favorable in all regions of Colorado. Regardless of heat pump incentive availability, these households should install heat pumps instead of CACs if they aim to reduce their overall space heating and cooling costs. Households with natural gas heating systems, however, have less favorable heat pump economics (with current natural gas and electric prices). Thus, this analysis of incentives and payback periods was only performed for households that have existing natural gas heating systems. Payback period is calculated by dividing the incremental cost of the heat pump ($2,200 for a meHP and $6,600 for a ccHP) by the sum of the annual heating and cooling utility bill savings the heat pump provides. The heat pump equipment lifetime is assumed to be 18 years, so payback periods longer than 18 years represent situations where the household does not break even or save money after installing a heat pump instead of a meCAC.

Table 15 shows how upfront incentives change the economics for meHP installations in households that have existing 96% AFUE natural gas furnaces for space heating (results for households with 80% AFUE natural gas furnaces are shown in Appendix Table 34). Without any upfront incentive, the payback periods for households in most regions of Colorado are over 100 years. The exceptions are the 6B Mountain and Morgan Area regions, which have payback periods less than 18 years without any incentives. These two regions have favorable ratios of electric to natural gas price and households in these regions would save money if they installed heat pumps instead of CACs, even with no upfront incentives. Households with 96% AFUE furnaces have longer payback periods than households with 80% AFUE furnaces because the potential heating utility bill savings are reduced when using the higher efficiency furnace.

For households with 96% AFUE natural gas furnaces, an upfront incentive of $1,600 results in payback periods shorter than 18 years in only 2 out of 16 Geographic Analysis Regions. Increasing the upfront incentive to $2,000 brings the payback period below 18 years in 15 out of 16 regions for the 96% AFUE furnace scenario. When

paired with an 80% AFUE natural gas furnace, a meHP has a payback period shorter than 18 years in 12 out of 16 Geographic Analysis Regions when an upfront incentive of $1,600 is available. An upfront incentive of approximately $2,000 is required for all regions to see payback periods shorter than 18 years. Thus, for the Residential CAC Standard to provide total savings or breakeven economics for most Colorado households, an upfront incentive of approximately $2,000 would be required for meHP installations.

Table 15. Payback period for the $2,200 incremental investment required to install a meHP instead of a meCAC (96% AFUE natural gas furnace dual fuel heating system)

Geographic Analysis Region	Payback Period (Years), $0 Upfront Incentive	Payback Period (Years), $400 Upfront Incentive	Payback Period (Years), $800 Upfront Incentive	Payback Period (Years), $1,200 Upfront Incentive	Payback Period (Years), $1,600 Upfront Incentive	Payback Period (Years), $2,000 Upfront Incentive
Southeastern Colorado	100	82	64	45	27	9
6B Mountain	10	8	6	5	3	1
7B High Mountain	440	360	280	200	120	40
Adams County	110	90	70	50	30	10
Arapahoe County	100	82	64	45	27	9
Boulder_Broomfield_Gilpin	116	95	74	53	32	11
Denver County	105	86	67	48	29	10
Douglas_Elbert	129	106	82	59	35	12
El Paso_Fremont_Teller	169	138	108	77	46	15
Jefferson County	122	100	78	56	33	11

Geographic Analysis Region	Payback Period (Years), $0 Upfront Incentive	Payback Period (Years), $400 Upfront Incentive	Payback Period (Years), $800 Upfront Incentive	Payback Period (Years), $1,200 Upfront Incentive	Payback Period (Years), $1,600 Upfront Incentive	Payback Period (Years), $2,000 Upfront Incentive
La Plata_Montezuma	183	150	117	83	50	17
Larimer County	116	95	74	53	32	11
Mesa Area	85	69	54	38	23	8
Morgan Area	12	10	7	5	3	1
Pueblo Area	85	69	54	38	23	8
Weld County	100	82	64	45	27	9

Table 16 shows the payback economics for ccHP installations in households that have 96% AFUE natural gas furnace heating systems (Appendix Table 35 shows results for 80% AFUE natural gas furnace scenarios). For both 96% and 80% AFUE furnace efficiency scenarios an upfront incentive of approximately $6,000 is required for households in all Geographic Analysis Regions to realize payback periods 18 years or shorter. A smaller incentive of $5,000 results in payback periods shorter than 18 years in 13 out of 16 Geographic Analysis Regions for the 80% AFUE natural gas furnace scenario and 12 out of 16 Geographic Analysis Regions for the 96% AFUE natural gas furnace scenario. Thus, incentivizing ccHP installations in CAC replacement scenarios in households with natural gas heating systems requires an incentive that is roughly 3 times larger than the incentive required to make meHP installations economical for the same scenarios ($6,000 vs. $2,000).

Table 16. Payback period for the $6,600 incremental investment required to install a ccHP instead of a meCAC (96% AFUE natural gas furnace dual fuel heating system)

Geographic Analysis Region	Payback Period (Years), $0 Incentive	Payback Period (Years), $2,000 Incentive	Payback Period (Years), $3,000 Incentive	Payback Period (Years), $4,000 Incentive	Payback Period (Years), $5,000 Incentive	Payback Period (Years), $6,000 Incentive
Southeastern Colorado	59	41	32	23	14	5
6B Mountain	15	10	8	6	4	1
7B High Mountain	194	135	106	76	47	18
Adams County	64	45	35	25	16	6
Arapahoe County	61	42	33	24	15	6
Boulder_Broomfield_Gilpin	62	43	34	25	15	6
Denver County	63	44	35	25	15	6
Douglas_Elbert	83	58	45	33	20	8
El Paso_Fremont_Teller	108	75	59	43	26	10
Jefferson County	70	49	38	28	17	6
La Plata_Montezuma	112	78	61	44	27	10
Larimer County	64	45	35	25	16	6
Mesa Area	51	36	28	20	12	5
Morgan Area	24	17	13	10	6	2
Pueblo Area	54	37	29	21	13	5
Weld County	64	45	35	25	16	6

In 2025, there are significant heat pump rebates available to many Colorado households. Table 17 summarizes many of the available rebates for both standard efficiency heat pumps and ccHPs. Note that nearly all incentive programs currently require that standard heat pumps have a SEER2 rating of at least 15.2 and heating seasonal performance factor (HSPF2) rating of at least 7.8, which are both higher than the federal minimum values of 14.3 and 7.5, respectively. Thus, the standard heat pumps eligible for most of these incentives are at least ~5% more efficient at heating and cooling than the meHP modeled in this white paper. The incremental cost estimate of $2,200 applies specifically to meHPs, but the components required to manufacture a standard heat pump with SEER2 of 15.2 and HSPF2 of 7.8 are likely only slightly more expensive than the components required to manufacture a meHP. The ccHP modeled in this white paper would likely qualify for the ccHP rebates listed here in most installation scenarios.

In many regions of Colorado, the current rebate level for standard heat pumps is similar to the $2,000 estimated upfront incentive required to make installing a meHP instead of a meCAC economical for households with natural gas heating. Thus, combining a utility rebate with a local government rebate or tax credit likely makes standard heat pumps economically competitive for most Colorado households with current incentive levels. The rebates available for ccHPs, however, are generally significantly lower than the $6,000 estimated upfront incentive required to make installing a ccHP instead of a meCAC economical for households with natural gas heating. One exception is that households with electric or gas service from Xcel Energy can currently receive a $5,400 rebate for a ccHP and can potentially stack that rebate with a local government rebate (from a community like Golden, Boulder, Denver, etc.) and a tax credit to reach an overall incentive level above the $6,600 incremental cost of a ccHP. In general, though, in situations where a CAC is being replaced by a heat pump, it is currently most economically advantageous for Colorado households to install standard heat pumps as opposed to ccHPs. That said, in situations where the full heating and cooling system in a home are being replaced, or in new construction situations, the economics of ccHPs improve because one can

potentially avoid installing a furnace and can rely on the ccHP to provide all heating and cooling.

Table 17. Upfront heat pump incentive levels for various programs in Colorado (retrieved in May 2025, not exhaustive)

Entity Providing Incentive	Incentive Type	Incentive for Standard Heat Pump	Incentive for ccHP
Xcel Energy[31]	Rebate	$2,700	$5,400
Platte River Power Authority (Efficiency Works)[32]	Rebate	$1,500	$2,000
Colorado Spring Utility[33]	Rebate	$1,500	$3,000
Black Hills Energy[34]	Rebate	$1,500	$2,500
United Power[35]	Rebate	$2,500	$2,500
Holy Cross Energy[36]	Rebate	Not Offered	$3,000
Poudre Valley REA[37]	Rebate	$1,800	$1,800
La Plata Electric Association[38]	Rebate	$1,500	$1,500
Gunnison County Electric	Rebate	$1,500	$3,000

[31] Standard heat pump must have SEER2 of 15.2 and HSPF2 of 7.8, $2,700 value assumes 3 tons of cooling capacity at 95 °F, $5,400 value assumes a ccHP that maintains 80% heating capacity at 5 °F

[32] Standard heat pump minimum 15.2 SEER2 and 7.8 HSPF2, ccHP must be sized for 100% of the design heating load

[33] Standard heat pump minimum 15.2 SEER2 and 7.8 HSPF2, ccHP must be NEEP certified

[34] Standard heat pump minimum 15.2 SEER2, ccHP minimum SEER2 of 16.0

[35] Standard heat pump minimum 15.2 SEER2 and 8.1 HSPF2, assuming 3 tons in size

[36] 25% of the total project cost, up to $3,000 total

[37] Standard heat pump minimum of 7.8 HSPF2

[38] Minimum HSPF2 of 8.5, assuming heat pump with 3 tons of heating capacity at 47 °F

Entity Providing Incentive	Incentive Type	Incentive for Standard Heat Pump	Incentive for ccHP
Association[39]			
City and County of Denver	Rebate	Not Offered	$1,200
City of Golden	Rebate	Not Offered	$2,000
City of Boulder[40]	Rebate	$750	$900
State of Colorado Heat Pump Tax Credit[41]	Tax Credit	$500-1,500	$500-1,500

When evaluating how upfront incentives can lessen the household financial burden caused by a Residential CAC Standard, it is important to also consider the potential budget required to maintain incentive programs. As shown in Table 2, an estimated 81,684 heat pumps would be installed per year if a Residential CAC Standard were put in place in Colorado. If these were all meHPs and a $2,000 incentive was provided to each impacted household, the annual incentive budget required would be approximately $163 million. If these were instead all ccHPs and a $6,000 incentive was provided for each installation, the required annual budget would be approximately $490 million. If incentives were only provided to households with existing natural gas heating systems, which have less favorable heat pump operating economics, these theoretical annual incentive budgets could be reduced by 15% (incentives only provided for 69,507 annual heat pump installations). If instead incentives were only provided to households with income below 80% area median

[39] Standard heat pump minimum 15.2 SEER2 and 7.8 HSPF2

[40] Minimum HSPF2 of 7.8 for standard heat pump, assuming 3 tons for ccHP and standard heat pump

[41] The state tax credit is claimed by the installing HVAC contractor, but the contractor must pass on at least 33% of the tax credit to the customer as an upfront discount. Heat pumps must be ENERGY STAR certified and must meet other system sizing/design requirements to qualify.

income, the annual incentive budget would likely be reduced by 60-70% (incentives for 25,000 to 33,000 heat pump installations). In 2024 in Colorado, the number of heat pump rebates provided to households by utilities was between 7,000 and 10,000.[42] Thus, the scale of existing incentive programs in Colorado would need to grow significantly if the goal was to provide an incentive to any household that would otherwise realize a negative economic impact because of a Residential CAC Standard.

Household Energy and GHG Impacts

As discussed previously, differences in the electricity-to-fuel price ratio determine heat pump economics, which in turn affect the economically optimal switchover temperature for a dual fuel heating system. How frequently a heat pump is utilized for heating plays a primary role in determining how large energy saving and GHG emission reduction impacts will be.

The household level electricity usage impacts when a meHP or ccHP are installed instead of a meCAC are shown in Table 18 and Appendix Table 36, respectively. Electricity impacts are displayed as percentage changes compared to total household electricity usage in Table 19 and Appendix Table 39 for meHP and ccHP scenarios, respectively. In all cases, heating systems are modeled assuming the heat pump is operated for heating whenever the outdoor temperature is above the economically optimal switchover temperature. Annual electricity usage from space heating increases in households with natural gas heating systems in all regions, but the increases are generally modest, between 500 and 1,500 kWh depending on furnace efficiency for meHP scenarios (5% to 30% increase in electricity usage). In households that have propane furnace heating systems, the annual electricity usage increases more significantly after installation of a heat pump, by roughly 4,000 kWh or a 50% increase in overall usage. Because propane is more expensive than natural gas, dual fuel systems that use propane have a lower economically optimal switchover temperature and use the heat pump to cover a greater portion of the building's

[42] Based on data provided to the Colorado Energy Office by Colorado utilities

annual heating needs. For households with existing electric resistance heating, utilizing a heat pump for space heating drives very significant electricity savings, around 11,000 kWh per year (roughly 50% decrease in usage). In general, heat pumps are 2-4 times more efficient at heating when compared to electric resistance heating. Thus, it is expected that using a heat pump instead of electric resistance heating will drive deep reductions in electricity usage. All households see small reductions in electricity usage for space cooling (1% to 2% decrease in overall electricity usage), which is a result of heat pumps having a higher federal minimum SEER2 than CACs.

The findings for ccHPs follow similar trends to those identified for meHPs. However, ccHP dual fuel systems have lower economically optimal switchover temperatures than meHP dual fuel systems, so the electricity usage increases for households that have natural gas or propane heating systems are magnified. Electricity usage increases are most drastic after installation of a ccHP for households that utilize a 96% AFUE furnace with natural gas. Because ccHPs can operate efficiently at lower temperatures, households with electric resistance heating systems see a slightly larger decrease in electricity usage when they utilize a ccHP, compared to a meHP. For space cooling, the ccHP delivers greater electricity usage savings when compared to the meHP because the ccHP used for this analysis had a higher SEER2 than the federal minimum.

