A Path to Pollution-Free Buildings:

Meeting Xcel's 2030 Gas Decarbonization Goals

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Executive Summary

In 2021, Colorado passed Senate Bill 21-264, legislation requiring Colorado's gas utilities to reduce their greenhouse gas emissions by 4% by 2025 and 22% by 2030, relative to 2015 levels. These goals cover emissions from customers' use of gas and leakage from the utility's distribution system. They are ambitious, and the steady growth in gas sales by Xcel Energy, Colorado's largest electricity and gas provider, makes them even more so. Since 2015, Xcel's retail gas sales have grown by 9%, meaning that the utility's 2030 emissions reduction goal is really a 28% reduction from current levels – which it must achieve in just seven years.

In this report, we recommend measures to drive a steep reduction in emissions from the gas utility and demonstrate how Xcel can meet Colorado's targets in a way that delivers the most emissions reductions per ratepayer dollar.

To achieve its 2030 goal, Xcel must rapidly increase adoption of efficient electric appliances – heat pumps and heat pump water heaters – and weatherize tens of thousands of homes and businesses. While the efforts necessary to meet the clean heat targets are challenging, they are achievable.

To understand the level of investments and pace of deployment needed to meet Xcel's emissions reduction goals, we analyzed two portfolios. The Reference Case portfolio examines Xcel's expected business-as-usual gas sales and emissions. The Policy Case portfolio focuses on two clean heat measures: electrifying space and water heating, and accelerating implementation of building energy efficiency measures such as air sealing and insulation. The Policy Case focuses on these measures because alternatives, like green hydrogen and renewable natural gas, are roughly five times more expensive, and are not able to achieve deep, long-term emissions reductions. Some of our report's key findings and recommendations include:

Prioritizing replacing air conditioners, gas furnaces and boilers, and gas water heaters with efficient electric appliances when those appliances reach end of life.

In the Policy Case, all residential air conditioning sales are either standard or cold-climate heat pumps by 2030. AC replacements are the single largest driver of emissions reductions in our Policy Case scenario. We model that beneficial electrification – switching from conventional gas-fueled appliances to efficient electric counterparts – achieves the majority of Xcel's emissions reductions over the next seven years.

Accelerating gas efficiency savings – to 900,000 dekatherms (Dth) per year by 2030 – focusing on weatherization, customer education and other measures to reduce gas demand for space and water heating.

Frontloading spending to stimulate the market for efficient electric appliances and promote workforce development and customer education.

Increasing deployment of heat pumps and heat pump water heaters will require a significant increase in the workforce, as well as education of customers, building owners, contractors, architects, and others. And larger incentives are needed in the next few years to spur distributors, contractors, and building owners to stock, sell, and purchase electric appliances. Making these investments in the next few years will help ensure the workforce is available to install a vast number of appliances in the latter part of the decade.

Ensuring robust incentives for low-income households.

Many of the federal and state incentives available for electric appliances are provided in the form of tax credits, which are inaccessible to lower-income families without tax liability. We recommend that at least 20%-25% of Xcel's clean heat budgets are dedicated toward incentives for Xcel's low-income customers. In addition, complementary policies, such as on-bill financing for heat pumps and weatherization measures, will likely be essential.

To deploy tens of thousands of heat pumps and improve the efficiency of homes and businesses, Colorado must spur a market transformation.

Current federal and state programs can support this transition, but robust, consistent utility investments along with workforce development and customer education will be critical. By 2030, under the Policy Case, we project that the utility's clean heat plan will need to provide roughly $125 million in additional incentives annually, beyond current programs, for efficient electric appliances and weatherization. However, the long-term benefits of these investments outweigh the significant costs: our report shows that by 2030, the avoided fuel costs, investments in new gas infrastructure to serve new homes, and greenhouse gas emissions exceed the annual costs of the proposed clean heat measures. For example, in 2030 the avoided fuel costs of gas range from an estimated $312 million per year to more than $477 million per year.

To ensure customers see net benefits on their utility bills, it is also essential that efficiency and electrification measures are strategically deployed so that Xcel can reduce annual investments in the gas system. **Energy efficiency and electrification can improve indoor and outdoor air quality, improve home comfort, and mitigate the risk of rising or volatile gas prices.** Incentives for heat pumps can help provide air conditioning to customers who currently lack it. Investments in market transformation today will set Colorado up for success in achieving deep emissions reductions in the building sector by 2050, as more air conditioning, gas furnace, and gas water heating stock turns over in the coming decades. Importantly, the near-term budgets represent an up-front investment in market transformation; if successful, utility incentives may be modest or even unnecessary in future years.

In August 2023, Xcel will be the first utility in the nation to file a clean heat plan. Colorado has shown critical leadership by adopting science-based emissions reduction goals, and for over a decade, the state's electric utilities have achieved significant emissions reductions. Now, Xcel has the opportunity to demonstrate how to rapidly and cost-effectively achieve emissions reductions from the gas utility.

If successful, Xcel – and Colorado – will serve as a model for other utilities and states striving to achieve economy-wide emissions reductions.

Chapter 1 – Introduction

In 2021, Colorado passed Senate Bill 21-264 (the "Clean Heat Standard"), which established emissions reduction goals for Colorado's gas utilities. The Clean Heat Standard's targets are ambitious: between now and 2030, Colorado's investor-owned utilities must reduce the greenhouse gas emissions associated with burning fossil gas in buildings by 22% below 2015 levels. These targets are also necessary to meet Colorado's economy-wide target of reducing emissions 50% from 2005 levels by 2030, and to set the state on a path to meeting its 2050 goal of reducing emissions by 100%.[1]

Cutting emissions by more than one-fifth would pose a formidable challenge even if gas sales, and associated greenhouse gas emissions, had remained flat since 2015. However, Colorado's gas utilities have experienced significant growth during this time. From 2015 to 2022, the gas sales to residential and commercial customers by Public Service Company of Colorado, or Xcel Energy, are estimated to have grown by 9%.[2] As a consequence, the utility's 22% emissions reduction target is really a 28% reduction from current levels, meaning Xcel has just seven years to cut emissions from its gas sales by nearly one-third.

At the same time, there is an unprecedented opportunity to reduce emissions through energy efficiency and beneficial electrification measures. As a result of the recently passed Inflation Reduction Act (IRA), customers may leverage up to $2,000 in federal tax credits for residential heat pumps starting in 2023, and up to $8,000 in incentives for heat pumps for low- and middle-income customers. These incentives are anticipated to be available in 2024. The IRA also provides significant funding for weatherization and efficiency improvements, including a tax credit for building to the U.S. Department of Energy's Zero Energy Ready Home standard. Additionally, recent Colorado legislation extends a 10% tax credit for residential and commercial heat pumps through 2023 and provides tax credits of up to $1,500 from 2024 through 2026, $1,000 from 2027 through 2029, and $500 from 2030 through 2032.[3] Federal and state tax credits are also available for heat pump water heaters.

The pace of electrification and efficiency proposed in this analysis meets this moment. Achieving the recommended levels of market penetration will require a significant transformation of Colorado's heating, ventilation, and air conditioning (HVAC) market in a short amount of time, but this transformation is technically and economically feasible. Since 2015, gas sales and greenhouse gas emissions in buildings have largely continued to increase at a steady pace. As a consequence, Xcel must now play catch-up to meet state climate goals, and our proposed sales growth for heat pumps and heat pump water heaters reflects this short time frame.

Finally, this analysis focuses on achieving Colorado's 2030 Clean Heat emissions reduction goals, as described in Chapter 2. **Rapidly increasing adoption of efficient heat pumps and heat pump water heaters, and weatherizing homes and businesses in the near term, are critical to achieving the 2030 goals.** In the following sections, we present detailed analyses of the 2015 baseline emissions and

[1] § 25-7-102.(2)(g)(I), C.R.S.
[2] Proceeding No. 22AL-0046G, Hearing Exhibit 111, Marks Direct Testimony, at 12 and 19.
[3] Colorado House Bill 23-1272.

Reference Case (Chapter 2), Policy Case (Chapter 3), clean heat plan estimated budget (Chapter 4), and conclusions and recommendations for ensuring success at reaching the emissions reduction goals (Chapter 5).

Conventional gas pipeline.

Chapter 2 – 2015 Baseline Emissions and Reference Case

The Clean Heat Standard establishes a goal for gas utilities to reduce their greenhouse gas emissions from retail customers by 4% by 2025 and 22% by 2030, relative to a 2015 baseline. The statute also requires the Colorado Public Utility Commission (PUC) to set emissions reduction goals for 2035-2050, in line with the state's economy-wide goals. This section summarizes our analysis of Xcel's 2015 baseline, 2030 emissions goal, and expected gas sales and emissions under a Reference Case scenario.

2015 Baseline Emissions and Emissions Reduction Goals

The Clean Heat goals are determined based on a gas utility's 2015 emissions from retail customers, which include three components:

- Methane leaked from the transportation and delivery of gas between the city gate and the customer's end use.

- Emissions resulting from combustion of gas by a company's residential, commercial, and industrial customers whose emissions are not otherwise regulated – essentially, retail customers.