Table 18. Estimated annual household electricity usage impacts for space heating and cooling when a meHP is installed instead of a meCAC (positive numbers indicate increases in usage)

Geographic Analysis Region	Space Heating 80% AFUE Nat. Gas Furnace (kWh)	Space Heating 96% AFUE Nat. Gas Furnace (kWh)	Space Heating 80% AFUE Propane Furnace (kWh)	Space Heating 96% AFUE Propane Furnace (kWh)	Space Heating Electric Resistance (kWh)	Space Cooling (kWh)
Southeastern Colorado	573	302	4,575	4,575	-11,758	-167
6B Mountain	3,508	3,508	3,508	3,508	-12,041	-68
7B High Mountain	450	90	3,998	3,998	-13,938	-122
Adams County	1,334	324	3,899	3,899	-11,110	-114
Arapahoe County	1,445	354	4,206	4,206	-11,874	-121
Boulder_Broomfield_Gilpin	1,888	565	4,839	4,839	-12,935	-107
Denver County	1,483	359	4,333	4,333	-12,184	-114
Douglas_Elbert	1,347	135	3,973	3,973	-11,282	-122
El Paso_Fremont_Teller	183	183	4,084	4,084	-11,657	-91
Jefferson County	1,743	474	4,611	4,611	-12,552	-97

Geographic Analysis Region	Space Heating 80% AFUE Nat. Gas Furnace (kWh)	Space Heating 96% AFUE Nat. Gas Furnace (kWh)	Space Heating 80% AFUE Propane Furnace (kWh)	Space Heating 96% AFUE Propane Furnace (kWh)	Space Heating Electric Resistance (kWh)	Space Cooling (kWh)
La Plata_Montezuma	179	85	2,980	2,980	-8,696	-88
Larimer County	2,394	370	3,993	3,993	-11,930	-93
Mesa Area	1,153	284	3,833	3,833	-9,667	-154
Morgan Area	4,926	4,926	4,926	4,926	-13,645	-119
Pueblo Area	1,277	375	3,937	3,937	-10,492	-166
Weld County	2,112	676	4,056	4,056	-12,265	-104

Table 19. Estimated annual household electricity usage impacts for space heating and cooling when a meHP is installed instead of a meCAC (positive numbers indicate increases), percentage changes based on household total electric usage

Geographic Analysis Region	Space Heating 80% AFUE Nat. Gas Furnace	Space Heating 96% AFUE Nat. Gas Furnace	Space Heating 80% AFUE Propane Furnace	Space Heating 96% AFUE Propane Furnace	Space Heating Electric Resistance	Space Cooling
Southeastern Colorado	7%	4%	56%	56%	-39%	-2%
6B Mountain	55%	55%	55%	55%	-56%	-1%
7B High Mountain	8%	2%	69%	69%	-55%	-2%
Adams County	15%	4%	43%	43%	-41%	-1%
Arapahoe County	16%	4%	48%	48%	-45%	-1%
Boulder_Broomfield_Gilpin	22%	7%	57%	57%	-47%	-1%
Denver County	18%	4%	54%	54%	-50%	-1%
Douglas_Elbert	14%	1%	43%	43%	-39%	-1%
El Paso_Fremont_Teller	2%	2%	51%	51%	-44%	-1%
Jefferson County	20%	6%	54%	54%	-49%	-1%

Geographic Analysis Region	Space Heating 80% AFUE Nat. Gas Furnace	Space Heating 96% AFUE Nat. Gas Furnace	Space Heating 80% AFUE Propane Furnace	Space Heating 96% AFUE Propane Furnace	Space Heating Electric Resistance	Space Cooling
La Plata_Montezuma	3%	1%	46%	46%	-32%	-1%
Larimer County	29%	5%	49%	49%	-43%	-1%
Mesa Area	14%	3%	45%	45%	-42%	-2%
Morgan Area	61%	61%	61%	61%	-36%	-1%
Pueblo Area	15%	4%	46%	46%	-49%	-2%
Weld County	25%	8%	48%	48%	-37%	-1%

Natural gas and propane savings for all equipment scenarios and all Geographic Analysis Regions are shown for meHP and ccHP scenarios in Appendix Table 38 and Appendix Table 39 (absolute fuel usage decreases), respectively. Appendix Table 40 and Appendix Table 43 show the same results displayed as percentage reductions based on household total fossil fuel usage. On average, households with 80% AFUE and 96% AFUE natural gas furnaces see fossil fuel use reductions of 16% and 5%, respectively, after installing a meHP. When ccHPs are installed these fuel usage reductions increase to 27% and 13% for 80% AFUE and 96% AFUE furnaces, respectively. However, there is significant variability based on region with natural gas households in 6B Mountain and Morgan Area reducing their natural gas usage by 30% to 40% with meHPs and households in El Paso_Fremont_Teller region only reducing natural gas usage by 2% to 3% with meHPs. Households with propane furnaces see average propane usage reductions of 36% and 40% after meHP installation for 80% AFUE and 96% AFUE furnace scenarios, respectively, and average reductions in propane usage of 58% and 48% after ccHP installation for 80% AFUE and 96% AFUE furnace scenarios, respectively. There is much less variability in propane usage reduction across regions because the delivered propane price is assumed to be the same in all regions of Colorado.

In general, the fossil fuel savings are correlated to the previously shown electricity usage impacts because the electricity used by the heat pump for space heating is directly displacing fossil fuels that would have otherwise been used by the existing furnace. ccHPs provide larger reductions in fossil fuel usage for all regions when compared to meHPs, because ccHPs have lower economically optimal switchover temperatures.

GHG emission reductions as a percentage of total household emissions for the meHPs and ccHPs scenarios are shown in Table 20 and Table 21, respectively (Appendix Table 42 and Appendix Table 43 show the absolute GHG emission reductions). As expected, GHG emissions reductions are higher for regions and equipment scenarios with stronger heat pump economic situations (lower electricity-to-fuel price ratios and, thus, lower economically optimal switchover temperatures). Households that use

propane for heating see significant GHG emission reductions of 40-60%, depending on region and furnace efficiency. Households that use electric resistance for heating see slightly lower, but still significant, reductions between 35-55%. For households with natural heating systems, GHG emission reductions are quite variable across the Geographic Analysis Regions examined. Regions with very low natural gas prices (e.g. El Paso_Fremont_Teller) see almost no reduction in GHG emissions regardless of furnace AFUE because the dual fuel switchover temperature is high, and the heat pump is seldom used for heating. Regions with favorable heat economics (6B Mountain and Morgan Area) see reductions of 30-40% for both 80% and 96% AFUE furnaces. The regions with more intermediate natural gas prices only realize GHG reductions of between 4% and 22% in households with 80% AFUE furnaces and 2% and 10% in households with 90% AFUE furnaces.

If ccHPs are installed instead of meHPs, the GHG emission reductions are increased for all heating system scenarios in all Geographic Analysis Regions. This result is due to the lower potential switchover temperatures for ccHP systems (5 degrees F instead of 20 degrees F) and the general higher efficiency of the ccHP modeled.

Table 20. Percentage reduction of annual household GHG emissions after a meHP is installed instead of a meCAC, by existing heating system type

Geographic Analysis Region	80% AFUE Nat. Gas Furnace	96% AFUE Nat. Gas Furnace	80% AFUE Propane Furnace	96% AFUE Propane Furnace	Electric Resistance Heating
Southeastern Colorado	10%	0.3%	63%	50%	40%
6B Mountain	36%	28%	45%	36%	55%
7B High Mountain	6%	0.1%	45%	36%	55%
Adams County	16%	4%	49%	39%	43%
Arapahoe County	17%	4%	50%	40%	45%

Geographic Analysis Region	80% AFUE Nat. Gas Furnace	96% AFUE Nat. Gas Furnace	80% AFUE Propane Furnace	96% AFUE Propane Furnace	Electric Resistance Heating
Boulder_Broomfield_Gilpin	22%	7%	57%	46%	48%
Denver County	17%	4%	52%	42%	51%
Douglas_Elbert	0.3%	0.3%	47%	38%	40%
El Paso_Fremont_Teller	0.1%	0.1%	51%	40%	46%
Jefferson County	20%	5%	54%	43%	50%
La Plata_Montezuma	4%	2%	50%	40%	34%
Larimer County	24%	4%	45%	36%	43%
Mesa Area	17%	4%	55%	44%	45%
Morgan Area	43%	33%	54%	43%	37%
Pueblo Area	17%	5%	53%	42%	55%
Weld County	22%	7%	46%	37%	39%

Table 21. Percentage reduction of annual household GHG emissions after a ccHP is installed instead of a meCAC, by existing heating system type

Geographic Analysis Region	80% AFUE Nat. Gas Furnace	96% AFUE Nat. Gas Furnace	80% AFUE Propane Furnace	96% AFUE Propane Furnace	Electric Resistance Heating
Southeastern Colorado	18%	10%	71%	56%	43%
6B Mountain	54%	42%	69%	54%	58%

Geographic Analysis Region	80% AFUE Nat. Gas Furnace	96% AFUE Nat. Gas Furnace	80% AFUE Propane Furnace	96% AFUE Propane Furnace	Electric Resistance Heating
7B High Mountain	28%	5%	73%	57%	58%
Adams County	27%	14%	61%	48%	46%
Arapahoe County	28%	15%	62%	49%	49%
Boulder_Broomfield_Gilpin	34%	13%	67%	53%	51%
Denver County	29%	15%	64%	51%	54%
Douglas_Elbert	34%	1%	59%	47%	42%
El Paso_Fremont_Teller	7%	3%	64%	51%	49%
Jefferson County	31%	11%	65%	51%	53%
La Plata_Montezuma	9%	4%	68%	54%	37%
Larimer County	32%	21%	58%	46%	47%
Mesa Area	40%	16%	64%	51%	49%
Morgan Area	51%	38%	67%	52%	38%
Pueblo Area	28%	11%	63%	50%	60%
Weld County	32%	19%	63%	50%	41%

Estimated Statewide Impacts

Aggregated impacts across all households

When the estimated impacts of the Residential CAC Standard are aggregated across all affected Colorado households, the electricity and GHG emission savings could be substantial. Each year, the Residential CAC Standard would reduce electricity consumption by 7 GWh and GHG emissions by 96,000 MT CO2e. Furthermore, households across the state would reduce their combined natural gas and propane usage by 14 million therms and would save $9 million per year on heating and cooling costs. As previously discussed, these benefits are not evenly distributed to all households in Colorado though. Most households with natural gas furnaces see a modest added annual cost after installing a heat pump, but households with propane furnaces or electric resistance heating systems see large annual savings after installing a heat pump. The savings for these households are so large in aggregate that they overcome the added cost realized by all the natural gas households.

Table 22 shows the statewide impacts broken down by household existing heating system fuel, for the meHP scenario. Impacted Colorado households with existing natural gas heating systems see aggregated heating and cooling utility bill savings of roughly $2.6 million per year, but these bill savings are outweighed by the incremental cost of installing a meHP instead of a meCAC. After accounting for heat pump incremental cost, these households see an annual total cost increase of $5.9 million. Households with propane heating systems realize large utility bill and total annual savings after installing meHPs and see very significant GHG emission reductions. Households that use electric resistance for heating see over $10 million in annual total savings and see a 91 GWh reduction in annual electricity usage.

Table 23 shows the statewide impacts for the ccHP scenario. In this scenario, the annual total economic impact across all households in the state is negative $3.7 million, indicating an added cost to households. This change from total savings ($8.9 million in the meHP scenario) to a total cost (negative $3.7 in the ccHP scenario) is

driven by the higher incremental cost of ccHPs compared to meHPs. ccHPs do drive roughly 70% higher fossil fuel usage reductions and GHG emission reductions when compared to the meHP scenario, but the utility bill savings are not large enough to make up for the higher incremental cost (absent incentives that may apply to reduce the ccHP cost).

The social cost of carbon calculated by Xcel Energy[43] is $92 per metric ton of CO2e reduced. For the meHP scenario, the estimated average cost of GHG emission reduction is roughly $100 per MT CO2e for households with existing natural gas heating systems. Thus, installing meHPs instead of meCACs in these households can produce GHG emission reductions at a cost that is comparable to the social cost of carbon determined by Xcel Energy. Households with propane or electric resistance heating systems have a negative cost of GHG emission reduction, which means these households both save money on an annual basis and reduce their carbon footprint.

In the ccHP scenario, the estimated cost of GHG emission reductions is less favorable. Households with natural gas heating systems have a $135 per MT CO2e cost of GHG emission reductions, 35% higher than the meHP scenario. Households with propane and electric resistance heating systems both still have negative costs of emission reductions, but the negative values are smaller in magnitude.

[43] As directed by the Colorado Public Utility Commission, Xcel Energy estimates a social cost of carbon of $83/short ton, or $92 per metric ton. See page 5. Hearing Exhibit 102, Attachment GKJ-8

Table 22. Statewide aggregated savings, energy, and GHG emission impacts organized by household primary heating fuel, data is for meHPs (negative savings values correspond to added costs)

Geographic Analysis Region	Annual Utility Bill Savings (M$)	Annual Total Savings (M$)	Annual GHG Emission Reduction (MT CO2e)	Annual Change in Electricity Consumption (GWh)	Annual Change in Fossil Fuel Consumption (therms)	Cost of GHG Emission Reductions ($ per MT CO2e)
Natural Gas	$2.6	-$5.9	59,600	66.6	-11,900,000	99
Electricity	$11.0	$10.1	20,680	-91.2	0	-488
Propane	$5.3	$4.7	15,880	17.5	-2,460,000	-296
Total:	$18.9	$8.9	96,168	-7.0	-14,360,000	N/A

Table 23. Statewide aggregated savings, energy, and GHG emission impacts organized by household primary heating fuel, data is for ccHPs (negative savings values correspond to added costs)

Geographic Analysis Region	Annual Utility Bill Savings (M$)	Annual Total Savings (M$)	Annual GHG Emission Reduction (MT CO2e)	Annual Change in Electricity Consumption (GWh)	Annual Change in Fossil Fuel Consumption (therms)	Cost of GHG Emission Reductions ($ per MT CO2e)
Natural Gas	$9.3	-$16.2	120,572	86.7	-21,460,000	135
Electricity	$12.0	$9.2	22,033	-98.4	0	-417
Propane	$5.0	$3.4	20,819	22.3	-3,290,000	-162
Total:	$26.3	-$3.7	163,420	10.6	-24,750,000	N/A

Impacts on households with natural gas heat

Overall, 69,507 annual CAC installations in households with existing natural gas furnace heating systems are expected to be impacted by a Residential CAC Standard (approximately 85% of all annual impacted CAC installations). Appendix Table 44 shows the annual number of natural gas households broken down by Geographic Analysis Region, and Table 24 and Table 25 show the economic and GHG emission impacts for these households after they install a meHP and ccHP, respectively. In general, the trends are similar to those shown at the household level.