- Methane leaked from the delivery of gas to other local distribution companies (LDCs).[4]

To calculate the emissions associated with the use of gas by retail customers, we use data provided by Xcel in its most recent gas rate case.[5] Specifically, the company reported gas sales to residential and retail commercial customers of 135,123,374 dekatherms (Dth) in 2016, and which reflects a 0.5% reduction in sales from 2015 levels.[6] Based on this data, we calculate total retail sales in 2015 of 135,798,991 Dth. Assuming 100% of gas delivered to customers is fully combusted, the emissions associated with retail sales are approximately 7.2 million metric tons of CO_2-equivalent ($MMTCO_2e$).[7]

The emissions calculated based on Xcel's reported retail sales differ from the emissions Xcel reported pursuant to the federal Mandatory Reporting Rule.[8] Under Subpart NN of the reporting rule, utilities must report gas sales, measured in million cubic feet (Mcf), and can use a standard emissions factor to calculate emissions associated with those sales. Based on this approach,[9] Xcel reported emissions associated with natural gas used by residential and commercial customers in 2015 of approximately 6.6 $MMTCO_2e$[10], which is 10% lower than emissions calculated based on retail sales. This discrepancy does not appear to be limited to one year: over the 2015-2020 period, the emissions Xcel reported under Subpart NN for residential and commercial end users are, on average, 8% lower than emissions calculated based on retail sales. However, the emissions associated with gas sales may vary depending on the energy content of the gas. According to staff at the Colorado Public Utilities Commission, Xcel's gas deliveries typically have higher energy content than the default value used in Subpart NN.[11] Using the emissions associated with the gas sales and energy content delivered to

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[4] Colorado Public Utilities Commission Rules, 4 CCR § 723-4:4527(b).
[5] Proceeding No. 22AL-0046G.
[6] Proceeding No. 22AL-0046G, Hearing Exhibit 111, Direct Testimony of J. Marks, Table JEM-D-1, Historical W/N Dth Throughput by Class 2016-2020.
[7] Calculation assumes full combustion of 1 Dth emits 0.053 metric tons CO_2e. US EPA, Greenhouse Gases Equivalencies Calculator - Calculations and References, https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references.
[8] Mandatory Greenhouse Gas Reporting, Subpart NN, 40 CFR § 98.400-408.
[9] U.S. EPA, Facility Level Information on Greenhouse Gas Tool ("FLIGHT"), available at https://ghgdata.epa.gov/ghgp/service/facilityDetail/2020?id=1002895&ds=E&et=&popup=true.
[10] Under Subpart NN, LDCs report gas sales to residential, commercial, and industrial customers and electric generating stations, and emissions associated with full combustion of all gas deliveries. Subpart NN does not report emissions associated with each individual sector. Under our calculation, we assign a pro-rata share of the total emissions reported, based on residential and commercial customers' portion of total sales.
[11] In Proceeding No. 21R-0449G, PUC Staff note that using the default heating value in Subpart NN likely underestimates Xcel's emissions, because most of Xcel's gas delivered has a higher heating value. PUC Staff Comments, September 19, 2022. Our calculation of the emissions associated with gas sales to retail customers uses the same default emissions value for full combustion of natural gas.

customers – as measured by Dth – likely provides a more accurate measure of the emissions associated with customers' use.

For purposes of this analysis, we calculate emissions associated with reported gas sales – measured in Dth – to retail customers to be 7.2 MMTCO_2e in 2015.[12] Using the energy content of gas sales is consistent with our approach to calculating Xcel's future emissions and the compliance measures needed, which relies on Xcel's projections of retail sales and is measured in Dth.

Gas leakage from the utility's distribution system – including from gas delivered to customers and to other local distribution companies – represents the second and third major components of the 2015 baseline. The Air Pollution Control Division's Clean Heat Plan workbook, which will be used to verify compliance with the clean heat rule, relies on methane leakage data reported by utilities under the federal Mandatory Reporting Rule, Subpart W, which estimates emissions based on the types, ages, and length of distribution system pipes, compressor stations, and other infrastructure; it is not based on empirical measurements of a utility's system. Under Subpart W, Xcel reported approximate methane leakage of 206,000 metric tons of CO_2e in 2015.[13] We assume the fugitive methane leakage emissions reported under Subpart W encompasses both leakage from Xcel's distribution system and leakage from deliveries to other LDCs.[14]

Behind-the-Meter Methane Leakage

While the estimate of Xcel's baseline emissions assumes that all gas delivered to customers is fully combusted, many studies, including the current EPA national inventory,[1] assume that a portion of gas delivered to a customer is leaked as fugitive methane from meters or appliances behind-the-meter (BTM). For example, a California analysis estimates a whole-home leakage rate of 0.5%. While the Commission rules do not direct utilities to include BTM emissions in the 2015 baseline or forecasts, the Commission retains the authority to include those emissions, if the availability of data on BTM emissions from Colorado customers improves.[2]

[1] U.S. EPA, "Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2020: Updates for Post-Meter Emissions" (April 2022), available at: https://www.epa.gov/ghgemissions/natural-gas-and-petroleum-systems-ghg-inventory-additional-information-1990-2020-ghg.

[2] Proceeding No. 21R-0449G, Decision No. C22-0760, ¶152.

Using this baseline, Xcel's emissions goal for 2025 is 7.1 MMTCO_2e, and is 5.77 MMTCO_2e for 2030. Based on retail sales data and methane leakage data from 2020, the 2025 emissions goal is a 10% reduction from 2020 levels, and the 2030 emissions goal is a 27% reduction from 2020 levels.[15] As sales have continued to grow since 2020, the reduction from current sales is slightly higher.

[12] To the extent Xcel's baseline emissions *and* current emissions are lower than what we calculate using retail sales data and standard emissions factors, meeting the Clean Heat emissions goals in 2030 will require lower levels of electrification and energy efficiency investments.

[13] EPA Facility Level Information on GreenHouse gases Tool (FLIGHT) Data, reported under Subpart W, 2015. https://ghgdata.epa.gov/ghgp/service/facilityDetail/2015?id=1002895&ds=L&et=undefined&popup=true. Note that this uses the AR4 100-year global warming potential of methane.

[14] Of note, if a utility deploys advanced leak detection to obtain a more accurate measurement of methane leakage, the utility may file with the PUC to update this portion of its emissions baseline.

[15] Proceeding No. 22AL-0046G, Hearing Exhibit 111, Direct Testimony of J. Marks, Table JEM-D-1, Historical W/M Dth Throughput by Class 2016-2020; and U.S. EPA, Facility Level Information on Greenhouse Gas Tool ("FLIGHT"), available at https://ghgdata.epa.gov/ghgp/service/facilityDetail/2020?id=1002895&ds=E&et=&popup=true

Table 1. *Estimated 2015 baseline emissions by component, estimated 2020 emissions by component, and 2025 and 2030 emissions goals, measured in metric tons of carbon dioxide equivalent.*

Emissions Source	2015 Emissions	2020 Emissions	2025 Emissions Goal	2030 Emissions Goal
Customer End Use (R&C Customers)	7,197,347	7,704,611		
Distribution System Leakage	206,286	191,976		
Total	**7,403,633**	**7,896,587**	**7,107,487**	**5,774,833**

Based on the level of reductions needed in 2025 and the likely timing of Xcel's clean heat plan approval and implementation, we focus on the measures needed to achieve the 2030 goals in this analysis. That does not discount the importance of the 2025 goal, but rather recognizes that programs deploying customer-sided measures, including energy efficiency and beneficial electrification, can cost-effectively achieve long-term emissions reductions but take time to build and deliver savings, but the Company's first clean heat plan will not likely be approved until the first or second quarter of 2024. The timeline makes it difficult to deploy efficiency and electrification measures at the levels needed to meet the goals by 2025, but a robust program to immediately deploy those measures can maximize cumulative emissions reductions over the 2024-2030 period. While the Clean Heat Standard legislation established emissions reduction goals for 2025 and 2030, from a climate perspective, the most important metric of success is cumulative emissions reductions.

Reference Case Emissions

The Reference Case emissions are based on Xcel's projected gas sales, as reported in its 2022 Demand Side Management and Beneficial Electrification Strategic Issues proceeding. Specifically, we assume Xcel's gas sales follow the trajectory presented under the "low case," under which sales increase by an average of 0.5% annually between 2022 and 2030, reaching 153,566,708 Dth in 2030.[16] Consistent with the methodology used to calculate the 2015 baseline emissions and consistent with the commission's current regulations, we assume 100% of gas sales are combusted, and apply an EPA greenhouse gas equivalency factor of 0.053 metric tons CO_2e/Dth.[17] As a result, under the Reference Case, emissions associated with customer end use of natural gas are projected to increase to 8.1 $MMTCO_2e$ in 2030.

Fugitive methane leakage from the distribution system remained relatively flat over the period 2015-2021, based on data reported by Xcel under Subpart W; the average emissions over that period were 192,000 $MMTCO_2e$ per year. We assume under the Reference Case that fugitive methane emissions continue to remain flat at 192,000 $MMTCO_2e$ per year through 2030.

[16] Proceeding No. 22A-0309EG, Hearing Exhibit 107, Supplemental Direct Testimony of Jack Ihle, Attachment JWI-1.
[17] US EPA, Greenhouse Gases Equivalencies Calculator - Calculations and References, https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references.

To summarize, under the Reference Case, we project Xcel's emissions would total 8.3 $MMTCO_2e$ in 2030 (Figure 1).

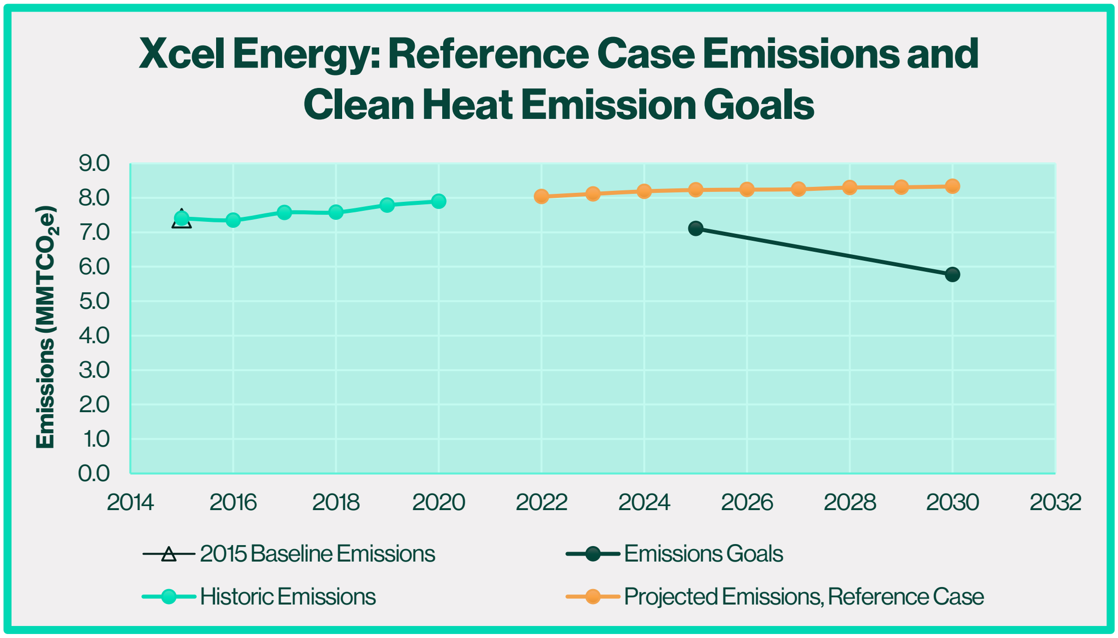

Figure 1. *Xcel Energy's historic and projected emissions and emissions reduction goals, including emissions from combustion of gas by end users and methane leakage in the distribution system.*

Row of methane gas meters.