The annual cost of GHG emission reductions for natural gas households is found to vary significantly across the Geographic Analysis Regions, ranging from -$70 to $8,000 per MT CO2e. The estimated total annual savings for households does not vary to this degree across regions, so these changes in emission reduction cost are primarily due to differences in the estimated GHG emission reductions for each region. The GHG emission reduction prices that are very high occur in regions where the dual fuel switchover temperature is high, and the heat pump is rarely used for heating (due to low regional gas prices or high regional electricity prices). In these cases, the estimated household GHG emission reduction is less than 1% and the cost of emission reductions becomes very high. In most regions analyzed, however, the estimated cost of GHG emission reductions is comparable to or lower than the Xcel Energy calculated social cost of carbon.

For the ccHP scenario, the estimated cost of GHG emission reductions varies between -$50 and $800 per MT CO2e. Thus, the highest estimated cost of emission reductions is reduced by an order of magnitude in comparison to the meHP scenario. This decrease occurs because all regions realize more GHG emission reductions from using a ccHP when compared to meHPs (because the ccHP operates more efficiently than the meHP, especially at low outdoor temperatures). On average, however, the cost of GHG emission reductions is slightly increased in the ccHP when compared to the meHP scenario ($135 per MT CO2e vs. $99 per MT CO2e).

Table 24. Aggregated cost, energy, and emissions impacts for households impacted by the Residential CAC Standard, data is for meHPs installed in households with existing natural gas heating systems

Geographic Analysis Region	Annual Utility Bill Savings (M$)	Annual Total Savings (M$)	Annual GHG Emission Reduction (MT CO2e)	Annual Change in Electricity Consumption (GWh)	Annual Change in Fossil Fuel Consumption (therms)	Cost of GHG Emission Reductions ($ per MT CO2e)
Southeastern Colorado	$0.0	$0.0	145	0.1	-28,684	$216
6B Mountain	$0.5	$0.3	4,443	6.6	-872,598	-$67
7B High Mountain	$0.0	-$0.3	736	0.5	-136,471	$378
Adams County	$0.2	-$0.6	5,364	5.1	-953,803	$107
Arapahoe County	$0.2	-$0.6	6,968	6.7	-1,242,961	$90
Boulder_Broomfield_Gilpin	$0.2	-$0.5	7,067	7.0	-1,255,102	$66
Denver County	$0.2	-$0.6	5,947	5.7	-1,060,875	$97
Douglas_Elbert	$0.1	-$0.6	98	4.1	-794,059	$5,813
El Paso_Fremont_Teller	$0.1	-$1.1	140	0.9	-347,993	$7,994
Jefferson County	$0.2	-$0.6	8,200	8.3	-1,478,103	$73

Geographic Analysis Region	Annual Utility Bill Savings (M$)	Annual Total Savings (M$)	Annual GHG Emission Reduction (MT CO2e)	Annual Change in Electricity Consumption (GWh)	Annual Change in Fossil Fuel Consumption (therms)	Cost of GHG Emission Reductions ($ per MT CO2e)
La Plata_Montezuma	$0.0	-$0.1	126	0.0	-19,258	$648
Larimer County	$0.2	-$0.4	6,966	7.7	-1,278,257	$59
Mesa Area	$0.1	-$0.4	3,397	3.0	-595,157	$106
Morgan Area	$0.1	$0.1	1,800	2.5	-357,037	-$41
Pueblo Area	$0.1	-$0.2	2,514	2.2	-442,884	$94
Weld County	$0.2	-$0.4	5,701	6.3	-1,038,366	$63
Total:	$2.6	-$5.9	59,611	66.6	-11,901,609	N/A

Table 25. Aggregated cost, energy, and emissions impacts for households impacted by the Residential CAC Standard, data is for ccHPs installed in households with existing natural gas heating systems

Geographic Analysis Region	Annual Utility Bill Savings (M$)	Annual Total Savings (M$)	Annual GHG Emission Reduction (MT CO2e)	Annual Change in Electricity Consumption (GWh)	Annual Change in Fossil Fuel Consumption (therms)	Cost of GHG Emission Reductions ($ per MT CO2e)
Southeastern Colorado	$0.0	-$0.1	330	0.0	-49,466	$235
6B Mountain	$1.0	$0.3	6,707	10.9	-1,417,524	-$51
7B High Mountain	$0.2	-$0.7	3,739	2.1	-644,537	$200
Adams County	$0.8	-$1.5	10,574	6.5	-1,807,813	$140
Arapahoe County	$1.0	-$1.6	13,249	8.5	-2,277,307	$121
Boulder_Broomfield_Gilpin	$0.7	-$1.2	11,277	7.8	-1,948,971	$108
Denver County	$0.8	-$1.5	11,736	7.8	-2,024,270	$128
Douglas_Elbert	$0.5	-$1.5	9,333	8.5	-2,009,346	$158
El Paso_Fremont_Teller	$0.7	-$3.1	4,280	-1.9	-600,559	$722
Jefferson County	$0.9	-$1.6	13,128	9.3	-2,282,735	$122

Geographic Analysis Region	Annual Utility Bill Savings (M$)	Annual Total Savings (M$)	Annual GHG Emission Reduction (MT CO2e)	Annual Change in Electricity Consumption (GWh)	Annual Change in Fossil Fuel Consumption (therms)	Cost of GHG Emission Reductions ($ per MT CO2e)
La Plata_Montezuma	$0.0	-$0.2	282	-0.1	-38,909	$806
Larimer County	$0.7	-$1.1	11,900	10.2	-2,118,710	$94
Mesa Area	$0.7	-$0.9	8,355	5.2	-1,459,322	$102
Morgan Area	$0.2	-$0.0	2,128	2.9	-428,792	$2
Pueblo Area	$0.4	-$0.6	4,173	1.5	-691,826	$144
Weld County	$0.6	-$1.0	9,382	7.7	-1,664,265	$103
Total:	$9.3	-$16.2	120,572	86.7	-21,464,351	N/A

Impacts on households with propane heat

Approximately 4,538 CAC installations impacted by the Residential CAC Standard would occur in households with existing propane furnace heating systems. This number of projects represents approximately 5.6% of all impacted CAC projects (see Appendix Table 45 for a detailed breakdown of the number of propane households by Geographic Analysis Region). Table 26 and Table 27 show the cost, energy, and GHG emission impacts for propane households that install meHPs and ccHPs, respectively.

On aggregate, households using propane for space heating realize annual total savings after heat pump installation in all regions of Colorado. This data shows that even absent incentives, it is economically advantageous for households with propane heating systems and CACs to replace their CACs with heat pumps at the time of CAC failure, in all regions of Colorado.

The average cost of GHG emissions reductions for households with propane heating systems (averaged across all regions in Colorado) is -$296 per MT CO2e. This cost is fairly consistent across all Geographic Analysis Regions, primarily due to the assumption that delivered propane prices are the same in all regions of Colorado. This assumption results in similar economically optimal switchover temperatures for all regions and thus similar GHG emission reductions. The negative cost of emission reductions means that these households both save money on heating and cooling and reduce carbon emissions. The ccHP scenario provides a less favorable cost of emission reduction than the meHP scenario (-$196 vs -$296 per MT CO2e) because the higher incremental cost of ccHPs leads to lower annual total savings for households.

Table 26. Aggregated cost, energy, and emissions impacts for households impacted by the Residential CAC Standard, data is for meHPs installed in households with existing propane heating systems

Geographic Analysis Region	Annual Utility Bill Savings (M$)	Annual Total Savings (M$)	Annual GHG Emission Reduction (MT CO2e)	Annual Change in Electricity Consumption (GWh)	Annual Change in Fossil Fuel Consumption (therms)	Cost of GHG Emission Reductions ($ per MT CO2e)
Southeastern Colorado	$0.1	$0.1	436	0.5	-68,180	-$251
6B Mountain	$0.7	$0.7	1,738	1.9	-266,121	-$384
7B High Mountain	$0.6	$0.5	1,760	2.0	-271,350	-$299
Adams County	$0.1	$0.1	214	0.2	-32,611	-$289
Arapahoe County	$0.1	$0.1	448	0.5	-69,454	-$242
Boulder_Broomfield_Gilpin	$0.3	$0.3	1,103	1.2	-171,018	-$256
Denver County	$0.0	$0.0	76	0.1	-11,515	-$285
Douglas_Elbert	$0.4	$0.4	1,334	1.5	-205,728	-$293
El Paso_Fremont_Teller	$0.8	$0.7	2,391	2.7	-372,329	-$291
Jefferson County	$0.1	$0.1	354	0.4	-54,258	-$276

Geographic Analysis Region	Annual Utility Bill Savings (M$)	Annual Total Savings (M$)	Annual GHG Emission Reduction (MT CO2e)	Annual Change in Electricity Consumption (GWh)	Annual Change in Fossil Fuel Consumption (therms)	Cost of GHG Emission Reductions ($ per MT CO2e)
La Plata_Montezuma	$0.3	$0.3	914	1.0	-142,489	-$292
Larimer County	$0.3	$0.3	875	0.9	-133,811	-$305
Mesa Area	$0.4	$0.4	1,534	1.7	-242,898	-$247
Morgan Area	$0.4	$0.4	1,047	1.1	-162,133	-$364
Pueblo Area	$0.3	$0.2	966	1.1	-151,794	-$257
Weld County	$0.2	$0.2	689	0.8	-106,320	-$284
Total:	$5.3	$4.7	15,878	17.5	-2,462,011	N/A

Table 27. Aggregated total cost and energy impacts for households impacted by the Residential CAC Standard, data is for ccHPs installed in households with existing propane heating systems

Geographic Analysis Region	Annual Utility Bill Savings (M$)	Annual Total Savings (M$)	Annual GHG Emission Reduction (MT CO2e)	Annual Change in Electricity Consumption (GWh)	Annual Change in Fossil Fuel Consumption (therms)	Cost of GHG Emission Reductions ($ per MT CO2e)
Southeastern Colorado	$0.1	$0.1	491	0.4	-75,562	-$176
6B Mountain	$0.6	$0.4	2,672	3.2	-432,311	-$157
7B High Mountain	$0.6	$0.4	2,811	3.4	-460,400	-$129
Adams County	$0.1	$0.0	266	0.2	-40,387	-$157
Arapahoe County	$0.1	$0.1	553	0.6	-85,921	-$158
Boulder_Broomfield_Gilpin	$0.3	$0.2	1,281	1.3	-201,179	-$172
Denver County	$0.0	$0.0	93	0.1	-14,247	-$165
Douglas_Elbert	$0.4	$0.3	1,658	1.7	-255,177	-$180
El Paso_Fremont_Teller	$0.8	$0.5	3,017	3.3	-478,499	-$171
Jefferson County	$0.1	$0.1	425	0.4	-65,991	-$166

Geographic Analysis Region	Annual Utility Bill Savings (M$)	Annual Total Savings (M$)	Annual GHG Emission Reduction (MT CO2e)	Annual Change in Electricity Consumption (GWh)	Annual Change in Fossil Fuel Consumption (therms)	Cost of GHG Emission Reductions ($ per MT CO2e)
La Plata_Montezuma	$0.3	$0.2	1,248	1.2	-192,788	-$128
Larimer County	$0.3	$0.2	1,123	1.2	-175,300	-$177
Mesa Area	$0.5	$0.3	1,791	1.5	-273,674	-$161
Morgan Area	$0.4	$0.3	1,290	1.5	-207,129	-$220
Pueblo Area	$0.3	$0.2	1,158	1.1	-181,131	-$161
Weld County	$0.2	$0.1	941	1.0	-147,817	-$148
Total:	$5.0	$3.4	20,819	22.3	-3,287,512	N/A

Impacts on households with electric resistance heat

7,639 annual residential CAC installations in households that have existing electric resistance heating systems are estimated to be impacted by the Residential CAC Standard. These projects represent approximately 9.4% of all CAC installations impacted by the standard. Appendix Table 46 breaks the number projects down by Geographic Analysis Region and project type, and Table 28 and Table 29 show the economic, energy, and GHG emission impacts on these households after they install a meHP and ccHP, respectively.

Households using electric resistance space heating realize a significant economic benefit by installing a meHP or ccHP to replace their meCAC, in all regions of Colorado. All these households both save on annual heating and cooling costs and realize significant GHG emission reductions, yielding a negative cost of GHG emission reduction.

The cost of GHG emission reductions is comparable across all Geographic Analysis Regions and comparable for both the meHP and ccHP scenarios. When averaged across all regions, the cost of GHG emission reductions is -$488 and -$417 per MT CO2e for households with electric resistance heating systems in the meHP and ccHP scenarios, respectively. Because there is no switchover temperature for these all-electric heating systems, the ccHP allowed to operate down to very low outdoor temperatures and this additional capacity provides enough additional GHG emission reductions to offset much of ccHP higher incremental cost.