Chapter 3 – Policy Case

The Policy Case implements clean heat measures to meet Xcel's 2030 emissions reduction targets. According to the clean heat statute, the allowed measures to meet clean heat targets include:

- Gas demand side management.
- Recovered methane measures, defined as:
  - Biomethane.
  - Methane derived from municipal solid waste, the pyrolysis of municipal solid waste, biomass pyrolysis or enzymatic biomass, or wastewater treatment.
  - Coal mine methane.
  - Methane that would have leaked without repairs of the gas distribution and service pipelines.
  - Pyrolysis of tires if the pyrolysis meets a recovered methane protocol.
- Green hydrogen.
- Beneficial electrification.
- Any technology that the Commission finds to be cost-effective and results in a reduction in carbon emissions from the combustion of gas in customer end uses.[18]

Our Policy Case portfolio focuses on electrifying space and water heating and accelerating implementation of building energy efficiency measures such as air sealing and insulation. The Policy Case does not include recovered methane or green hydrogen. We take this approach for several reasons:

First, space and water heating comprise the largest portion of emissions. For example, in residences in the Mountain West, space and water heating accounts for 93% of natural gas usage.[19] Replacing other end uses, such as gas stoves, with efficient electric devices can provide important indoor air quality and health benefits, and numerous reports find that long term, full electrification of homes will likely be essential to manage customer costs.[20] However, because the total fuel use of stoves and associated greenhouse gas emissions reductions are small, we do not include them in this Policy Case.

Second, the Policy Case emphasizes the importance of energy efficiency, and particularly weatherization of homes and businesses. An efficient building shell reduces natural gas used to heat buildings in the near term, and as homes and businesses electrify, it ensures that heat pumps are effective and keep homes comfortable, minimize reliance on inefficient electric resistance heat, and minimize customer bills.

[18] § 40-3.2-108(2)(c), C.R.S.
[19] U.S. EIA, June 2023. Residential Energy Consumption Survey (RECS), Table CE4.5 Annual household site end-use consumption by fuel in the West – totals, 2020.
[20] See, e.g., California Energy Commission, 2020. The Challenge of Retail Gas in California's Low-Carbon Future: Technology Options, Customer Costs, and Public Health Benefits of Reducing Natural Gas Use. Prepared by Dan Aas, Amber Mahone, Zack Subin, Michael Mac Kinnon, Blake Lane, and Snuller Price, Energy and Environmental Economics, Inc.

Third, other eligible clean heat measures, including green hydrogen and recovered methane, have a limited ability to meet Colorado's long-term emissions reduction goals.[21] Researchers have estimated that hydrogen may be integrated into the existing gas distribution system at a maximum level of 20% by volume, which results in emissions reductions of 7% by energy.[22] The level of hydrogen blend for certain end-use appliances may be lower; a report prepared for the Colorado PUC finds that the maximum safe hydrogen blend in gas appliances is as little as 5% by volume.[23] Integrating hydrogen at higher levels could likely require significant retrofits to the gas distribution system and customer appliances, at exceedingly high costs.

Like hydrogen, recovered methane is limited in its availability. Many eligible forms of recovered methane, such as gas captured from landfills, wastewater treatment plants, or animal waste facilities, are generally described as renewable natural gas. A study developed by the Colorado Energy Office estimated the potential renewable natural gas that could be produced from four major sources – agriculture, food waste, landfills, and wastewater – at approximately 19 million Dth. For reference, this is less than 5% of the total annual natural gas demand in the state (estimated at 423 million Dth in 2018), and less than 10% of the volume delivered to residential and commercial customers (198 million Dth).[24] Furthermore, that limited supply is likely to be in high demand in other sectors that are also required to reduce GHG emissions, such as industry, which will likely have a higher willingness to pay.

Finally, both hydrogen and recovered methane are more expensive resources than incentivizing efficiency and electrification. For example, with current federal incentives, the cost of reducing greenhouse gas emissions by using hydrogen in 2025 is projected to be approximately $236 per ton, and the cost of reducing emissions using renewable natural gas is approximately $332 per ton.[25,26] Over a 15-year period – a reasonable life of a heat pump – the net present value (NPV) of relying on renewable natural gas and green hydrogen for emissions reductions is $234 per ton and $247 per ton to ratepayers (2022$), respectively.[27] In comparison, Xcel's current rebates for cold-climate air source heat pumps reduce emissions at a present value cost of $48/ton to ratepayers.[28] Xcel could increase

[21] Colorado has an economy-wide goal to reduce emissions 100% by 2050; accordingly, emissions from natural gas utilities will need to be virtually eliminated.

[22] Baldwin, S., D. Esposito, and H. Tallackson, March 2022. Assessing the Viability of Hydrogen Proposals: considerations for State Utility Regulators and Policymakers. Energy Innovation Policy & Technology, Inc.

[23] One reference cited estimates the blend level at just 5%. Loiter, J. and L. Hanna, National Regulatory Research Institute, Green Hydrogen for Pipeline Injection in LDC Infrastructure: Applications specific to Colorado's SB 21-264, A Report for the Colorado Public Utilities Commission (October 12, 2022), available at https://drive.google.com/file/d/1zC37DW0_uJBpjK9MjXHeNH3AzZNmpxyi/view

[24] Colorado Energy Office, "Renewable Natural Gas (RNG) in Transportation: Colorado Market Study" (June 30, 2019), available at https://drive.google.com/file/d/1oewEgxtchUJS60djChqQF8jsJxRETnNJ/view.

[25] Takahashi, K., E. Carlson, P. Eash-Gates, K. Schultz, P. Rhodes, and A. Hopkins. July 2023. "Building Decarbonization Strategies for the Southwest: Analysis of the costs and emissions reduction potential of space and water heating decarbonization," Forthcoming study.

[26] The estimated cost of hydrogen includes the federal tax incentives, available through 2033. The estimated price of avoided emissions per ton of RNG is comparable with the cost estimates provided by Public Service Company of Colorado in their 2022 Renewable Energy Standard Plan.

[27] To calculate the NPV of hydrogen and RNG, we use annual cost estimates developed by Synapse Energy Economics, Inc. *See* Takahashi, K., E. Carlson, P. Eash-Gates, K. Schultz, P. Rhodes, and A. Hopkins. July 2023. "Building Decarbonization Strategies for the Southwest: Analysis of the costs and emissions reduction potential of space and water heating decarbonization," Forthcoming study. Hydrogen prices reflect the application of the federal PTC and cost reductions of 20% over the 15-year period; RNG costs are assumed to remain constant (simulating a 15-year contract with a project). The annual costs are discounted using a discount rate of 4.3%, which reflects Xcel's approved weighted average cost of capital of 6.7% (Proceeding No. 22AL-0046G, Decision No. C22-0642, ¶ 150), and an assumed adjusted inflation rate of 2.4%.

[28] The calculation assumes a $2,250 rebate for a cold climate heat pump, provided in 2025, and the appliance enables avoided emissions of 2.8 M tons/year for a 15-year appliance lifetime. The avoided emissions are calculated based on displacing an annual household heating demand of 52.4 MMBtu/year and an emissions rate of 0.053 $MTCO_2e$/MMBtu. We use a real discount rate of 4.3%, which reflects Xcel's approved weighted average cost of capital of 6.7% (Proceeding No. 22AL-0046G, Decision No. C22-0642, ¶ 150), and an assumed adjusted inflation rate of 2.4%.

these rebates to $11,000 per heat pump and over the life of the appliance, the incentive would still save ratepayers money, on a net present value basis, compared to investing in renewable natural gas.[29] Of note, in a recent case, Xcel also stated that it expects energy efficiency and electrification to be among the lowest-cost resources to achieve its emissions-reduction targets under the Clean Heat Standard.[30]

Our analysis also omits any measures that fall outside of the statutory definition of a clean heat resource. For example, we do not consider certified natural gas or carbon offsets, which do not reduce carbon emissions from the combustion of gas in customer end uses or meet an approved recovered methane protocol.[31]

The adoption levels for electric appliances and weatherization outlined in the following section are ambitious. To achieve these levels, Colorado must effectively spur a market transformation between now and 2030, which will require critical investments in workforce development, contractor awareness, and customer education. In addition to outlining the deployment levels for electric appliances and efficiency, we include a series of recommendations from other states and contractors within Colorado that can help support this market transformation.

Base Assumptions

To develop the appliance adoption trajectories and associated greenhouse gas emissions reductions in the Policy Case, we use the technology menu, technology performance assumptions, and stock turnover assumptions from the Technical Appendix to the Greenhouse Gas Pollution Reduction Roadmap, developed for the Colorado Energy Office. Specifically, we incorporate assumptions about the incremental number of electric appliances (heat pumps and heat pump water heaters) under our Policy Case, compared with the Roadmap's Reference Case, and calculate the associated reductions in gas usage given the Roadmap's assumptions about unit energy consumption per year. The Roadmap analysis largely assumes that residential and commercial customers replace appliances at their end of life; 85% of HVAC replacements today are done on an emergency basis when the existing appliance fails.[32]

Table 2 summarizes the modeled lifetimes for major appliances and the percentage of appliance stock reaching end of life each year. Heat pump adoption may occur among a combination of end-of-life replacements and early retrofits – however, assuming that replacements are performed at or near end of life helps ensure that the total pace of adoption is realistic. At present, replacing a gas furnace or water heater with an electric heat pump upon burnout is difficult, because of the complexity of installing these appliances, and potential electrical upgrades. While we model replacing appliances at end of life, to be successful, utilities and stakeholders will likely need to educate customers on the need to replace appliances *near* the end of their life, not on burnout.[33]

[29] Calculation reflects an incentive of $11,000 in year 1, avoided emissions of 2.8 MT/year over years 1-15, and a real discount rate of 4.3%. The cost per ton, in 2025$, is approximately $235.
[30] Proceeding No. 22A-0309EG, Hearing Exhibit 102, Direct testimony of N. Mark, at 48.
[31] § 40-3.2-108(2)(c)(VI), C.R.S.
[32] CLASP, "Combating High Fuel Prices with Hybrid Heating: The Case for Swapping Air Conditioners for Heat Pumps", https://www.clasp.ngo/research/all/ac-to-heat-pumps at 5.
[33] See Chapter 4 infra.

Table 2. *Average lifetime and percent of appliance stock reaching end of life in each year, by appliance category.*

Subsector	Mean Lifetime (years)	Percent of appliance stock reaching end of life in each year
Residential Central Air Conditioning	14	7%
Residential Multifamily Space Heating	16	6%
Residential Single Family Space Heating	16	6%
Residential Water Heating	9	11%
Commercial Air Conditioning	18	6%
Commercial Space Heating	15	7%
Commercial Water Heating	13	8%

Source: *State of Colorado, Greenhouse Gas Pollution Reduction Roadmap: E3 Technical Appendix Assumptions and Results (January 14, 2021) available at* **https://energyoffice.colorado.gov/climateenergy/ghg-pollution-reduction-roadmap**.

In addition to end-of-life replacements, we assume that a limited number of gas appliances are retrofitted with heat pumps early, before end of life, in each year. Under the Policy Case, early retrofits start at 0.1% of residential and commercial stock of gas furnaces, boilers, and water heaters in 2023, escalating to 0.3% of gas space and water heating appliance stock annually by 2025, and 1.5% to 2% annually in the residential and commercial sector, respectively, by 2030.

Energy Efficiency Assumptions

As a result of improved building shell efficiencies, annual incremental savings from weatherization and efficiency escalate from roughly 500,000 Dth in 2024 to approximately 900,000 Dth in 2030. These efficiency savings reduce gas demand for space and water heating, primarily weatherization, and represent a significant increase in savings compared to Xcel's recent demand side management (DSM) plans. For example, in its 2022 DSM Annual Status Report, Xcel achieved just over 207,000 Dth of gas savings from weatherization-related programs in single-family and multifamily residences; over 70% of these savings were realized in income-qualified households.[34] To achieve the efficiency savings under the Policy Case, Xcel will need to increase deployment of weatherization measures in market-rate single-family residences from its current level of weatherizing approximately 2,000 households per year to approximately 28,000 households per year in 2030, while maintaining the current weatherization levels in income-qualified (IQ) households.[35] In total, under the Policy Case, building

[34] **Proceeding No. 20A-0287EG, March 31, 2023. Public Service Company of Colorado 2022 Demand Side Management Annual Status Report. Table 10d: 2022 Natural Gas Participation. The calculation includes the following programs: Residential Insulation & Air Sealing, Whole Home Efficiency, IQ Multifamily Weatherization, and IQ Single-Family Weatherization.**

[35] **This reflects a simplified calculation to demonstrate the order of magnitude increase in weatherization. Some weatherization will occur in multifamily buildings and commercial buildings. Additionally, this assumes customers implement one or two weatherization measures; alternatively, Xcel could focus on deep energy retrofits across a lesser number of households, though that may affect the overall program cost.**

envelope improvements contribute to a 5% reduction in gas consumption and emissions relative to 2015 levels. This contributes 13% of the greenhouse gas emissions reduction required by 2030.

Technology Adoption Assumptions

While energy efficiency contributes significantly to our assumed emissions reduction portfolio, 87% of the emissions reductions we model in 2030 come from switching from gas appliances to efficient electric appliances, rather than incentivizing gas appliances that are only incrementally more efficient than conventional gas appliances. While efficient gas furnaces and water heaters can generate modest reductions in demand in the short term, they lock in emissions in the longer term, making it more difficult to meet future targets.

For example, we assume that a residential gas furnace lasts 16 years. To the extent that incentives associated with a clean heat plan encourage continued gas furnace purchases in the coming years, this would lock in gas consumption, and associated greenhouse gas emissions, in homes through 2040 and beyond. A recent PUC decision will end Xcel's subsidies for residential gas water heaters in 2024 and gas space heaters by 2027.[36] Accordingly, the Policy Case focuses on advancing electric heat pumps and heat pump water heaters, rather than incentives for efficient gas appliances.

Finally, this analysis focuses on the impact of air-source heat pumps and energy efficiency because those are the primary technologies deployed in the GHG Roadmap. The Roadmap does include a modest number of ground-source heat pumps in the commercial sector, which are included in this analysis. The modeling assumption to focus on air-source heat pumps is not intended to discount the potential role of ground source heat pumps or other, emerging technologies, such as networked geothermal or wastewater heat. Indeed, there may be applications, such as neighborhood developments and commercial campuses, where geothermal applications are more cost-effective. Additionally, ground source heat pumps may provide important grid benefits, as they maintain higher coefficients of performance in cold winter conditions, compared to air-source heat pumps.

RESIDENTIAL SECTOR

Of the emissions reductions in our portfolio attributed to electrification, most come from the residential sector. This sector is responsible for more than 70% of Xcel's current retail gas sales and emissions, and electric space- and water-heating technologies are readily available to replace gas usage in residential homes. By contrast, some commercial building types may be harder to electrify, particularly in the near term, due to equipment availability, cost, and space constraints.

Our analysis assumes that central air conditioner (AC) replacements largely drive electrification through 2030. Air conditioner replacements are more likely to be technically straightforward. Homes with a central AC likely have existing ducts and panels that can support cold-climate heat pumps or standard heat pumps with a gas backup furnace. Additionally, current market conditions support

[36] **Proceeding No. 22A-0309EG, Decision No. C23-0413, ¶¶ 226-233.**

replacing central AC units with standard heat pumps. Whereas a gas furnace can be changed out virtually immediately with a like-for-like replacement, heat pump replacements typically require at least a few days, if not more. Supply shortages have eased since the COVID-19 pandemic, but labor reportedly remains a bottleneck for heat pump installations along Colorado's Front Range.[37] As a result, we anticipate that heat pump replacements for ACs – where customers are more likely to be able to wait a few days – may be more palatable to more customers than for failed gas furnaces. Finally, non-cold-climate heat pumps are comparable in price or only modestly more expensive than a one-way air conditioner.[38]

We assume that heat pump replacements for ACs ramp up quickly, and by 2030, all ACs are replaced with heat pumps upon failure. Half of these replacements are assumed to be cold-climate heat pumps, and half are assumed to be standard heat pumps with gas furnace backup.[39] For those customers who retain a gas furnace backup system, we assume that the heat pump displaces 80% of gas consumption.[40] For comparison, we assume a smaller proportion of customers replace gas furnaces on burnout with cold-climate heat pumps – reaching 35% by 2030. The 35% figure reflects only the heat pump sales *driven* by gas furnace-only replacements. By 2030, because the heat pump share of AC replacements is so high, more gas furnaces are being removed from the residential equipment stock or converted to a backup for a heat pump than are being added as the primary heating appliance in homes.

We assume a policy pathway for AC replacements similar to that proposed by Collaborative Labeling and Appliance Standards Program (CLASP) in a 2021 report.[41] Initially, we assume that incentives drive uptake of heat pumps, as described in more detail in Chapter 4. Achieving 100% heat pump replacements for ACs by 2030, however, will likely require additional policy measures. We recommend that the State of Colorado implement an appliance standard taking effect in 2029 requiring all ACs to have two-way cooling and heating operation, guaranteeing 100% heat pump replacement in 2029 and 2030. Such an appliance standard, coupled with robust incentives in the near term, is the most cost-effective way to achieve the clean heat goals for ratepayers.

Meeting the 2030 heat pump sales target requires a compound annual growth rate in heat pump sales (both standard and cold climate) of 50% between 2023 and 2030, and a compound annual growth rate in heat pump water heater sales of 70%. The most rapid growth occurs early in the period, as sales roughly double from year to year; by 2030, sales are still growing at 4% for air source heat pumps and 18% for heat pump water heaters.

Finally, all-electric new homes currently cost less than new homes with gas. If designed up-front, all-electric new homes have appropriate panel sizing, ductwork, and efficiency measures, and avoid the costs of gas piping (both internal and external), meters, and hook-up fees. These avoided costs can be

[37] Colorado Energy Office, 2020, "Beneficial Electrification in Colorado: Market Barriers and Policy Recommendations," available at https://drive.google.com/file/d/1d_O7u2SUgt4ASvJ0LLry16h5dffNF19l/view.
[38] CLASP, "3H Hybrid Heat Homes: An Incentive Program to Electrify Space Heating and Reduce Energy Bills in American Homes", https://www.clasp.ngo/research/all/3h-hybrid-heat-homes-an-incentive-program-to-electrify-space-heating-and-reduce-energy-bills-in-american-homes.
[39] This 50-50 split is a modeling assumption made for simplicity; the actual ratio could vary, while still making it feasible for Xcel to meet the 2030 target.
[40] SWEEP, 2022, "Benefits of Heat Pumps for Colorado Homes," available at https://www.swenergy.org/wp-content/uploads/heat-pump-study-2022.pdf.
[41] CLASP, 2021, "3H 'Hybrid Heat Homes': An Incentive Program to Electrify Space Heating and Reduce Energy Bills in American Homes," available at https://www.clasp.ngo/wp-content/uploads/2021/05/3H-Hybrid-Heat-Pumps_CLASP_May26.pdf.

substantial. Recent policies remove gas customer subsidization of these system expansion costs, eliminating incentives for developers to construct dual-fuel homes.[42] Other policies, such as local building codes, are likely to further incentivize the development of all-electric new homes.[43] Accordingly, we assume that a portion of new homes constructed are all-electric in 2023, rising to 100% of new homes in 2029 (Table 3); this percentage is applied to Xcel's estimate that 14,000 new homes are constructed in its service territory each year.[44] We assume these new homes install a cold-climate heat pump and a grid-enabled ("smart") heat pump water heater. The number of heat pumps and heat pump water heaters deployed in new homes reduces the number required to be installed in existing homes, which is reflected in the data in Table 4.