Table 28. Aggregated total cost, energy, and emission impacts for households impacted by the Residential CAC Standard, data is for meHPs installed in households with existing electric resistance heating systems

Geographic Analysis Region	Annual Utility Bill Savings (M$)	Annual Total Savings (M$)	Annual GHG Emission Reduction (MT CO2e)	Annual Change in Electricity Consumption (GWh)	Annual Change in Fossil Fuel Consumption (therms)	Cost of GHG Emission Reductions ($ per MT CO2e)
Southeastern Colorado	$0.0	$0.0	74	-0.3	0	-$510
6B Mountain	$0.3	$0.2	712	-3.1	0	-$346
7B High Mountain	$0.8	$0.7	1,340	-5.9	0	-$540
Adams County	$1.1	$1.0	1,930	-8.7	0	-$537
Arapahoe County	$1.5	$1.4	2,584	-11.6	0	-$541
Boulder_Broomfield_Gilpin	$0.5	$0.5	908	-4.0	0	-$529
Denver County	$1.0	$1.0	1,769	-7.9	0	-$541
Douglas_Elbert	$0.7	$0.6	1,513	-6.8	0	-$405
El Paso_Fremont_Teller	$1.7	$1.5	3,577	-15.5	0	-$419
Jefferson County	$1.3	$1.2	2,186	-9.6	0	-$532

Geographic Analysis Region	Annual Utility Bill Savings (M$)	Annual Total Savings (M$)	Annual GHG Emission Reduction (MT CO2e)	Annual Change in Electricity Consumption (GWh)	Annual Change in Fossil Fuel Consumption (therms)	Cost of GHG Emission Reductions ($ per MT CO2e)
La Plata_Montezuma	$0.1	$0.1	256	-1.1	0	-$442
Larimer County	$0.4	$0.4	834	-3.8	0	-$448
Mesa Area	$0.4	$0.4	779	-3.3	0	-$498
Morgan Area	$0.1	$0.1	420	-1.8	0	-$261
Pueblo Area	$0.3	$0.3	628	-2.6	0	-$497
Weld County	$0.7	$0.6	1,168	-5.2	0	-$546
Total:	$11.0	$10.1	20,679	-91.2	0	N/A

Table 29. Aggregated total cost, energy, and emission impacts for households impacted by the Residential CAC Standard, data is for ccHPs installed in households with existing electric resistance heating systems

Geographic Analysis Region	Annual Utility Bill Savings (M$)	Annual Total Savings (M$)	Annual GHG Emission Reduction (MT CO2e)	Annual Change in Electricity Consumption (GWh)	Annual Change in Fossil Fuel Consumption (therms)	Cost of GHG Emission Reductions ($ per MT CO2e)
Southeastern Colorado	$0.0	$0.0	79	-0.3	0	-$443
6B Mountain	$0.3	$0.2	757	-3.3	0	-$276
7B High Mountain	$0.8	$0.7	1,401	-6.4	0	-$477
Adams County	$1.2	$1.0	2,080	-9.4	0	-$460
Arapahoe County	$1.7	$1.3	2,767	-12.6	0	-$468
Boulder_Broomfield_Gilpin	$0.6	$0.4	957	-4.2	0	-$464
Denver County	$1.1	$0.9	1,887	-8.5	0	-$469
Douglas_Elbert	$0.8	$0.5	1,628	-7.4	0	-$330
El Paso_Fremont_Teller	$1.8	$1.3	3,765	-16.5	0	-$346
Jefferson County	$1.3	$1.1	2,309	-10.3	0	-$463

Geographic Analysis Region	Annual Utility Bill Savings (M$)	Annual Total Savings (M$)	Annual GHG Emission Reduction (MT CO2e)	Annual Change in Electricity Consumption (GWh)	Annual Change in Fossil Fuel Consumption (therms)	Cost of GHG Emission Reductions ($ per MT CO2e)
La Plata_Montezuma	$0.1	$0.1	281	-1.2	0	-$347
Larimer County	$0.5	$0.3	909	-4.1	0	-$375
Mesa Area	$0.5	$0.4	848	-3.6	0	-$433
Morgan Area	$0.1	$0.1	441	-1.9	0	-$199
Pueblo Area	$0.4	$0.3	676	-2.9	0	-$423
Weld County	$0.8	$0.6	1,249	-5.7	0	-$479
Total:	$12.0	$9.2	22,033	-98.4	0	N/A

Insights from HVAC contractor focus groups

The team conducted two group interviews with HVAC contractors in Colorado who performed heat pump installations (Table 30). In total, 15 HVAC contractors participated in the focus groups, which took place in late 2024. The team screened contractors to ensure that their companies regularly installed CACs or centrally ducted heat pumps, including at least 10 such installations in the past year. Additionally, the team screened for contractors whose HVAC work included some portion of single-family homes or small multifamily buildings using residential equipment and screened for participants that were in sales/estimating roles or management and oversight positions, rather than solely installation or administrative roles. These roles were prioritized because they lead or influence decisions about equipment and provide insights into business considerations, costs, and technical requirements that influence projects.

The team developed a sample frame for focus group recruitment that included contractors located in and/or serving the major geographic regions of the state: Front Range, Western Slope, Rocky Mountains, Southwest, and Eastern Plains. However, no contractors from the Eastern Plains responded to the focus group invitation or attended the sessions.

Table 30. HVAC contractor focus group participant characteristics

Focus Group Number - Participant Number	Service Area(s)	CAC Installation Frequency	Ducted Heat Pump Installation Frequency	Ductless Heat Pump Installation Frequency
1-1	Front Range, Rocky Mountains	Do Not Offer	Occasionally Install	Frequently Install
1-2	Western Slope, Southwest	Do Not Offer	Rarely Install	Frequently Install

Focus Group Number - Participant Number	Service Area(s)	CAC Installation Frequency	Ducted Heat Pump Installation Frequency	Ductless Heat Pump Installation Frequency
1-3	Front Range	Occasionally Install	Frequently Install	Frequently Install
1-4	Front Range	Frequently Install	Frequently Install	Rarely Install
1-5	Rocky Mountains	Occasionally Install	Frequently Install	Frequently Install
1-6	Front Range	Frequently Install	Occasionally Install	Occasionally Install
1-7	Western Slope, Rocky Mountains	Do Not Offer	Occasionally Install	Frequently Install
2-1	Western Slope	Frequently Install	Occasionally Install	Occasionally Install
2-2	Front Range	Do Not Offer	Frequently Install	Frequently Install
2-3	Western Slope, Rocky Mountains	Rarely Install	Frequently Install	Frequently Install
2-4	Western Slope, Rocky Mountains	Frequently Install	Occasionally Install	Frequently Install
2-5	Front Range	Frequently Install	Frequently Install	Do Not Offer

Focus Group Number - Participant Number	Service Area(s)	CAC Installation Frequency	Ducted Heat Pump Installation Frequency	Ductless Heat Pump Installation Frequency
2-6	Front Range, Rocky Mountains	Do Not Offer	Frequently Install	Occasionally Install
2-7	Front Range	Frequently Install	Frequently Install	Frequently Install
2-8	Front Range	Do Not Offer	Frequently Install	Frequently Install

Residential Heat Pump Installations

Some concerns contractors raised about heat pump installation reflect a general orientation toward ccHPs rather than meHPs that might be a more direct replacement for a meCAC. For example, contractors discussed the potential need for electrical service panel upgrades or need to modify inadequate duct systems in retrofit situations. Both considerations are most relevant in situations where a ccHP is sized to cover a home's entire heating load and are less applicable to situations where a CAC is replaced with a meHP or ccHP sized to cooling load and set up as part of a dual fuel heating system.

Specifically for situations where a CAC is being replaced by a new CAC or heat pump, contractors described minimal differences between installing a heat pump and CAC. Contractors reported that the most notable differences between a heat pump installation and a CAC installation were the need for additional low voltage control wiring. Adding this wiring could be particularly challenging for certain installations, like those in finished basements or in homes with long wiring runs.

Contractors stated that the cost of a meHP installation is higher than meCAC installation in replacement scenarios. Multiple contractors suggested that the cost difference for high efficiency equipment ranged from $1,000-$3,000 after incentives. As one respondent explained, “It’s still a bit more expensive, but it’s close from my experience.” Another contractor said the cost gap could be around $2,000 in their region (implicitly for a meHP vs. a meCAC). One other contractor explained that heat pump installations are similar enough to CAC installations that their labor pricing was the same for either: “Flat rate pricing on installation, labor and everything else.”

Current utility incentives and state and federal tax credits may reduce customer expenses if the installation meets certain qualification criteria. One contractor reported that the combination of tax credits and utility incentives were large enough to make it break even between the option of a CAC and a heat pump that qualified for incentives: “Usually it can be a wash, as long as they have the ductwork to support it and it makes sense for them to get it, the rebate and the tax credit, it makes it a wash or has them coming out ahead.” However, most rebates and tax credits available at the utility, state, and federal level are currently targeted ccHPs or standard heat pumps that are paired with a new matched furnace as part of a new dual fuel heating system. As a result, less expensive meHPs installed alongside an existing furnace are unlikely to qualify for all available incentives.

Contractors found that different regions also had local rebates which could make heat pump equipment more appealing. Areas like Fort Collins, Vail Valley, and Denver were highlighted as ideal areas for heat pump projects as project costs were often low for customers after incentives were applied. One contractor described the benefits of working in Denver: “Denver is actually the highest rebate community in the Denver metro area. No one else has anything anywhere close.” Fort Collins was also discussed as an ideal location; one contractor noted that “Fort Collins right now, they have a triple rebate on rentals. They're trying to encourage the rental property owners to do some high efficiency upgrades.”

New Construction and Cooling Choice

The contractors in the focus groups described heat pumps as a frequent cooling choice in new construction, though the contractors in the focus groups had only worked on a limited number of new construction projects. Contractors' preference and experiences with heat pumps in new construction applications were driven primarily by financial incentives, with many areas offering substantial rebates for electrification.

CAC and Gas furnace, with CAC failure

In the case of CAC failure with a functional furnace, most contractors strongly recommend a dual-fuel heat pump system, citing reliability and customers familiarity with furnaces. Contractors found that dual-fuel configurations provided households with a dependable backup heating option while still ushering customers toward heat pump technology. One contractor found that the dual-fuel system especially benefited those reluctant to adopt a heat pump: "We're leaving the furnace in place. You can still have that as a backup. When everything switches over, you will be ready. You can use it out of the gate. I've only had one client say they didn't want the furnace backup. I talked them out of it, it's just a blower basically." The reliability of the gas furnace backup during winter peaking was also a draw for one contractor. This contractor, who reported they typically focused on full electrification, praised the furnace backup in some special cases, describing the limitations of current heating backups: "We've got a 10KW heat strip, and they've got 27kWh on battery, that's 2.7 hours of emergency backup heat. Having those conversations about dual fuel, a blower and lights and other things. If you have a super-efficient Mitsubishi Hyper Heat system, that's great, but if you have to kick over, it burns [i.e. uses a lot of electricity]."

Despite the availability and size of current incentives, contractors reported that a cohort of customers still select CACs due to income limitations. Two contractors in the focus groups reported instances of customers proactively choosing to replace a

failed CAC with another CAC, rather than a heat pump. These contractors attributed this to customer preference and financial limitations. As one contractor described, "We do a lot of ACs as well, it just boils down to what the customer wants." Another contractor explained that there may be financial limitations even after heat pump incentives that lead to the selection of a CAC: "It boils down at the end of the day to what the customer is trying to get and what their budget is."

After a CAC failure the decision to install a heat pump and set up a dual fuel heating system is informed by the existing furnace type, load calculations, and availability of incentives. In cases where a CAC fails but the home has a fairly new furnace, contractors found that replacing the CAC with a heat pump and setting up a dual-fuel system can work well: "If they have a brand new 95% AFUE furnace, the dual-fuel can make sense as well when you're just adding a coil." However, if the furnace is older, contractors felt replacement of both the furnace and CAC could be possible: "It depends on the age of their existing furnace and if they're comfortable using that. If it's 20+ years old, it's a switch out. If less than 10, it merits looking at both avenues." The available heat pump incentives also influenced what contractors would suggest to customers; as one contractor stated, "I'm working under the Xcel rebate. That pretty much dictates that I'm going to a full system replacement [i.e. installing a new furnace along with the new heat pump to make a matched system]."

Contractors have a significant role in directing customer equipment choice. Contractors report that most heat pump installations are driven by contractor suggestions and the value proposition of incentives. Customers generally have low awareness of heat pumps, and rebates and tax credits are often the primary motivators to move forward when contractors introduce heat pumps to customers. One contractor explained that "It's pretty much a slam dunk every time. The incentives are what drives it. By the end of year, we will probably do 500 heat pumps. Not one of [those customers] was pitching it. It's not common knowledge." Another contractor also used the incentives as an entry point to get customers to adopt the technology: "The incentives at a state and local level, and Xcel and different energy

companies help to broach the topic when it's something the customer hasn't thought about before." Notably, the contractors that are taking advantage of all available incentives are primarily installing cold climate heat pumps or dual fuel systems that have both a new furnace and new heat pump. Projects where a CAC is simply replaced with a like-sized meHP are not likely to qualify for the more generous incentives currently available in Colorado.

Policy response

The contractors had mixed responses to a potential Residential CAC Standard, with their concerns primarily focused on implementation and market impacts rather than opposition to heat pumps. Roughly half of participants supported a standard and felt that it would have a positive impact on their business and the market. Some of the supporting contractors cited existing municipal codes driving the majority of their heat pump installations (including one contractor who thought Denver had already implemented such a mandate) and believed these codes had already transformed their regional markets. Other contractors differentiated themselves as heat pump specialists, and described how they would thrive under a mandate: "I would love it. I can put them in, and a lot of people can't." As contractors benefited from existing heat pump incentives, some felt that regulation driving further heat pump business would only be positive for contractors: "I would think that would be a boon to our industry."

Other contractors expressed market concerns about the impact of standardizing their specialty across HVAC projects, especially for smaller businesses. Several contractors felt that the current incentive-based approach was effective in driving market transformation toward heat pumps. Just under half of the contractors preferred the market-driven evolution heavily supported by incentives (with a few contractors feeling neutral about the mandate). These contractors stated that the current system allows educated contractors to naturally guide homeowners toward the best heat pump solution for the home. Some contractors were concerned that broadening the pool of contractors offering heat pump equipment may hurt smaller HVAC businesses

that have specialized in heat pump installation and built expertise around available incentives.

Some contractors were also concerned that larger firms would have an advantage in leveraging incentive programs. These contractors suggested that larger HVAC companies have the cash flow to wait for multiple heat pump rebates, while smaller companies with less capital reserves are unable to do so. According to one of these contractors, “The opportunity for a larger company to take $3,000 off of a four-ton Hyper Heat upfront— I'm out waiting for that check for three or four months. That actively hurts my working capital and my ability to scale.” Another contractor questioned the availability of rebates should larger contractors begin to do heat pump work: “Will the money run out? Bigger contractors got in line first?”

Project quality was cited as a chief concern, as some contractors suggested that a Residential CAC Standard could push lower income customers toward the cheapest possible heat pump solution, rather than the one best suited for their home. As one contractor described, “It will increase heat pump installations, but maybe not the right one for the home.” Expressing a similar concern, another contractor noted how certain projects require unique, custom approaches and suggested a mandate could unintentionally push customers to an inadequate, one-size-fits-all solution: “Let’s not forget that the technologies within available heat pumps are still widely different. What I don’t want to start is a race toward single stage equipment and things like that. We want the cost to drop on the best equipment, not for all of us to be incentivized to move towards the bottom.”

Contractors also expressed concerns that customers would install sub-optimal heat pump systems in emergency-replacement scenarios. One contractor characterized emergency replacement customers as being especially financially constrained and limited in their options: “Customers who don’t plan are more likely to make a price conscious decision.” One contractor described that a Residential CAC Standard could leave some customers only able to buy the least expensive heat pump option possible:

"How are we going to propose this to low-income folks that just barely have enough to get the system they need?"