Table 3. *The percentage of new homes constructed in Xcel's territory that are all-electric.*

	2024	2025	2026	2027	2028	2029 - 2030
Percent of new homes that are all-electric	5%	10%	25%	50%	75%	100%

Table 4. *Electric replacements of residential gas equipment under the Reference Case, as a percentage of annual sales.*

	2023	2024	2025	2026	2027	2028	2029	2030
Residential Multifamily Space Heating	2%	4%	8%	15%	20%	25%	35%	35%
Residential Single Family Space Heating	2%	4%	8%	15%	20%	25%	35%	35%
Residential Water Heating	2%	8%	17%	28%	42%	55%	65%	75%
Residential Central Air Conditioning	2%	8%	20%	33%	50%	75%	100%	100%
Residential Cooking	2%	8%	15%	30%	45%	60%	75%	80%

[42] Senate Bill 23-291, codified at § 40-3.2-104.3, C.R.S. requires utilities to file a revised tariff removing gas line extension allowances by December 31, 2023.
[43] Cities across Colorado are already adopting all-electric and electric-preferred building codes. For example, the cities of Crested Butte and Lafayette, the latter of which is in Xcel's service territory, have all-electric new building codes for both residential and commercial construction. Cities across the Front Range such as Denver, Northglenn, and Erie have electric-preferred building codes for residential construction, and Denver and Louisville have requirements for all-electric commercial new construction.
[44] Proceeding No. 22A-0309EG, Decision No. C22-0548-I, ¶ 11; see also Proceeding No. 22AL-0046G, Hearing Exhibit 149, Wishart Rebuttal Testimony, at 48.

COMMERCIAL SECTOR

Generally, commercial building types are more varied than in the residential sector, and some are more difficult to electrify. On the other hand, state and local policies have the potential to drive significant electrification in the commercial sector. For example, Denver's Energize Denver ordinance will require all existing commercial and multifamily buildings to electrify space- and water-heating appliances upon replacement; furnaces, unitary air conditioners, and storage water heaters must be electrified or replaced with two-way heat pumps starting in 2025, and gas-fired boilers must be electrified starting in 2027.[45] Statewide, Colorado's Building Performance Standard requires large commercial buildings over 50,000 square feet to reduce greenhouse gas emissions by 7% by 2025 and 20% by 2030, providing an additional incentive for large building owners to consider electrification.[46]

We assume that the percentage of electric replacements in the commercial sector varies according to the gas appliance being replaced. For some appliances, such as gas furnaces and gas storage water heaters, we assume that electric replacements proceed at nearly the same pace as furnace and AC replacements in the residential sector. Other appliances, like commercial gas boilers, are more difficult to electrify. For commercial buildings with heat pumps that retain a gas backup system, we assume that the heat pump displaces 80% of the building's gas consumption. Our specific assumptions are detailed below and in Table 5:

- **Gas furnaces:** We assume an existing furnace/AC rooftop unit can be replaced with a heat pump rooftop unit at relatively low complexity and incremental cost.[47] We assume a similar ramp-up rate for heat pump replacements of commercial furnaces as for residential furnace replacements, driven by incentives, performance requirements, and building codes. By 2030, we assume that heat pumps replace 35% of Reference Case gas furnace sales. As with the residential sector, by 2030, due to a high AC replacement rate, more gas furnaces are being removed from the commercial equipment stock or converted to a backup for a heat pump than are being added as the primary heating appliance.

- **Gas heat pumps:** There is not a large market for gas-fired heat pumps in Colorado. We assume that electric heat pumps replace gas heat pump sales by 2025.

- **Gas storage water heaters:** We assume that many gas storage water heaters can be replaced cost-effectively with a central heat pump water heater, although heat pump water heaters may be more costly or poorly suited to larger buildings or buildings with high hot water loads.[48] In total, 63% of Reference Case gas storage water heater sales are replaced with heat pump water heaters by 2030.

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[45] Ord. No. 1310-21, § 3, 11-22-21; Ord. No. 967-22, § 1, 9-12-22; https://www.denvergov.org/Government/Agencies-Departments-Offices/Agencies-Departments-Offices-Directory/Climate-Action-Sustainability-Resiliency/High-Performance-Buildings-and-Homes/Energize-Denver-Electrification-Program.

[46] H.B. 21-1286, § 25-7-142(8)(c), C.R.S.

[47] City of Denver and Lotus Engineering and Sustainability, 2021, "The Energize Denver Renewable Heating and Cooling Plan," available at https://www.denvergov.org/files/assets/public/climate-action/documents/hpbh/renewable-hampc/denver-renewable-heating-and-cooling-plan_june-2021.pdf.

[48] U.S. Department of Energy, 2021, "Decarbonizing HVAC and Water Heating in Commercial Buildings, available at https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Decarbonizing%20HVAC%20and%20Water%20Heating%20in%20Commercial%20Buildings%2011.21.pdf.

- **Residential-type central AC and rooftop AC replacements:** As with gas furnaces, we assume that central ACs and rooftop units can be replaced with heat pumps at relatively low complexity and cost. We assume that heat pumps replace 70% of rooftop unit AC sales by 2030 and 100% of residential-type AC sales.

- **Packaged terminal ("WallRoom") ACs:** Packaged terminal heat pumps are readily available to replace packaged terminal air conditioners, although they may incur a higher upfront cost.[49] We assume that packaged terminal heat pumps replace 55% of packaged terminal air conditioner sales by 2030.

- **Gas boilers:** We assume that commercial gas boilers are among the most complicated and potentially costly appliances to electrify. Boilers can be replaced by air-to-water or water-to-water heat pumps, or by variable refrigerant flow heat pump systems; however, expensive redesign and retrofit work may be necessary. Nonetheless, we assume that heat pump retrofits for commercial boilers begin to accelerate in 2027, as the Energize Denver performance standard for existing buildings with boilers takes effect. By 2030, we assume that heat pumps will replace 25% of Reference Case gas boiler installations.

Heat pumps on the rooftop of a commercial building.

[49] City of Denver and Lotus Engineering and Sustainability, 2021, "The Energize Denver Renewable Heating and Cooling Plan," available at https://www.denvergov.org/files/assets/public/climate-action/documents/hpbh/renewable-hampc/denver-renewable-heating-and-cooling-plan_june-2021.pdf.

Table 5. *Electric replacements of commercial gas equipment under the Policy Case, as a percentage of annual sales.*

Original Technology	Replacement Technology	2023	2024	2025	2026	2027	2028	2029	2030
Commercial Space Heating									
Gas Boiler	Hybrid Gas Electric Heat	2%	3%	3%	4%	10%	15%	20%	25%
Gas Furnace	Hybrid Gas Electric Heat	1%	2%	4%	5%	8%	13%	18%	18%
Gas Furnace	Air-Source Heat Pump	1%	2%	4%	5%	8%	13%	18%	18%
Gas Heat Pump	Air-Source Heat Pump	50%	75%	100%	100%	100%	100%	100%	100%
Commercial Water Heating									
Gas Storage	Electric Heat Pump Storage	2%	7%	15%	25%	37%	45%	57%	63%
Commercial Air Conditioning									
Reference Commercial	Air-Source Heat Pump	2%	8%	20%	33%	50%	75%	100%	100%
Reference Rooftop Air	Hybrid Gas Electric Heat	1%	4%	9%	14%	21%	28%	30%	35%
Reference Rooftop Air	Air-Source Heat Pump	1%	4%	9%	14%	21%	28%	30%	35%
Reference WallRoom	Hybrid Gas Electric Heat	1%	5%	10%	15%	25%	35%	40%	55%
Commercial Cooking									
Gas Convection	Electric Oven	2%	3%	5%	7%	15%	22%	30%	40%
Gas Stove	Electric Induction Stove	2%	7%	15%	25%	37%	45%	57%	63%

Emissions Reductions from Beneficial Electrification and Demand Side Management

The electrification and efficiency measures in the Policy Case significantly reduce residential and commercial gas sales – and associated emissions – by 2030 (Figure 2). In contrast, under the Reference Case, and absent any interventions, Xcel projects that its residential and commercial gas sales will grow 13% from 2015 levels by 2030. With aggressive beneficial electrification and efficiency, under the Policy Case, 2030 gas sales are 31% lower than the Reference Case level for that year, and 22% lower than they were in 2015. Again, because the Policy Case relies on energy efficiency and beneficial electrification, and does not include recovered methane or hydrogen, gas sales are a direct proxy for emissions.

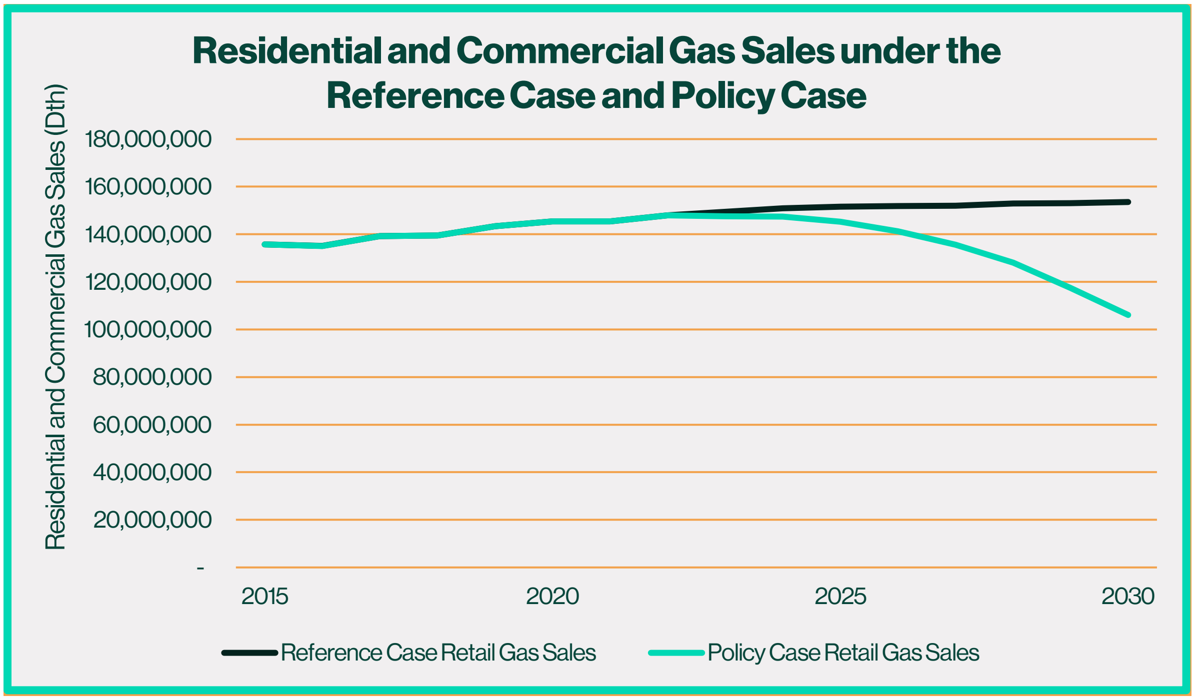

Figure 2. *Residential and commercial gas sales under the Reference Case and Policy Case.*

As Figure 2 clearly shows, residential and commercial gas sales have increased in Xcel's service territory since 2015, and under the Reference Case, are projected to continue increasing. Even with a rapid switch from gas to electric appliance sales, it will take several years to "bend the curve" and reduce emissions below 2015 levels. Under the Policy Case, retail gas sales do not return to 2015 levels until 2027. By 2030, gas sales and emissions are 22% lower than the 2015 baseline, consistent with the clean heat statute.

Air source heat pump for cooling or heating the home. Outdoor unit powered by renewable energy.

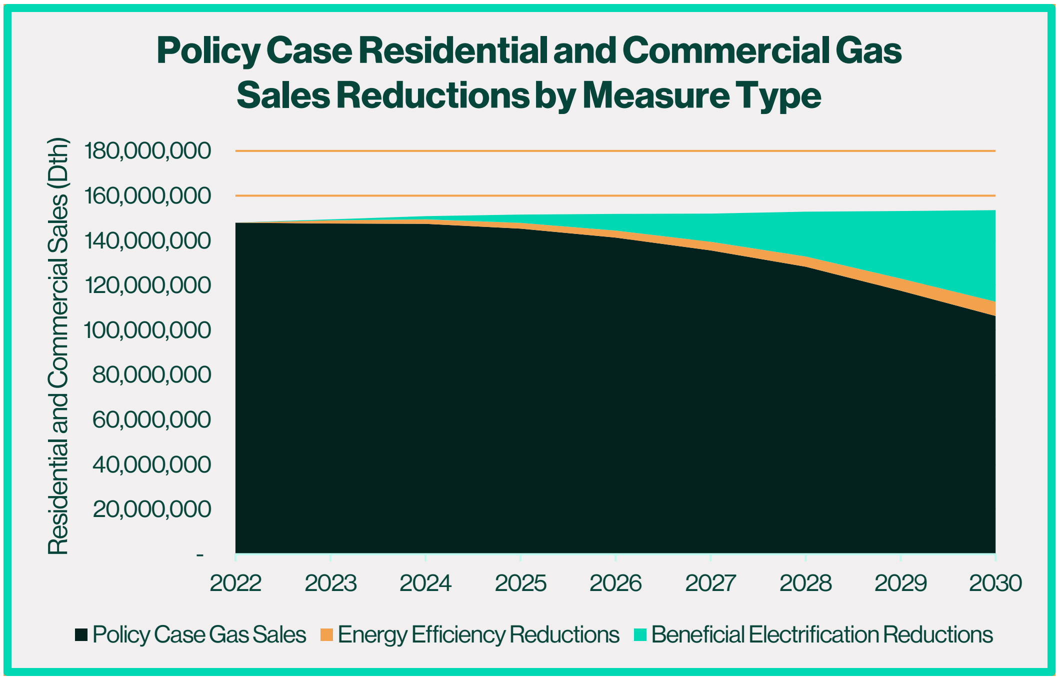

Figure 3. *Residential and commercial gas sales reductions by measure type under the Policy Case.*

Figure 3 shows how each type of measure – beneficial electrification and energy efficiency – contributes to gas sales and greenhouse gas emissions reductions. As adoption of electric appliances accelerates, beneficial electrification contributes a progressively larger portion of the total reductions. By 2030, beneficial electrification is responsible for 87% of realized gas sales reductions and emissions reductions, while energy efficiency is responsible for 13% of the reductions.

Table 6. *Policy Case residential and commercial gas sales and emissions.*

Year	Policy Case Gas Sales (Dth)	Policy Case Emissions (metric tons CO_2e)	Policy Case Emissions Reduction
2015	135,798,991	7,197,347	0%
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2023	147,583,595	7,821,931	-9%
2024	147,421,437	7,813,336	-8%
2025	145,351,666	7,703,638	-7%
2026	141,316,600	7,489,780	-4%
2027	135,634,566	7,188,632	0%
2028	128,246,360	6,797,057	6%
2029	117,626,320	6,234,195	14%
2030	106,343,495	5,636,205	22%

The Path Forward: Outreach, Contractor Training, and Financing

To achieve the emissions reduction and appliance adoption pathways outlined above, Xcel's service territory will need to see rapid market transformation in just seven years. Although appliance and weatherization incentives comprise the majority of budgets for clean heat plans (see Chapter 4), market transformation cannot be achieved with incentives alone. Stakeholders interviewed for this research expressed broad agreement that workforce shortages for heat pump installations are among the most significant barriers to electrification today.[50] Additionally, homes and businesses require attractive financing to overcome the "first-cost" problem. Cold-climate heat pumps replace both a gas furnace and an AC, but gas furnaces and ACs do not always fail at the same time in existing homes. The upfront cost of a cold-climate heat pump is considerably higher than the upfront cost of simply replacing a failed furnace. Innovative solutions can help mitigate this cost and reach more customers.

It is possible to achieve robust adoption of heat pumps, even in cold climates, despite the barriers. In Maine, for example, contractors installed close to 30,000 heat pumps and 10,000 heat pump water heaters per year in 2021 and 2022.[51] Scaled to the number of households in Xcel's service territory, this is equivalent to nearly 70,000 heat pumps and 23,000 heat pump water heaters – close to the sales that we project for Xcel in 2030. Maine has a goal of installing at least 100,000 heat pumps, cumulatively, by 2025 and is on track to exceed this goal. While Maine has a large percentage of customers who currently use heating oil or propane – which makes the economics of electrification favorable for many of its residents – with IRA incentives, Colorado state incentives, and utility incentives combined, Colorado can also achieve favorable economics for electric appliances within this decade.

To achieve this growth, it is critical that programs are streamlined and that the utility is proactively addressing barriers across the supply chain. Contractor acceptance of heat pump technologies, and availability to install them, is one key barrier. According to a 2020 Colorado Energy Office study of market barriers for electrification, many HVAC and plumbing contractors "actively discourage or simply do not sell heat pump technologies."[52] The authors of this report have experienced this firsthand. Many contractors do not install cold-climate heat pumps without a gas backup furnace – adding significant cost for projects where the existing gas furnace has failed or is near failure. One author was told that Denver's climate is too warm for cold-climate heat pumps.

A recent survey by the Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI) provides some insight into the hurdles for contractors.[53] The survey found that contractors are open to leading on climate change mitigation, energy efficiency, and fuel switching. However, many lack familiarity with fuel switching and whole-home retrofits. The survey pointed out that HVAC contractors often rely on free manufacturer trainings, which do not typically include whole-home approaches such as integrated weatherization and electrification. To the extent that electrification or whole-home projects require

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[50] Colorado Energy Office, 2020, "Beneficial Electrification in Colorado: Market Barriers and Policy Recommendations," available at https://drive.google.com/file/d/1d_O7u2SUgt4ASvJ0LLry16h5dffNF19l/view.
[51] "How Maine Became a National Electrification Leader," Building Decarbonization Coalition presentation, April 25, 2023, available at https://drive.google.com/file/d/1ND0i8beMRwCSisnPiKbXYVYX0NBTzjxa/view.
[52] Colorado Energy Office, 2020, "Beneficial Electrification in Colorado: Market Barriers and Policy Recommendations," available at https://drive.google.com/file/d/1d_O7u2SUgt4ASvJ0LLry16h5dffNF19l/view.
[53] HRAI, "Overcoming Implementation Barriers to HVAC Contractor-Led Building Retrofits" (May 31, 2021), available at https://www.hrai.ca/uploads/userfiles/files/2021%2005%2031%20--%20HRAI%20Final%20Report.pdf. Although this report polled Canadian contractors, its main conclusions were echoed by HVAC 2.0, a U.S.-based nonprofit. See HVAC 2.0, 2021, "HRAI Viewpoint on Electrification," https://www.hvac20.com/blog/hrai-viewpoint#/.

subcontracting of electrical or insulation services, this poses another barrier, as warranties typically are covered internally at the contractor's cost. HVAC 2.0, a company that markets training and software to contractors, further points out that "very few contractors are trained on how to do load or heating calculations" – a point that has surfaced repeatedly in our conversations with industry professionals.[54] Combined with contractor risk aversion, this causes many installations to be oversized, at greater expense to customers.