Contractors also raised other considerations for the development and implementation of a Residential CAC Standard:

- *Faster rebate preapproval and payment*: Contractors described the current burden of "carrying" rebates until they are funded, which can be significant amounts of money for small businesses to wait for: "It would be nice to have that, not necessarily instant, but at least keep it rolling, rather than wait and bulk in tens of thousands of dollars of rebates." Additionally, in replacement projects the time spent waiting for approval could be a project obstacle, especially with potential increased contractor rebate volume following a Residential CAC Standard: "How long it takes to get approval is going to be a really big factor. If there is a turnaround time of about a week, it's going to be hard to get anything done for a customer." Some contractors described waiting two weeks to learn if they'd qualify for a rebate, which could be a problem with equipment failure in hot weather.
- *Contractor hesitancy*: Most contractors in the focus groups noted that many other contractors are resistant to heat pump technology. They described a strong sentiment among other HVAC contractors that "heat pumps don't work." Contractors suggested that some portion of contractors would continue to install CACs despite a mandate: "Say it would start to incentivize folks to not report what they're installing, right? You're going to look at a lot of AC units unpermitted." Another contractor described how contractors occasionally passed on their resistance to heat pumps to customers, making them doubt and distrust the technology. These contractors noted that they then had to address these negative attitudes when engaging with the customer.
- *Support for low-income customers*: As mentioned earlier, contractors stated that requiring customers to install a heat pump could create a financial burden for some customers. Contractors suggested creating new incentives, especially

for lower cost heat pump equipment (e.g. meHPs) which they perceived as having a limited market share: "I have a hard time believing there will be a lot of incentives for the normal people. It seems like when something is required, they aren't going to incentivize some of the midrange, base model stuff. Not that there's too much anymore." One contractor suggested that incentives should make heat pump installation comparable with CAC like-for-like replacements: "Make sure that takes the cost down to replacing an AC with an AC, so there isn't an additional cost burden."

- *Contractor qualifications and project installation quality*: Some focus group participants were concerned that some contractors would be unwilling to pursue heat pump-specific education or training. As one respondent predicted, "Other guys wouldn't go through schooling, they would just install it improperly and we would have to go back and fix it." A few contractors in the focus group suggested that the state should develop some way of qualifying contractors and ensuring project quality: "You want to keep people permitting, doing inspections and on the right side of things here." Another contractor felt that qualification and testing would preserve their market advantage of being earlier heat pump adopters: "The people we're talking to right now that are cutting edge, we should be able to pass whatever safety standards or whatever testing we need. We should be the people that can move forward. We're better than our competition, so a serious testing, qualification point…"
- *Transparency of rules and budgets for incentive programs*: Should all CAC installations become heat pump installations, contractors wanted increased transparency about incentive program rules and budget runway. One contractor described their uncertainty when applying for the rebate and awaiting funds: "Right now I have so much anxiety about will I get the rebate…" Another contractor brought up program expiration dates, and the risk that a mandate would come when existing incentives expire: "When those rebates start to go away, all of this technology is priced out of market."

Insights from Stakeholder Interviews

The team conducted interviews with 22 stakeholders in late 2024. Table 31 shows the various stakeholder categories and the interview group sizes. Findings from these interviews are summarized below.

Table 31. Number of stakeholder interviews and of participants in each interview

Stakeholder Category	Interview Group Size
National Policy Experts	1
National Policy Experts	2
National Market Technology Experts	2
Colorado Environmental Stakeholders	4
Colorado Business Stakeholders	1 (HVAC equipment distributor)
Colorado Business Stakeholders	1 (home builder)
Colorado Local Government	7
Utilities	2
Equity	2

Efficacy of a Residential CAC Standard

Environmental advocates, national policy experts, and some local government staff see a Residential CAC Standard as an effective means to accelerate heat pump adoption in Colorado. These stakeholders reported that at the state level, a Residential CAC Standard for replacement and new equipment could be more

effective than adoption and enforcement of the local energy codes in many different code jurisdictions. Stakeholders also supported the idea of Colorado taking on a leadership role by implementing such a standard, which could influence legislation in other states. One environmental stakeholder noted that a singular policy would be insufficient, and that complementary policies and actions are also required such as utility rate designs that ensure cost parity: "Don't think of this standard as being a replacement, but a complement. One policy can't do everything. (…) One of the things in SB24-214 was to require the utilities to propose a heating specific rate to promote parity with the operating costs of gas furnaces."

There are legislative alternatives to a Residential CAC Standard, including air quality standards and local energy codes. Alternative approaches have distinct benefits and drawbacks. One policy expert in California described the Bay Area's recent passing of a zero-NOx requirement for newly installed furnaces and water heaters, applicable to the nine counties within the Bay Area Air Quality Management District's jurisdiction. The requirement will dramatically limit the installation of gas water heaters and furnaces. Currently, the California Air Resources Board is considering the feasibility of implementing this type of rule statewide. In California, there was also a potential measure considered for the 2025 energy code that required heat pumps to replace CACs. However, the California Energy Commission did not adopt the measure due to likely "immediate bill impacts on consumers": "To create opportunity where measures might be challenging for one part of a state, we publish[ed] those measures under a voluntary code, CalGreen." This voluntary code can then be adopted by a local jurisdiction at the discretion of that jurisdiction. Once a local jurisdiction adopts the code, it is mandatory in that jurisdiction for projects to comply with the CalGreen code.

Some stakeholders in the local government and utility stakeholder group interviews anticipated challenges with a Residential CAC Standard, such as increased consumer costs and heat pump installation quality concerns.

Across interview groups, stakeholders identified a potential challenge with the Energy Policy and Conservation Act's (EPCA) preemption clause, which could lead to legal challenges. Market technology experts, policy stakeholders, environmental advocates, a distributor, and a manufacturer all identified the risks of challenging the EPCA exemption provision that prevents states and municipalities from regulating the energy use and efficiency of appliances that are subject to federal efficiency standards. Two policy experts cited the EPCA preemption of the City of Berkeley's 2019 ordinance to ban new natural gas pipes as a recent related example to reference. Stakeholders advised pursuing significant legal advice when wording the Residential CAC Standard to avoid implying energy use regulation, and to recognize the possibility of lawsuits.

Building code changes may be needed to complement a Residential CAC Standard in order to mitigate potential negative effects. One manufacturer expressed concern that, under a Residential CAC Standard, the least expensive option for home builders would be to install a meHP with electric resistance heat as a backup. This reliance on electric resistance as a backup heat source could lead to large winter peaks in energy use and high bills for customers. To avoid these outcomes, the manufacturer suggested that a Residential CAC Standard should be paired with building code changes requiring that heat pumps be sized to heat to relatively low temperatures (5 or 10 degrees) and that electric resistance heat be limited in some way (e.g. size restrictions or not allowed).

Residential CAC Standard market impacts

An interviewed equipment distributor supported a Residential CAC Standard but said heat pump availability is currently an issue for some supply houses. While an interviewed home builder reported no current problems with acquiring heat pumps for their all-electric residential buildings, a distributor shared that they and other distributors statewide had recurring heat pump supply issues (note that the team was only able to interview one Colorado HVAC distributor). The distributor described how manufacturers paid little attention to Colorado’s emerging heat pump market,

despite increasing customer interest in heat pumps since 2021. According to this distributor, their company's heat pump supply issue has improved since they began stocking equipment from multiple heat pump manufacturers. The distributor anticipates that availability issues will be exacerbated in the short term by the new refrigerant requirements for residential central cooling equipment.[44] While this supply disruption is likely to impact both CAC and heat pump supply chains, the heat pump supply chain may be harder hit given it is already strained. Nonetheless, the distributor strongly supported a Residential CAC Standard because not needing to stock CACs would free up warehouse space and allow the distributor to stock more heat pumps: "I hope this does pass, I really do, I'm biased because I don't have to store as much stuff. I can store one product type instead of two." This is consistent with the predictions of two policy experts, who suggested that distributors would support the Residential CAC Standard for the same purpose of stock optimization. Although this distributor experienced issues with heat pump supply, it should be emphasized that the contractors interviewed in focus groups reported no issues sourcing and purchasing heat pump equipment.

Availability of heat pumps designed for use with an existing furnace may be limited in the short term. An interviewed heat pump manufacturer reported that most heat pumps are sold as full HVAC systems in Colorado; there are few heat pump products on the market designed to be used alongside an existing furnace. This manufacturer anticipated that the scarcity of these systems could result in a significant short-term price increase following the adoption of a Residential CAC Standard. This manufacturer anticipated that, over a roughly four-year period, additional heat pump models suitable as CAC replacements would enter the market and prices would decrease. It is possible that the manufacturer was implicitly talking about ccHPs, rather than meHPs, which are widely available elsewhere in the United States.

[44] Manufacturers will meet these requirements using A2L refrigerants. All heat pumps and CACs manufactured after January 1, 2025, and installed after January 1, 2026, must utilize these A2L refrigerants.

In Colorado, heat pumps are currently considered a premium product with modest market share, but some stakeholders predicted that a Residential CAC Standard may change that. As heat pump demand increases in Colorado, customers may face a cost premium for the product. Market technology experts pointed to Colorado's "supply/demand imbalance in the HVAC industry," which allows contractors to charge a premium for installations. Some environmental advocates stated that this standard would eventually decrease costs for heat pumps, by increasing the density of contractors with heat pump experience and skills and introducing competition: "The data portal for the California program found that, of the elements that really decrease costs, it's a log scale of the number of contractors offering and installing heat pumps within a single area. Competition drives down the cost of an install and can have a measurable, logarithmic impact."

Nearly all stakeholder groups reported the need to ensure contractor familiarity and comfort with heat pumps to produce quality installations. When stakeholders considered market readiness, contractor skillset was the primary factor described. Stakeholders reported some contractor discomfort and inexperience in heat pump installations. One local government stakeholder described how some contractors will do what they can to avoid installing heat pumps, including reducing costs for CAC projects: "It's unfamiliar, and they don't want to install it, so they will discount the central AC system. $500 or $1000 is not a big deal for them."

Multiple stakeholders also spoke of contractor markups on heat pump projects. One local government stakeholder described how they had seen "lots of inflation in quotes where contractors are less comfortable with the technology." A market technology expert explained that the extra costs are built in to cover potential customer callbacks: "Contractors are often pricing in their own fears and concerns about heat pump performance"; a CEO staff member stated that, "There have been a number of anecdotal comments where a customer inquiries about a heat pump and a contractor tries to dissuade them [and push them towards a new furnace purchase instead.]" Some stakeholders pointed to the need to collect more cost data to better parse how

much of the cost difference between CACs and heat pumps is truly labor and equipment, and how much is markup for a "premium" project.

To meet the needs of an evolving market, stakeholders advocated for contractor training opportunities statewide. Heat pump-specific training can alleviate concerns with equipment performance, especially for ccHPs, and can increase contractor confidence in heat pump performance. Utilities that have conducted their own heat pump incentive programs have firsthand experience with providing training opportunities. A utility stakeholder with a heat pump program shared that they had experienced some poor-quality installations as contractors developed heat pump experience. Their process to address the issue included "contractor training efforts, including the program bringing expert installers and commissioning agents, and we have had to change program requirements. It has been a 2.5-3-year effort to get to this point. And we see issues." Stakeholders also brought up small HVAC businesses in rural areas of the state that may be unable to attend a training opportunity, how busy current HVAC contractors are, and that the current distribution of training opportunities favors the Denver area over other regions in the state as potential challenges in delivering training to contractors. Stakeholders also noted that Colorado does not have a statewide license requirement for HVAC contractors and suggested implementing a license requirement or a quality assurance program.

Heat pump costs and economics

All stakeholders agreed that heat pumps cost more than a CAC whether for new construction or replacement projects; however, incentives have potential to offset much of the upfront costs, especially for low-income households. Explaining cost differences, one manufacturer noted that federal minimum efficiency requirements differ between air conditioners and heat pumps, and, as a result, they do not expect the price differences of minimum efficiency models to narrow significantly in the next five years without incentives. Equity advocates urged for an analysis of federal, state, local government, and utility incentives to see how they interact and to estimate cost impacts a Residential CAC Standard would place on low-income households.

Some low-income customers may be unable to pay the upfront incremental cost of a heat pump installation, even after incentives. In these cases, customers may need to utilize project financing, which helps alleviate upfront costs but adds ongoing monthly costs. Equity advocates noted that HVAC companies typically only can offer high-cost financing options (annual percentage rates above 20%) to customers with low credit ratings. High interest equipment financing cannot be attributed to a Residential CAC Standard but is likely to persist and may be exacerbated by the higher incremental cost of a heat pump compared to an CAC. Mitigating financing costs for heat pumps could significantly reduce the financial burden of getting a heat pump for low-income households. One equity stakeholder noted that regulated on-bill financing offered by utilities or nonprofits, can provide a lower cost option for low-income households that need to replace a CAC with a heat pump: “It takes away the predatory offers that many are blind to. Even if there aren’t much savings on the consumption side, it’s a lot of savings for households to not rely on financing options from contractors, payday loans, if they don’t have the financing to pay.”

Conclusion

If implemented in Colorado, a Residential CAC Standard would have a profound effect on the residential HVAC market, resulting in an estimated 80,000 additional heat pump installations each year. This large acceleration in heat pump adoption would lead to significant reductions in GHG emissions for the residential building sector. Such significant growth of the heat pump market in Colorado could potentially lead to a transformation of the residential HVAC market, with more competition between heat pump installers and reduced project costs for households that install heat pumps.

The household economic impacts that would result from a Residential CAC Standard present a more nuanced picture. Roughly 20% of Colorado households, those with existing propane furnaces or electric resistance heating systems, would see a clear economic benefit if they install a heat pump instead of a CAC. These households could save upwards of $1,000 per year by using a heat pump for heating and cooling and should be encouraged to adopt heat pump technology regardless of whether a Residential CAC Standard is in place or not.

The other 80% of Colorado households, those with natural gas furnaces, would not realize a clear economic benefit if they install a heat pump instead of a CAC, unless they have access to incentives to reduce the upfront cost of the heat pump (assuming current natural gas and electricity prices persist). To make heat pumps economically beneficial to these households, an incentive of approximately $2,000 would be required to offset the incremental cost of a meHP vs. a meCAC (or $6,000 in the case of ccHPs). Alternatively, these households would see improved heat pump operating economics if natural gas prices increase faster than electric rates in the coming years.