Overcoming these barriers will require outreach by the State of Colorado, Xcel, and peer contractors and other private sector businesses. Some outreach is happening already. Stakeholders we interviewed praised Xcel's contractor trainings on electrification, and the Energy Efficiency Business Coalition provides a 40-hour certification in cold-climate heat pump installation, design, and service.[55] The Beneficial Electrification League of Colorado, a stakeholder organization of utility, state government, and nonprofit members, conducts outreach to contractors and distributors. And startup companies like Elephant Energy serve as a one-stop shop for recruiting and streamlining contractors offering electrification (see sidebar on page 25).

HVAC worker installing electric heat pump.

[54] HVAC 2.0, 2021, "HRAI Viewpoint on Electrification," https://www.hvac20.com/blog/hrai-viewpoint#.
[55] Energy Efficiency Business Coalition, "EEBC Workforce Training & Hiring Pipeline, available at https://www.eebco.org/WORKFORCE-TRAINING.

To reach contractors, the outreach and training that has occurred to date will need to be expanded, with a particular focus on optimal cold-climate heat pump sizing and configurations along the Front Range. Programs must be designed to make incentives for heat pumps and weatherization retrofits as easy as possible for contractors to access. We recommend that Xcel and the Colorado Public Utilities Commission adopt the following additional policy measures:

- **Offer upstream and midstream incentives for electrification.** Upstream and midstream incentives for heat pumps – i.e., incentives provided to manufacturers, distributors, and contractors, rather than end users – can simplify the rebate process, help build relationships with contractors and distributors, and encourage distributors and contractors to stock, sell and install these appliances. They can also be more cost-effective, as they are provided prior to appliance markup.[56] Although upstream incentives are not widely used for electrification to date, utilities such as Southern California Edison are beginning to offer them,[57] and Xcel's 2023 Demand Side Management Plan will add a midstream rebate for heat pump water heaters. The proposed Clean Heat Plan budget, outlined in Chapter 4, models incentives per appliance, but these incentives could readily be awarded to the end user or to contractors or distributors.

- **Make incentives quick and easy to access.** An important consideration is to ensure that incentives are paid out to contractors and homeowners quickly – within days, not months. Maine can serve as a model in this regard; Efficiency Maine reports that 98% of incentives are paid out within two weeks, with a goal of processing all complete applications in the same week.[58] Most contractors are small businesses requiring a steady and predictable cash flow. Contractors in Maine have indicated that this speed is a key factor contributing to the state's success in expanding its base of heat pump contractors and scaling its heat pump program.[59] To make its program easier to access, Efficiency Maine has also simplified its claim form, installation checklist, and product criteria for heat pumps. Additionally, various incentive programs, including utility programs and the IRA incentive programs, should coordinate to offer customers a full

New Models: Elephant Energy's Vertically Integrated Installation Model

Elephant Energy, a Colorado-based startup, reduces barriers to heat pump installations by serving as a "one-stop shop" for electrification. The company partners with a network of vetted contractors, who follow a standardized process for sizing and quality control of the heat pump installations – Elephant Energy sources the equipment, provides working capital, and guarantees profit margins. The company also uses proprietary software that sizes the appliances based on a home's prior gas use data, helping to size systems correctly and avoid excess cost for customers and installers. Finally, by bundling a large number of electrification projects, the company is able to secure more attractive financing, helping customers and contractors to overcome the first-cost problem commonly associated with heat pumps.

[56] CLASP, "3H Hybrid Heat Homes: An Incentive Program to Electrify Space Heating and Reduce Energy Bills in American Homes", https://www.clasp.ngo/research/all/3h-hybrid-heat-homes-an-incentive-program-to-electrify-space-heating-and-reduce-energy-bills-in-american-homes.
[57] ACEEE, Charlotte Cohn & Nora Wang Esram, "Building Electrification: Programs and Best Practices" (Feb. 2022) https://www.aceee.org/sites/default/files/pdfs/b2201.pdf.
[58] "How Maine Became a National Electrification Leader," Building Decarbonization Coalition presentation, April 25, 2023, available at https://drive.google.com/file/d/1ND0i8beMRwCSisnPiKbXYVYX0NBTzjxa/view.
[59] Building Decarbonization Coalition, 2023, "National Policy Call: How Frigid Maine Became a National Electrification Leader," available at https://drive.google.com/file/d/1ZwPp2CPp5bxwrVbl54vbGk5ROPBcoMy0/view.

package of assistance in a streamlined manner. For example, programs focused on low- to moderate-income customers should have streamlined eligibility requirements.

- **Market heat pumps aggressively to customers and encourage preventative maintenance.** Another key factor is aggressive marketing. For example, Mass Save, which provides energy efficiency programs to customers in Massachusetts, recommends ensuring that customers who weatherize their homes and would benefit from heat pumps have appropriate follow-up by preferred heat pump contractors.[60] HVAC 2.0 recommends marketing "preventative maintenance" – replacing an AC or furnace before the appliance is anticipated to reach end of life – to homeowners. This prevents HVAC purchases "under duress," where quick sales are prioritized over quality and efficiency, and allows for the additional time it may take for a customer to locate and schedule an installation with a qualified heat pump contractor.[61] A preventative approach is easier with financing options that mitigate upfront cost and risk for families and businesses.

- **Make it easy to locate contractors that prioritize heat pump sales.** For customers who desire a heat pump, it is not always obvious whom to call.[62] Many contractors, even those that are registered as trade partners with utilities, dissuade customers from purchasing or refuse to install cold-climate heat pumps in existing, particularly older, homes. To remedy this problem, Efficiency Maine's website ranks contractors by heat pump program participation within the last four months. This makes it easier for customers to locate the contractors with the most heat pump experience and provides free marketing for the most prolific contractors, incentivizing contractors to sell more heat pumps. One-stop shop approaches, like the one used by Elephant Energy, can also make installing heat pumps easier for customers.

- **Leverage on-bill financing to reduce or eliminate upfront costs to customers**. Even with a contractor base that is ready and willing to sell heat pumps, households and businesses often need to overcome the "first-cost problem" described at the beginning of this section. This is particularly necessary to entice customers to adopt a preventative maintenance approach and replace HVAC equipment before, rather than at, the point of failure. Financing which allows building owners to avoid a large upfront cost, while saving money over time on their utility bills, would be ideal. The Colorado Public Utilities Commission has already begun to consider a proposal for a on-bill financing program for demand side management programs for low-income customers.[63] Such a program would allow customers to fully finance efficiency and electrification improvements and pay the installed cost of these measures back through the utility bill savings that these measures generate. We recommend expanding any future on-bill financing to all residential customers, which we view as a cost-effective way to incentivize beneficial electrification and leverage traditional incentive programs.

[60] Mass Save, 2021, "Massachusetts Joint State Wide Electric and Gas Three-Year Energy Efficiency Plan 2022-2024," available at https://ma-eeac.org/wp-content/uploads/Exhibit-1-Three-Year-Plan-2022-2024-11-1-21-w-App-1.pdf.
[61] HVAC 2.0, 2021, "HRAI Viewpoint on Electrification," https://www.hvac20.com/blog/hrai-viewpoint#.
[62] Loveelectric.org, a project of the Beneficial Electrification League of Colorado (BELCO), provides this important service in Colorado.
[63] Proceeding No. 22A-0309EG, Decision No. C23-0413, ¶¶ 166-171.

Chapter 4 – Estimating Clean Heat Budgets

Currently, efficient electric heat pumps and heat pump water heaters have a small market share: nationally, approximately 112,000 heat pump water heaters were shipped in 2021[64], compared to approximately 10 million gas-fired storage and electric resistance water heaters.[65] To achieve Colorado's clean heat and economy-wide emissions reduction goals, the Colorado market for space- and water-heating appliances must be transformed. To do this on a short time scale, incentives will likely need to cover a significant portion of customer costs to install efficient electric appliances. In the very near term, utility incentives, when paired with state and federal tax incentives, may even need to exceed the incremental costs of an electric appliance.

This section addresses several key elements of the cost analysis:

- The incremental costs of efficient residential electric appliances such as heat pumps and heat pump water heaters, which is used to inform incentive levels.
- An annual budget for electrifying space and water heating in residences and commercial buildings, and weatherization of existing homes.
- Sources of funding, including Xcel's recently approved budgets for DSM and beneficial electrification and elements of Xcel's electric energy efficiency budget, and the incremental budget needed to achieve the Colorado clean heat targets.
- An assessment of benefits, including avoided gas investments and climate benefits.

Finally, while this analysis provides an estimate of the budget needed to meet Xcel's clean heat targets, there are a multitude of factors that can influence the budget, particularly how quickly the market for heat pumps and heat pump water heaters develops and the attendant impacts on appliance costs. While this analysis models a set of incentive levels, those levels will need to be adjusted, depending on adoption rates. Additionally, while we focus on incentives to drive customer adoption, as described in Chapter 3, a major impediment to electrification is the up-front cost of efficient electric appliances and weatherization. Other policy approaches, such as on-bill financing, may be effective at addressing customers' up-front costs at a lower cost to ratepayers.

Capital and Installation Costs for Efficient Electric Appliances

Incentive programs typically cover a portion of the incremental cost for a customer to acquire an efficient appliance. Incentive levels may be informed by a variety of factors, including surveys of customer adoption at different incentive levels. At present, however, we are unaware of many recent

[64] Energy Star, 2022. ENERGY STAR® Unit Shipment and Market Penetration Report Calendar Year 2021 Summary. https://www.energystar.gov/partner_resources/products_partner_resources/brand_owner_resources/unit_shipment_data/archives.
[65] AHRI, Residential Automatic Storage Water Heaters Historical Data. https://www.ahrinet.org/analytics/statistics/historical-data/residential-automatic-storage-water-heaters-historical-data.

customer willingness-to-pay surveys; therefore, the incentive levels are informed primarily by incremental costs.