This analysis found that there are likely no significant technical or workforce barriers that would prevent the existing residential HVAC workforce from adapting to installing heat pumps instead of CACs. That said, the heat pump market in Colorado is currently small and is primarily concentrated in the Front Range region of the state.

More heat pump-specific training opportunities for the residential HVAC workforce in the rest of the state would be important to keep heat pump installation quality high and bolster consumer confidence in the capabilities of heat pump technology.

Lastly, care should be taken to ensure low-income households do not experience negative economic impacts because of a Residential CAC Standard. These households may struggle to pay the upfront incremental cost for a heat pump and current financing offers available for HVAC projects often come with high interest rates. It would be important to ensure these households have support to help them navigate the heat pump incentive ecosystem. Alternatively, development of low-cost financing options or on-bill repayment programs could help alleviate this potential issue.

Appendix

Households impacted by the Residential CAC Standard

Table 32. Estimated number of households impacted by the Residential CAC Standard, by climate zone, region, and county name

Climate Zone	Geographic Analysis Region	County Name	Number of Impacted Households
4B	4B Southeast Colorado	Baca County	757
4B	4B Southeast Colorado	Las Animas County	4,289
4B	4B Southeast Colorado	Otero County	3,532
5B	Adams County	Adams County	92,595
5B	Arapahoe County	Arapahoe County	116,311
5B	Boulder_Broomfield_Gilpin	Boulder County	65,346
5B	Boulder_Broomfield_Gilpin	Broomfield County	16,904
5B	Boulder_Broomfield_Gilpin	Gilpin County	1,262
5B	Denver County	Denver County	96,127
5B	Douglas_Elbert	Douglas County	84,016
5B	Douglas_Elbert	Elbert County	5,046
5B	El Paso_Fremont_Teller	El Paso County	151,633
5B	El Paso_Fremont_Teller	Fremont County	10,849
5B	El Paso_Fremont_Teller	Teller County	8,578

Climate Zone	Geographic Analysis Region	County Name	Number of Impacted Households
5B	Jefferson County	Jefferson County	117,573
5B	La Plata_Montezuma	La Plata County	12,110
5B	La Plata_Montezuma	Montezuma County	5,551
5B	Larimer County	Larimer County	75,943
5B	Mesa Area	Delta County	8,074
5B	Mesa Area	Garfield County	11,606
5B	Mesa Area	Mesa County	35,575
5B	Mesa Area	Montrose County	8,326
5B	Morgan Area	Logan County	4,794
5B	Morgan Area	Morgan County	5,803
5B	Morgan Area	Phillips County	1,009
5B	Morgan Area	Sedgwick County	757
5B	Morgan Area	Washington County	757
5B	Morgan Area	Yuma County	2,271
5B	Pueblo Area	Bent County	757
5B	Pueblo Area	Cheyenne County	252
5B	Pueblo Area	Crowley County	757
5B	Pueblo Area	Huerfano County	3,280

Climate Zone	Geographic Analysis Region	County Name	Number of Impacted Households
5B	Pueblo Area	Kiowa County	505
5B	Pueblo Area	Kit Carson County	2,018
5B	Pueblo Area	Lincoln County	1,514
5B	Pueblo Area	Prowers County	2,775
5B	Pueblo Area	Pueblo County	38,602
5B	Weld County	Weld County	58,282
6B	6B Mountain	Alamosa County	2,775
6B	6B Mountain	Archuleta County	3,532
6B	6B Mountain	Chaffee County	5,803
6B	6B Mountain	Conejos County	1,514
6B	6B Mountain	Costilla County	1,009
6B	6B Mountain	Custer County	2,523
6B	6B Mountain	Dolores County	1,262
6B	6B Mountain	Eagle County	11,101
6B	6B Mountain	Moffat County	2,271
6B	6B Mountain	Ouray County	2,271
6B	6B Mountain	Rio Blanco County	1,009
6B	6B Mountain	Saguache County	1,514

Climate Zone	Geographic Analysis Region	County Name	Number of Impacted Households
6B	6B Mountain	San Miguel County	3,785
7B	7B High Mountain	Clear Creek County	2,271
7B	7B High Mountain	Grand County	5,551
7B	7B High Mountain	Gunnison County	5,046
7B	7B High Mountain	Hinsdale County	757
7B	7B High Mountain	Lake County	2,523
7B	7B High Mountain	Mineral County	505
7B	7B High Mountain	Park County	7,569
7B	7B High Mountain	Pitkin County	4,794
7B	7B High Mountain	Rio Grande County	3,028
7B	7B High Mountain	Routt County	7,569
7B	7B High Mountain	San Juan County	252
7B	7B High Mountain	Summit County	11,354
Total	N/A	N/A	1,147,720

Economically optimal switchover temperature

Table 33. Calculated economically optimal switchover temperatures for dual fuel heating systems utilizing *propane* as the heating fuel

Geographic Analysis Region	meHP + 80% AFUE Propane Furnace	meHP + 96% AFUE Propane Furnace	ccHP + 80% AFUE Propane Furnace	ccHP + 96% AFUE Propane furnace
Southeastern Colorado	20	20	10	10
6B Mountain	20	20	5	5
7B High Mountain	20	20	5	5
Adams County	20	20	5	5
Arapahoe County	20	20	5	5
Boulder_Broomfield_Gilpin	20	20	5	5
Denver County	20	20	5	5
Douglas_Elbert	20	20	5	5
El Paso_Fremont_Teller	20	20	5	5
Jefferson County	20	20	5	5
La Plata_Montezuma	20	20	5	5
Larimer County	20	20	5	5
Mesa Area	20	20	5	5
Morgan Area	20	20	5	5

Geographic Analysis Region	meHP + 80% AFUE Propane Furnace	meHP + 96% AFUE Propane Furnace	ccHP + 80% AFUE Propane Furnace	ccHP + 96% AFUE Propane furnace
Pueblo Area	20	20	5	5
Weld County	20	20	5	5

Effects of rebates and tax credit incentives

Table 34. Payback period for the $2,200 incremental investment required to install a meHP instead of a meCAC (dual fuel heating system with 80% AFUE nat. gas furnace)

Geographic Analysis Region	Payback Period (Years), $0 Upfront Incentive	Payback Period (Years), $400 Upfront Incentive	Payback Period (Years), $800 Upfront Incentive	Payback Period (Years), $1,200 Upfront Incentive	Payback Period (Years), $1,600 Upfront Incentive	Payback Period (Years), $2,000 Upfront Incentive
Southeastern Colorado	85	69	54	38	23	8
6B Mountain	7	6	4	3	2	1
7B High Mountain	183	150	117	83	50	17
Adams County	59	49	38	27	16	5
Arapahoe County	55	45	35	25	15	5
Boulder_Broomfield_Gilpin	50	41	32	23	14	5
Denver County	56	46	36	26	15	5
Douglas_Elbert	129	106	82	59	35	12
El Paso_Fremont_Teller	169	138	108	77	46	15
Jefferson County	54	44	34	24	15	5
La Plata_Montezuma	157	129	100	71	43	14
Larimer County	42	34	26	19	11	4
Mesa Area	55	45	35	25	15	5
Morgan Area	8	6	5	3	2	1

Geographic Analysis Region	Payback Period (Years), $0 Upfront Incentive	Payback Period (Years), $400 Upfront Incentive	Payback Period (Years), $800 Upfront Incentive	Payback Period (Years), $1,200 Upfront Incentive	Payback Period (Years), $1,600 Upfront Incentive	Payback Period (Years), $2,000 Upfront Incentive
Pueblo Area	51	42	33	23	14	5
Weld County	45	37	29	20	12	4

Table 35. Payback period for the $6,600 incremental investment required to install a ccHP instead of a meCAC (dual fuel heating system with 80% AFUE nat. gas furnace)

Geographic Analysis Region	Payback Period (Years), $0 Upfront Incentive	Payback Period (Years), $2,000 Upfront Incentive	Payback Period (Years), $3,000 Upfront Incentive	Payback Period (Years), $4,000 Upfront Incentive	Payback Period (Years), $5,000 Upfront Incentive	Payback Period (Years), $6,000 Upfront Incentive
Southeastern Colorado	51	35	28	20	12	5
6B Mountain	11	7	6	4	3	1
7B High Mountain	80	56	44	32	20	7
Adams County	44	31	24	17	11	4
Arapahoe County	43	30	23	17	10	4
Boulder_Broomfield_Gilpin	42	29	23	16	10	4
Denver County	44	30	24	17	11	4
Douglas_Elbert	64	45	35	25	16	6

Geographic Analysis Region	Payback Period (Years), $0 Upfront Incentive	Payback Period (Years), $2,000 Upfront Incentive	Payback Period (Years), $3,000 Upfront Incentive	Payback Period (Years), $4,000 Upfront Incentive	Payback Period (Years), $5,000 Upfront Incentive	Payback Period (Years), $6,000 Upfront Incentive
El Paso_Fremont_Teller	99	69	54	39	24	9
Jefferson County	46	32	25	18	11	4
La Plata_Montezuma	102	71	55	40	25	9
Larimer County	40	28	22	16	10	4
Mesa Area	38	26	20	15	9	3
Morgan Area	17	12	9	7	4	2
Pueblo Area	40	28	22	16	10	4
Weld County	40	28	22	16	10	4

Household Energy and GHG Impacts

Table 36. Estimated annual household electricity usage impacts for space heating and cooling when a ccHP is installed instead of a meCAC (positive numbers indicate increases in usage)

Geographic Analysis Region	Space Heating 80% AFUE Nat. Gas Furnace (kWh)	Space Heating 96% AFUE Nat. Gas Furnace (kWh)	Space Heating 80% AFUE Propane Furnace (kWh)	Space Heating 96% AFUE Propane Furnace (kWh)	Space Heating Electric Resistance (kWh)	Space Cooling (kWh)
Southeastern Colorado	806	429	4,714	4,714	-12,169	-781
6B Mountain	6,021	6,021	6,021	6,021	-12,666	-321
7B High Mountain	2,099	354	7,177	7,177	-14,569	-570
Adams County	1,910	1,082	4,790	4,790	-11,688	-536
Arapahoe County	2,093	1,180	5,299	5,299	-12,415	-568
Boulder_Broomfield_Gilpin	2,573	851	5,859	5,859	-13,426	-501
Denver County	2,158	1,210	5,508	5,508	-12,717	-535
Douglas_Elbert	2,782	1,098	4,950	4,950	-11,836	-570

Geographic Analysis Region	Space Heating 80% AFUE Nat. Gas Furnace (kWh)	Space Heating 96% AFUE Nat. Gas Furnace (kWh)	Space Heating 80% AFUE Propane Furnace (kWh)	Space Heating 96% AFUE Propane Furnace (kWh)	Space Heating Electric Resistance (kWh)	Space Cooling (kWh)
El Paso_Fremont_Teller	302	135	5,440	5,440	-12,096	-426
Jefferson County	2,355	759	5,857	5,857	-13,055	-452
La Plata_Montezuma	306	135	3,729	3,729	-9,335	-411
Larimer County	2,768	1,970	5,521	5,521	-12,733	-436
Mesa Area	2,479	928	3,947	3,947	-10,199	-719
Morgan Area	6,294	5,414	6,859	6,859	-14,085	-558
Pueblo Area	1,705	577	4,723	4,723	-10,953	-777
Weld County	2,614	1,746	5,964	5,964	-12,853	-485

Table 37. Estimated annual household electricity usage impacts for space heating and cooling when a ccHP is installed instead of a meCAC (positive numbers indicate increases), percentage changes based on household total electric usage

Geographic Analysis Region	Space Heating 80% AFUE Nat. Gas Furnace	Space Heating 96% AFUE Nat. Gas Furnace	Space Heating 80% AFUE Propane Furnace	Space Heating 96% AFUE Propane Furnace	Space Heating Electric Resistance	Space Cooling
Southeastern Colorado	10%	5%	57%	57%	-41%	-10%
6B Mountain	94%	94%	94%	94%	-59%	-5%
7B High Mountain	36%	6%	124%	124%	-58%	-10%
Adams County	21%	12%	53%	53%	-44%	-6%
Arapahoe County	24%	13%	60%	60%	-47%	-6%
Boulder_Broomfield_Gilpin	30%	10%	69%	69%	-49%	-6%
Denver County	27%	15%	69%	69%	-52%	-7%
Douglas_Elbert	30%	12%	53%	53%	-41%	-6%
El Paso_Fremont_Teller	4%	2%	68%	68%	-45%	-5%
Jefferson County	28%	9%	68%	68%	-50%	-5%

Geographic Analysis Region	Space Heating 80% AFUE Nat. Gas Furnace	Space Heating 96% AFUE Nat. Gas Furnace	Space Heating 80% AFUE Propane Furnace	Space Heating 96% AFUE Propane Furnace	Space Heating Electric Resistance	Space Cooling
La Plata_Montezuma	5%	2%	58%	58%	-34%	-6%
Larimer County	34%	24%	68%	68%	-46%	-5%
Mesa Area	29%	11%	47%	47%	-44%	-9%
Morgan Area	78%	67%	85%	85%	-37%	-7%
Pueblo Area	20%	7%	55%	55%	-51%	-9%
Weld County	31%	21%	71%	71%	-39%	-6%

Table 38. Estimated annual household natural gas and propane usage decreases for space heating when a meHP is installed instead of a meCAC

Geographic Analysis Region	80% AFUE Nat. Gas Furnace (therms)	96% AFUE Nat. Gas Furnace (therms)	80% AFUE Propane Furnace (therms)	96% AFUE Propane Furnace (therms)
Southeastern Colorado	110	50	731	609
6B Mountain	494	412	540	450
7B High Mountain	81	15	602	502
Adams County	221	51	615	513
Arapahoe County	239	56	663	553
Boulder_Broomfield_Gilpin	316	90	776	647
Denver County	246	57	683	569
Douglas_Elbert	223	22	626	522
El Paso_Fremont_Teller	36	30	642	535
Jefferson County	290	76	733	611
La Plata_Montezuma	34	14	57	381
Larimer County	374	59	634	528
Mesa Area	190	45	596	496
Morgan Area	707	589	772	644
Pueblo Area	214	60	617	514
Weld County	329	102	632	527

Table 39. Estimated annual household natural gas and propane usage decreases for space heating when a ccHP is installed instead of a meCAC

Geographic Analysis Region	80% AFUE Nat. Gas Furnace (therms)	96% AFUE Nat. Gas Furnace (therms)	80% AFUE Propane Furnace (therms)	96% AFUE Propane Furnace (therms)
Southeastern Colorado	110	50	731	609
6B Mountain	494	412	540	450
7B High Mountain	81	15	602	502
Adams County	221	51	615	513
Arapahoe County	239	56	663	553
Boulder_Broomfield_Gilpin	316	90	776	647
Denver County	246	57	683	569
Douglas_Elbert	223	22	626	522
El Paso_Fremont_Teller	36	30	642	535
Jefferson County	290	76	733	611
La Plata_Montezuma	34	14	57	381
Larimer County	374	59	634	528
Mesa Area	190	45	596	496
Morgan Area	707	589	772	644
Pueblo Area	214	60	617	514

Geographic Analysis Region	80% AFUE Nat. Gas Furnace (therms)	96% AFUE Nat. Gas Furnace (therms)	80% AFUE Propane Furnace (therms)	96% AFUE Propane Furnace (therms)
Weld County	329	102	632	527

Table 40. Percentage reduction in annual household natural gas or propane usage when a meHP is installed instead of a meCAC, based on heating system type (percentage reduction calculated based on total annual household fossil fuel usage)

Geographic Analysis Region	80% AFUE Nat. Gas Furnace	96% AFUE Nat. Gas Furnace	80% AFUE Propane Furnace	96% AFUE Propane Furnace
Southeastern Colorado	9%	4%	57%	47%
6B Mountain	36%	30%	37%	31%
7B High Mountain	5%	1%	37%	30%
Adams County	16%	4%	43%	36%
Arapahoe County	16%	4%	43%	36%
Boulder_Broomfield_Gilpin	21%	6%	50%	42%
Denver County	17%	4%	45%	37%
Douglas_Elbert	16%	2%	42%	35%
El Paso_Fremont_Teller	3%	2%	44%	37%
Jefferson County	19%	5%	47%	39%

Geographic Analysis Region	80% AFUE Nat. Gas Furnace	96% AFUE Nat. Gas Furnace	80% AFUE Propane Furnace	96% AFUE Propane Furnace
La Plata_Montezuma	4%	1%	6%	38%
Larimer County	23%	4%	38%	32%
Mesa Area	17%	4%	52%	43%
Morgan Area	44%	37%	46%	39%
Pueblo Area	18%	5%	48%	40%
Weld County	22%	7%	40%	33%

Table 41. Percentage reduction in annual household natural gas or propane usage when a ccHP is installed instead of a meCAC, based on heating system type (percentage reduction calculated based on total annual household fossil fuel usage)

Geographic Analysis Region	80% AFUE Nat. Gas Furnace	96% AFUE Nat. Gas Furnace	80% AFUE Propane Furnace	96% AFUE Propane Furnace
Southeastern Colorado	15%	7%	61%	52%
6B Mountain	58%	49%	61%	51%
7B High Mountain	24%	4%	62%	52%
Adams County	27%	14%	53%	45%
Arapahoe County	27%	14%	54%	45%

Geographic Analysis Region	80% AFUE Nat. Gas Furnace	96% AFUE Nat. Gas Furnace	80% AFUE Propane Furnace	96% AFUE Propane Furnace
Boulder_Broomfield_Gilpin	32%	11%	59%	49%
Denver County	28%	14%	55%	46%
Douglas_Elbert	34%	13%	52%	43%
El Paso_Fremont_Teller	6%	2%	57%	48%
Jefferson County	29%	10%	57%	47%
La Plata_Montezuma	7%	3%	61%	51%
Larimer County	31%	20%	50%	41%
Mesa Area	40%	15%	58%	49%
Morgan Area	54%	41%	59%	49%
Pueblo Area	27%	9%	58%	48%
Weld County	30%	18%	56%	46%

Table 42. Estimated annual household GHG emission reduction after a meHP is installed instead of a meCAC, based on home existing heating system type

Geographic Analysis Region	80% AFUE Nat. Gas Furnace (MT CO2e)	96% AFUE Nat. Gas Furnace (MT CO2e)	80% AFUE Propane Furnace (MT CO2e)	96% AFUE Propane Furnace (MT CO2e)	Electric Resistance Heating (MT CO2e)
Southeastern Colorado	0.67	0.02	4.32	3.42	2.79

Geographic Analysis Region	80% AFUE Nat. Gas Furnace (MT CO2e)	96% AFUE Nat. Gas Furnace (MT CO2e)	80% AFUE Propane Furnace (MT CO2e)	96% AFUE Propane Furnace (MT CO2e)	Electric Resistance Heating (MT CO2e)
6B Mountain	2.57	2.02	3.26	2.59	2.79
7B High Mountain	0.48	0.01	3.62	2.88	3.19
Adams County	1.23	0.31	3.7	2.94	2.5
Arapahoe County	1.33	0.33	3.99	3.17	2.67
Boulder_Broomfield_Gilpin	1.77	0.53	4.62	3.67	2.99
Denver County	1.36	0.34	4.1	3.26	2.74
Douglas_Elbert	0.02	0.02	3.77	3	2.53
El Paso_Fremont_Teller	0.01	0.01	3.82	3.03	2.72
Jefferson County	1.6	0.43	4.37	3.47	2.87
La Plata_Montezuma	0.22	0.1	2.71	2.15	2.06
Larimer County	2.02	0.35	3.83	3.05	2.66
Mesa Area	1.07	0.28	3.49	2.76	2.33
Morgan Area	3.61	2.82	4.59	3.64	3.19
Pueblo Area	1.2	0.37	3.63	2.87	2.54
Weld County	1.79	0.58	3.78	3.01	2.75

Table 43. Estimated annual household GHG emission reduction after a ccHP is installed instead of a meCAC, based on home existing heating system type

Geographic Analysis Region	80% AFUE Nat. Gas Furnace (MT CO2e)	96% AFUE Nat. Gas Furnace (MT CO2e)	80% AFUE Propane Furnace (MT CO2e)	96% AFUE Propane Furnace (MT CO2e)	Electric Resistance Heating (MT CO2e)
Southeastern Colorado	1.22	0.66	4.86	3.86	2.96
6B Mountain	3.91	3.02	5.02	3.94	2.97
7B High Mountain	2.2	0.43	5.81	4.55	3.34
Adams County	2.09	1.1	4.6	3.66	2.69
Arapahoe County	2.25	1.18	4.92	3.91	2.86
Boulder_Broomfield_Gilpin	2.73	1.01	5.37	4.25	3.16
Denver County	2.3	1.2	5.04	4	2.92
Douglas_Elbert	2.73	0.08	4.68	3.72	2.72
El Paso_Fremont_Teller	0.53	0.25	4.83	3.81	2.86
Jefferson County	2.48	0.87	5.25	4.16	3.04
La Plata_Montezuma	0.48	0.24	3.7	2.94	2.26
Larimer County	2.76	1.75	4.92	3.9	2.9
Mesa Area	2.5	0.99	4.07	3.25	2.54
Morgan Area	4.32	3.19	5.66	4.44	3.34
Pueblo Area	1.92	0.74	4.35	3.45	2.74
Weld County	2.58	1.56	5.17	4.09	2.94

Statewide Residential CAC Standard Impacts

Impacts on households with natural gas heating systems

Table 44. Annual number of households and CAC installations impacted by the Residential CAC Standard, only counting households with existing natural gas heating systems

Geographic Analysis Region	Annual Number of Households Impacted	Annual Retrofit CAC Installations	Annual New Construction CAC Installations	Total Annual CAC Installations
Southeastern Colorado	6,055	303	16	319
6B Mountain	28,258	1,413	492	1,905
7B High Mountain	37,088	1,854	614	2,468
Adams County	81,746	4,087	2,171	6,258
Arapahoe County	100,668	5,033	1,992	7,025
Boulder_Broomfield_Gilpin	75,690	3,785	1,568	5,352
Denver County	87,044	4,352	2,006	6,359
Douglas_Elbert	75,438	3,772	1,643	5,415
El Paso_Fremont_Teller	143,307	7,165	3,068	10,233
Jefferson County	104,453	5,223	1,477	6,700
La Plata_Montezuma	10,597	530	217	747
Larimer County	68,374	3,419	1,583	5,002
Mesa Area	53,236	2,662	1,486	4,148

Geographic Analysis Region	Annual Number of Households Impacted	Annual Retrofit CAC Installations	Annual New Construction CAC Installations	Total Annual CAC Installations
Morgan Area	9,083	454	73	527
Pueblo Area	42,387	2,119	645	2,764
Weld County	50,965	2,548	1,736	4,285
Total:	974,389	48,719	20,787	69,507

Impacts on households with propane heating systems

Table 45. Annual number of households and CAC installations impacted by the Residential CAC Standard, only counting households with existing propane heating systems

Geographic Analysis Region	Annual Number of Households Impacted	Annual Retrofit CAC Installations	Annual New Construction CAC Installations	Total Annual CAC Installations
Southeastern Colorado	2,018	101	5	106
6B Mountain	8,326	416	145	561
7B High Mountain	7,821	391	129	521
Adams County	757	38	20	58
Arapahoe County	1,766	88	35	123
Boulder_Broomfield_Gilpin	3,532	177	73	250

Geographic Analysis Region	Annual Number of Households Impacted	Annual Retrofit CAC Installations	Annual New Construction CAC Installations	Total Annual CAC Installations
Denver County	252	13	6	18
Douglas_Elbert	5,298	265	115	380
El Paso_Fremont_Teller	9,335	467	200	667
Jefferson County	1,262	63	18	81
La Plata_Montezuma	5,046	252	103	356
Larimer County	3,280	164	76	240
Mesa Area	6,055	303	169	472
Morgan Area	4,037	202	32	234
Pueblo Area	4,289	214	65	280
Weld County	2,271	114	77	191
Total:	65,346	3,267	1,270	4,538

Impacts on households with electric resistance heating systems

Table 46. Annual number of households and CAC installations impacted by the Residential CAC Standard, only counting households with existing electric resistance heating systems

Geographic Analysis Region	Annual Number of Households Impacted	Annual Retrofit CAC Installations	Annual New Construction CAC Installations	Total Annual CAC Installations
Southeastern Colorado	505	25	1	27
6B Mountain	3,785	189	66	255
7B High Mountain	6,308	315	104	420
Adams County	10,092	505	268	773
Arapahoe County	13,877	694	275	968
Boulder_Broomfield_Gilpin	4,289	214	89	303
Denver County	8,831	442	204	645
Douglas_Elbert	8,326	416	181	598
El Paso_Fremont_Teller	18,418	921	394	1,315
Jefferson County	11,858	593	168	761
La Plata_Montezuma	1,766	88	36	124
Larimer County	4,289	214	99	314
Mesa Area	4,289	214	120	334
Morgan Area	2,271	114	18	132

Geographic Analysis Region	Annual Number of Households Impacted	Annual Retrofit CAC Installations	Annual New Construction CAC Installations	Total Annual CAC Installations
Pueblo Area	3,785	189	58	247
Weld County	5,046	252	172	424
Total:	107,733	5,387	2,253	7,639

HVAC contractor focus group guide

This memo presents a screening questionnaire and discussion guide for focus groups with HVAC contractors that the team used. Table 47 provides details about this data collection activity.

Table 47. Data collection *d*etail*s for the HVAC contractor focus groups*

Aspect	Detail
Data Collection Type	Focus group
Target Population	HVAC contractors installing residential CACs
Data Collection Mode	Online using standard video conferencing software (e.g. Microsoft Teams)
Recruiting Mode	Email
Anticipated Interview Duration	90 minutes
Incentive	$200

The aim of these focus groups was to understand how a Residential CAC Standard would impact the residential HVAC market. To explore this topic, the team started with several basic research questions shown below:

- Is the market able to supply a heat pump alternative for all air conditioner replacement/ installation scenarios?
- How would a standard impact the cost of a residential air conditioner installation/ replacement?
- How would a standard impact the business models of installers and other market actors?

Because these research questions are broad, more granular questions were also asked during the focus groups. These questions are as follows:

- Are there scenarios where a viable heat pump alternative does not exist? If so, which ones?
- How easy or difficult is it to obtain heat pumps currently?
- What is the current difference in cost to the consumer between installing an air conditioner and a heat pump? What drives that cost difference (equipment costs, labor, etc.)?
- What funding sources do contractors leverage to offset any increased costs of installing a heat pump? What gaps exist in those funding sources?
- What populations would be most affected by any increase in costs? How, if at all, would contractors change the options they present to these customers?
- From a business perspective, how does a heat pump installation differ from an air conditioner installation for the contractor? Is one more profitable than the other?

Participant recruitment

Focus group participants were primarily recruited by email. We sent up to three emails to contractors identified as potential focus group participants. We waited three-to-five days between each email contact. Following email outreach, we conducted targeted phone outreach to potential focus group participants if necessary to fill out the focus groups.

The following email script was used for the first email outreach to HVAC contractors.

> Subject: Help Inform Colorado Heat Pump Policy
>
> Hello <**Name**>,
>
> We are writing to invite you to participate in a discussion with other HVAC contractors that will help inform the Colorado Energy Office as it considers approaches to increase heat pump adoption in the state. Feedback from contractors like you will help Colorado develop policies that best balance the

state's environmental goals with the needs of its residents and businesses. Please click the link below to answer a few questions that will help us make sure you are a good fit for these discussions.

<**Link to Screener Survey>**

We know you are busy, and we appreciate your time to support this research. We are offering **a $200 electronic gift card**, redeemable in a variety of ways, to everyone who participates in one of our discussions.

The Colorado Energy Office has partnered with Apex Analytics, an independent research firm, to hold these discussions. If you would like to verify the legitimacy of this research, please reach out to [NAME] at the Colorado Energy Office at [EMAIL]. If you have questions about this research or any technical difficulties, please reach out to Apex Analytics.

Thank you very much.

For the second email contact, the following email script was used.

Subject: Colorado Heat Pump Policy Research

Hello <**Name>**,

I reached out to you last week to invite you to participate in a discussion to inform approaches to increase heat pump adoption in Colorado. We have had a good response so far, but we want to include a few more contractors in our discussion to make sure we hear from the full range of HVAC installer experiences in the state. Please click the link below and answer a few questions so we can make sure your voice is part of the discussion.

<Link to Screener Survey>

We value the time and information you provide to this research effort, and we are offering **a $200 electronic gift card** that you can redeem in a variety of ways to everyone who participates in one of our discussions.

The Colorado Energy Office has partnered with Apex Analytics, an independent research firm, to hold these discussions. If you would like to verify the legitimacy of this research, please reach out to [NAME] at the Colorado Energy Office at [EMAIL]. If you have questions about this research or any technical difficulties, please reach out to Apex Analytics.

Thank you very much.

When required, the following email was used for the final email outreach to potential focus group participants.

Subject: Last Chance to Contribute to Heat Pump Policy Research

Hello **<Name>**,

As we mentioned in previous emails, we are holding discussions with HVAC contractors like you to inform the Colorado Energy Office as it considers ways to increase heat pump adoption in the state. Those discussions are going to occur the week of [DATE], and we need to hear from you by [DATE] in order to have your perspective included in the conversation. Please click the link below and answer a few questions so we can make sure you are a good fit.

<Link to Screener Survey>

To thank you for participating in this research, we are offering **a $200 electronic gift card** to everyone who participates in one of our discussions. You will be able to redeem the gift card in a variety of ways.

The Colorado Energy Office has partnered with Apex Analytics, an independent research firm, to hold these discussions. If you would like to verify the legitimacy of this research, please reach out to [NAME] at the Colorado Energy Office at [EMAIL]. If you have questions about this research or any technical difficulties, please reach out to Apex Analytics.

Thank you very much.

Participant screening

We reached out to potential focus group participants via email invitations directing them to complete a short screening questionnaire to confirm their eligibility and availability to participate in the focus group discussions. The screening questionnaire included items that helped us segment respondents into groups with others that share

similar experiences.[45] Table 4-4 summarizes criteria respondents must meet to participate in the focus group discussion.

Table 48. HVAC contractor focus group eligibility criteria

Eligibility Criteria	Indicator
Regularly install residential ducted central cooling in Colorado	Represent a company completing at least 10 residential central ducted cooling installations in the past year.
Be familiar enough with central ducted heat pumps to make a meaningful comparison to central air conditioners	Rate familiarity with central ducted heat pumps as at least "somewhat familiar."
Be involved in recommending equipment to customers	Role includes sales/specifying and/or management/oversight.

The screening questionnaire used to determine if a potential participate met all eligibility criteria is shown below:

> Thank you for your interest in this research. Please answer a few questions that will help us make sure you are a good fit for the discussions we are planning to hold to inform the Colorado Energy Office as it considers ways to increase heat pump adoption.
>
> If you have any questions or technical difficulties with this questionnaire, please contact Apex Analytics.
>
> [ASK ALL]
>
> S1. Does your company install residential central air conditioners or ducted heat pumps in Colorado?
>
> [SELECT ONE]

[45] While it is beneficial to have respondents with a range of perspectives in a focus group, discussions are typically most productive when the respondents share common experiences. This common experience allows respondents to relate and react to each other's responses.

1. Yes
2. No [TERMINATE]
3. Don't know [TERMINATE]

[ASK ALL]

S2. About how many residential central air conditioner or central ducted heat pump installations did your company complete in Colorado over the past year?

[SELECT ONE]

1. None [TERMINATE]
2. 10 or fewer [TERMINATE]
3. 11 to 50
4. 50 to 99
5. 100 to 499
6. 500 or more

[ASK ALL]

S3. How much of your company's HVAC work is in single-family homes and small multifamily buildings that use residential equipment?

[SELECT ONE]

1. Very little or none [TERMINATE]
2. Less than half
3. About half
4. More than half
5. All or almost all

[ASK ALL]

S4. Which region(s) do you install residential HVAC equipment in?

[SELECT MULTIPLE]

1. Front Range
2. Western Slope

3. Rocky Mountains
4. Southwest
5. Eastern Plains

S5. How frequently does your company install each of the following equipment types in single-family homes?

[SINGLE RESPONSE MATRIX]

	Frequently Install	Occasionally Install	Rarely Install	Do Not Offer
a. Central air conditioners				
b. Central ducted heat pumps				
c. Ductless heat pumps				

[IF S5b OR S5c = 1 OR 2 (Company frequently or occasionally installs heat pumps)]

S6. Does your company consider itself a heat pump specialist?

[SELECT ONE]

1. Yes
2. No

[ASK ALL]

S7. What share of your company's residential HVAC equipment installations are replacements or retrofits, as opposed to new construction or additions?

[SELECT ONE]

1. Very little or none
2. Less than half

3. About half
4. More than half
5. All or almost all

[ASK ALL]

S8. How many employees does your company have?

[SELECT ONE]

1. One
2. 2 to 10
3. 11 to 30
4. 31 to 50
5. More than 50

[ASK ALL]

S9. How are you typically involved in a residential central air conditioner or central ducted heat pump installation?

[SELECT MULTIPLE]

1. Sales/estimating
2. Installation
3. Administrative (pulling permits, ordering equipment, completing rebate applications, etc.)
4. Management/oversight
5. Other, please specify: [OPEN-ENDED RESPONSE]

[IF S9.1 AND S9.4 AND S9.5 ARE NOT SELECTED (Respondents role is purely installation and/or administrative)]

S10. We would really like to speak with people who are more closely involved in decisions around which types of equipment to recommend and install in homes. Is there someone else in your company who is involved in sales or management that might be able to participate in our discussion?

[SELECT ONE]

1. Yes
2. No

[IF S10=1 (There is another contact)]

S11. Please provide that person's contact information and we will reach out to them directly:

1. Name: [OPEN-ENDED RESPONSE]
2. Title/Role: [OPEN-ENDED RESPONSE]
3. Email: [OPEN-ENDED RESPONSE]

[IF S1=2 OR 3, S2=1 OR 2, OR S3=1, OR S9=2 (Company does not regularly install residential central air conditioners or respondent is not involved in decision-making)]

TERMINATION SCRIPT: Thank you for your interest in our research. Unfortunately, our discussions will focus on specific aspects of central air conditioner and central ducted heat pump installations, and it does not appear that your experience would be a good fit.

[IF RESPONDENT IS QUALIFIED]

S12. It sounds like you would be a great fit for our research. We are planning on holding discussions with groups of about six contractors, using video conferencing software. Do you have access to a reliable internet connection and a web camera, and are you comfortable participating in that type of discussion?

1. Yes
2. No

[IF S12=2 (Respondent is not able to participate)]

S13. What type of support, if any, could we provide that would enable you to participate?

1. [OPEN-ENDED RESPONSE]

Thank you for the information you have given us so far. We will consider whether we can provide the support you need and reach out to you if we can.

[IF S12=1 (Respondent is able to participate)]

S14. The discussions we are planning to have will last 90 minutes, and you will receive $200 in appreciation for your time and input. Please select the dates and times below when you are available to participate.

[SELECT MULTIPLE]

1. [DATE/TIME OPTION 1]
2. [DATE/TIME OPTION 2]
3. [DATE/TIME OPTION 3]
4. [DATE/TIME OPTION 4]
5. None of the above

[IF SS14=5 (None of the listed times work)]

S15. We're sorry none of the dates we listed work for you. Please tell us some dates and times between [START DATE] and [END DATE] when you are available to participate.

1. [OPEN-ENDED RESPONSE]

[IF S12=1 (Respondent is able to participate)]

S16. Thank you very much, we look forward to talking with you. Our research team, will be in touch with you soon to confirm a date and time for the discussion and give you additional details about how to participate. Is the email address we have on file for you - **<Respondent Email>** - the best way to reach you with that information?

[SELECT ONE]

1. Yes
2. No, enter preferred email address: [OPEN-ENDED RESPONSE]
3. Other, please specify: [OPEN-ENDED RESPONSE]

[IF S12=1 (Respondent is able to participate)]

S17. It can be easiest to resolve technical issues by phone if any come up on the day of the discussion. What is the best phone number for us to reach you if needed?

1. Phone: [OPEN-ENDED RESPONSE]

Focus group discussion guide

Introduction

Hello everyone and thanks for joining us today. My name is [NAME], and I am with a company called Apex Analytics. As we mentioned when we reached out to you about joining this conversation, we're conducting research on behalf of the Colorado Energy Office to help inform approaches to increase heat pump adoption in Colorado. We wanted to talk to you as part of that research so we can understand the different situations where heat pumps work well and where they don't work as well and what kind of support might be needed to increase uptake.

Before we get started, I am going to go over a few housekeeping items:

- Our discussion will take 90 minutes. We will take a break partway through in case you need to step away. If you need to step away at other times, we just ask that you come back as soon as you can.
- If there is background noise where you are, please mute yourself when you are not speaking.
- There may be distractions, and it is tempting to multitask, but I'll ask everyone to stay focused on the discussion, just like you would if we were in a room together.
- That said, we are not in person and online conversations can be a bit awkward. We ask everyone to assume positive intent during our discussion. We don't all know each other, so we might need to give each other a little extra slack and patience.
- It is OK to respectfully disagree with someone. Our goal is not to arrive at a consensus. We want to learn how your views and experiences are different as well as what's similar for each of you. We welcome different opinions.

- It is my job to make sure we hear from everyone. If you haven't spoken up in a while, I might call on you. Or, if you have been talking a lot, I might ask you to give someone else a turn. I appreciate your understanding and cooperation in making sure everyone gets to speak.
- We are audio and video recording the conversation today to make sure we capture everything accurately. We may also have some observers from the Colorado Energy Office on the line. They wanted to hear your perspectives firsthand.
- The recordings will not be available publicly, and we will not report our findings in ways that identify individual respondents.

Does anyone have any questions before we begin?

Q1. Let's begin by going around with introductions. Please share your first name, what part of the state you work in, and the craziest thing you encountered on a job this past summer? This is one of the few times that I'm going to call on people and ask everyone to talk – most of the time we can let the conversation flow more naturally and you can pipe in if you have something to say.

Installation Scenarios

Q2. I'd like to start by talking a little bit about what equipment you would recommend in different situations. What are the biggest differences between what you need to do to install a central air conditioner and a central ducted heat pump?

a. Are there cases where it is significantly more difficult to install a heat pump? What makes it more difficult in those cases?

b. Are there cases where it is significantly easier to install a heat pump? What makes it easier in those cases?

Q3. Now I'd like to talk through a few specific scenarios. What would you typically recommend for a home with a central air conditioner and a gas furnace when the air conditioner fails? [*Allow first participant to respond, then*

ask for a show of hands for who would also typically recommend the equipment type stated. Probe others on what they would recommend.]

a. [*For those that didn't mention a heat pump:*] Are there situations when you would recommend a heat pump for that type of installation? When?

b. Have you had customers request a heat pump in that type of situation? How often does that happen?

c. When you install a heat pump in that type of situation, are you typically looking to fully replace the gas furnace? Why or why not?

Q4. Our next situation is a home with a central gas furnace that wants to add air conditioning. What would you typically recommend in that case? Why?

a. [*If not addressed:*] For those of you that would recommend a central air conditioner, why would you suggest that over a central heat pump in that scenario?

b. Have you had customers request a heat pump in that type of situation? How often does that happen?

c. [*If not addressed:*] Do you encounter situations where the ducts are undersized? What do you recommend in these cases?

Q5. Finally, I'd like to know about new construction. When would you recommend a central AC over a heat pump for a new home? Why?

a. What type of backup heating system would you recommend for a new home where a heat pump was going to be installed?

General Considerations

Q6. Beyond the scenarios we just discussed, in what situations are central ducted heat pumps a particularly good solution?

a. What is appealing to your customers about heat pumps in those situations?

b. How common are those situations?

Q7. In what situations is a central ducted heat pump not a good fit, even if a home has existing ducts?

a. How common are those situations?

b. What do you recommend in those situations instead of a heat pump?

c. [*If not addressed*:] Are there cases where ductless heat pumps could help overcome those challenges? When?

Q8. What is the cost difference to the customer between installing a heat pump as opposed to a central AC, with the same cooling efficiency, if you are not trying to fully replace the existing heating system?

a. What is the difference in equipment cost alone?

b. What else drives that difference in costs: how much of it is labor, and how much of it comes down to a greater risk of callbacks?

c. Besides size or efficiency, what factors cause a heat pump installation to cost significantly more? What factors cause a heat pump installation to cost significantly less?

d. What is the cost difference if you are trying to fully electrify the heating system? What drives that?

e. What is the cost difference between installing a heat pump vs. a central AC in a new home?

Q9. What types of financial incentives or tax credits are available to your customers for installing heat pumps?

a. Do you use those incentives or tax credits to encourage customers to install heat pumps? Why or why not?

b. How much of the cost difference do those incentives or tax credits cover?

c. Are there certain situations where the incentives or tax credits do not apply? What are they? How common are they?

d. What impact do you anticipate the IRA incentives will have on the market? Are you doing anything to plan for those incentives to become available [*If needed: like stocking more equipment that will qualify, hiring or retraining staff, etc.*]?

Q10. How easy or difficult is it to get a central ducted heat pump, relative to a central air conditioner?

a. [*If not addressed*:] Do you stock central ducted heat pumps? Do you stock central air conditioners?

b. [*If not addressed*:] How quickly can you get a central ducted heat pump? How quickly can you get a CAC?

Q11. From a business perspective, how do heat pumps compare to a standard central AC for you: Are they more or less profitable to install?

What makes them more or less profitable?

Are there situations where a heat pump is more profitable? When?

Heat Pump Installation

Q12. For those of you who install heat pumps with gas furnace backup frequently, where do you set the temperature to switch over between the heat pump and gas furnace?

a. Do you typically keep the furnace locked out below that temperature, or allow furnace to run for recovery?

b. Why do you set it up that way?

Q13. For those of you who install heat pumps with electric resistance strips as backup frequently, where do you set the electric resistance lockout temperature?

a. Where do you set the heat pump lockout temperature?

b. Why do you set it up that way?

Q14. When people ask you about installing a heat pump without backup heating, what do you tell them? Why?

Policy Reaction

Q15. The State of Colorado is considering a policy that, if enacted, would require all residential central air conditioners to be heat pumps. How would a policy like that affect your business?

a. How, if at all, do you think it would impact the number of units you install? Why do you say that?

b. Would you change your business strategy – in terms of the ways you reach out to customers or the products and services you emphasize – if a policy like that were in place? How?

Q16. How would that type of policy impact your customers?

a. For those that said you would install fewer units, what would the customers that would install an AC but not a heat pump do instead?

b. Are there some customers that would be more impacted by this type of policy than others? Which ones? Why?

c. What kind of assistance would those customers need?

Q17. To close, I'd like to go around the table and have everyone tell us the most important things you think the State of Colorado should consider around a policy requiring that all central air conditioners be heat pumps.

Thank you very much for your time today. We got a lot of good feedback and information from this discussion.