To determine a reasonable range of incentive levels, we first estimate the incremental costs for efficient electric residential appliances, based on current installation costs and estimated available federal and state tax incentives. We focus on appliances deployed in the residential sector and pro-rate the incentive levels for multifamily households and commercial applications.[66] The commercial sector contributes significant savings to the overall compliance pathway, but the incremental costs of commercial equipment, the overall emissions reductions, and the appropriate incentive level may be widely variable; modeling a standard incentive level was a necessary simplifying assumption for this analysis.[67]

Over the period of the analysis, we do not assume any changes in the cost of heat pumps or heat pump water heaters. Reports such as NREL's Electrification Futures Study[68] model steady cost declines and efficiency improvements between 2017 and 2050; however, heat pumps and heat pump water heaters have seen cost increases in the last few years. A significant portion of costs come from installation.[69] In part because most HVAC companies install relatively few heat pumps or heat pump water heaters, installation costs likely reflect uncertainty about the extent of a job, unforeseen costs, and general risks to the contractor. As the frequency of installations increases, contractors will likely become more familiar with the technology, which can in turn reduce installation costs. While we assume appliance prices remain flat between now and 2030, as market adoption increases, installation costs may decline.

The incremental capital cost of efficient electric equipment is based on the capital and installation cost of the electric appliance, and the cost of a comparable gas-fueled appliance. To determine incremental costs, we assume the following equivalencies, consistent with the analysis in Chapter 3:

- **Residential cold-climate air source heat pump:** In an existing home, a cold-climate air source heat pump replaces a natural gas-fueled furnace and air conditioner. For a cold-climate heat pump to operate effectively, many existing homes will require additional insulation and air sealing. The incremental cost of this weatherization is considered in greater detail below. Cold-climate heat pumps installed in some existing homes may require additional electric resistance heat; these costs are not shown in Table 8, below, because they are relatively modest.[70] Some homes may also require duct system upgrades, depending on the sizing of the existing system. For example, if ducting is primarily sized to meet cooling loads, rather than heating loads, it may require upgrades. However, one contractor that specializes in heat pumps indicated that while they rarely upgrade ductwork, they do sometimes use a product to reduce the leakiness of ducts.[71]

[66] **For example, if the residential incentive level is $2,000 for a 4-ton cold-climate heat pump, the multifamily and commercial incentive for a cold-climate heat pump is $500/ton.**
[67] **This approach is consistent with the structure of Colorado's state tax credits for heat pumps.**
[68] **Jadun, Paige, Colin McMillan, Daniel Steinberg, Matteo Muratori, Laura Vimmerstedt, and Trieu Mai. 2017. Electrification Futures Study: End-Use Electric Technology Cost and Performance Projections through 2050. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-70485. https://www.nrel.gov/docs/fy18osti/70485.pdf.**
[69] **One HVAC company estimated that equipment comprised approximately 40% of the total installation cost.**
[70] **Electric resistance strip heating included in the heat pump itself is estimated to cost roughly $300 - $350 for a 10 kw system, which is equivalent to a 30,000 Btu heat pump. https://www.pickhvac.com/heat-pump/basics/electric-heat-strips.**
[71] **Personal communication, Elephant Energy (June 2, 2023).**

- **Residential air source heat pump:** For this measure, we assume the customer replaces an air conditioning unit with a non-cold climate air source heat pump but retains a gas-fueled furnace.

- **Heat pump water heater:** We assume this appliance replaces a conventional gas storage tank water heater.

- **All-electric new home:** We assume a new all-electric home includes a cold-climate heat pump, with adequate insulation such that no electric resistance heating elements are required, and a heat pump water heater. This all-electric new home is compared with a new home with an efficient gas furnace, air conditioner, and gas storage tank water heater.

Person adjusting the temperature on a water heater.

Federal and State Funding Sources for Electrification

Through the IRA, the federal government allocates funding to states through the High-Efficiency Electric Home Rebate Act (HEEHRA) and Home Energy Performance-Based, Whole-House Rebates (HOMES) programs. Colorado is expected to receive approximately $70 million through each of these programs,[1] which the state may deploy over the next ten years. If other states do not use their allocated funding, Colorado may be eligible to receive additional federal funding. The HEEHRA program and federal tax credits provide rebates or tax credits for installing efficient electric appliances, insulation, and electrical or panel upgrades. The magnitude of federal and state tax incentives depends on several factors, including the customer's income and tax liability, as well as Colorado's plan to distribute federal funding rebates for low- and moderate-income customers.

Under the HEEHRA program, a customer can receive point-of-sale incentives for electrification costs, including up to 100% of electrification costs for low-income households and up to 50% of costs for moderate income households, up to a maximum of $14,000. A household may receive up to $8,000 for installing a heat pump, $1,750 for a heat pump water heater, $1,600 for insulation, and $6,500 for electrical wiring and panel upgrades.[2]

The Energy Efficient Home Improvement credit (25C) provides a tax credit to households for installing efficient electric devices. The tax credits include up to 30% of the costs for various appliances and insulation; for most measures, the deductions are limited to $600/measure, or $1,200/household per year. Eligible appliances include efficient gas furnaces, standard tank gas water heaters, and air conditioners, as well as electric panel upgrades. For heat pumps and heat pump water heaters, a household can deduct up to $2,000/measure.

The Colorado tax incentives for installing heat pumps and heat pump water heaters step down over time. For heat pumps, the tax credits per unit are $1,500 in 2024-2025; $1,000 in 2026-2028; and $500 in 2029-2032. The tax credits for heat pumps are available for Energy Star rated, variable speed heat pumps, and the heat pump must meet at least 80% of the building's heating load and provide heat to all conditioned spaces in the building. While we model standard, non-cold climate heat pumps, it is unclear whether available models are eligible for the state tax credits. For heat pump water heaters, the state offers tax credits of $500 in 2024-2025, and $250 in 2026-2032. Finally, heat pumps and heat pump water heaters are exempt from state sales tax (not included in cost calculations).

[1] **U.S. Department of Energy, November 2, 2022. Biden-Harris Administration Announces State and Tribe Allocations For Home Energy Rebate Program. https://www.energy.gov/articles/biden-harris-administration-announces-state-and-tribe-allocations-home-energy-rebate.**

[2] **Congressional Research Service, November 28, 2022. The Inflation Reduction Act: Financial Incentives for Residential Energy Efficiency and Electrification Projects.**

The cost of conventional appliances (gas furnaces and water heaters and conventional air conditioning systems), including the potential benefit of federal tax rebates, are presented in Table 7. A wide range of costs for heat pumps and heat pump water heaters is reported in the literature.[72] This range may reflect regional differences in costs, costs that have changed rapidly due to supply chain issues, relatively low contractor familiarity with the technology, and premiums charged for perceived risks.[73] The costs shown in Table 8 reflect values between the high and low end of reported costs based on discussions with local industry experts and published reports, as well as the impact of potential state and federal tax incentives.

The federal and state tax incentives, described in the box on page 30, can be critical in transforming the market. However, funding from HEEHRA is limited, and likely to reach only a small subset of low- and moderate-income customers.[74] Furthermore, nationally, roughly 40% of households have no tax liability, and would not be able to take advantage of federal or state tax credits. Because the impact of these incentives is uncertain[75], Table 8 includes cost estimates assuming customers may or may not have the ability to take advantage of state and federal tax credits.

Table 7. *Cost of natural gas furnaces, water heaters, and air conditioning units (including equipment and installation costs) and available federal tax rebates.*

Conventional Equipment	Cost of Equipment	Estimated Federal Tax Rebate – conventional appliances (25C) (30%, up to $600)	Total Cost (customers with full tax liability)	Sources
Gas furnace	$8,500	$600	$7,900	SWEEP 2023
Air Conditioner (3.5-4.5 ton)	$16,000	$600	$15,400	SWEEP 2023
Gas tank water heater	$2,400	$600	$1,800	SWEEP 2023
Mixed-fuel new home*	$31,700	$2,500	$29,200	SWEEP 2023, SWEEP 2022

**Cost of equipment includes external gas piping (distribution system expansion), internal gas piping, and meter and hookup charges. (SWEEP 2022) Assumes a mixed-fuel new home would qualify for federal Energy Star Residential New Home Construction credits ($2,500).*

[72] For example, a study by Lawrence Berkeley National Laboratory (LBNL) published in 2021 using data collected over the 2010-2020 period estimates the cost of a cold-climate heat pump with variable speed at approximately $20,500 in 2019; due to inflation, this cost would be approximately $24,000 in 2023. Less, Brennan, I. Walker, N. Casquero-Modrego, and L. Rainer. 2021. The Cost of Decarbonization and Energy Upgrade Retrofits for US Homes. LBNL. SWEEP (2022) estimated the cost of a cold-climate heat pump at $15,200; in 2023, SWEEP estimates the cost of a cold-climate heat pump at $29,000, based on homeowner reports. Personal communication with Neil Kolwey, May 19, 2023. A local contractor specializing in heat pumps estimates the average total cost is roughly $20,000 for a cold-climate heat pump; the contractor is typically able to avoid panel upgrades and additional duct work. Personal communication with Elephant Energy, June 2, 2023.

[73] I.e., because each retrofit is essentially a "custom" job, contractors may charge a premium to cover potential unforeseen expenses and other risks. Industry experts also expressed that the market is not transparent, and contractors may be over-sizing heat pumps (to avoid risk of customer call-backs) or charging a premium because of high demand and limited supply.

[74] If each household receives the maximum benefits, $14,000, Colorado's $70 million budget will serve only 5,000 homes, statewide.

[75] For example, the Area Median Income (AMI) of a two-person household in Denver County was $89,000 in 2022. The maximum level of eligibility for HEEHRA rebates is 150% of AMI, which would amount to 134,000 for a two-person household. The majority of taxpayers in this range have tax liability. (For households making $89,000/year, an estimated 85% have tax liability; households making $134,000/year fall within a range where an estimated 94% have tax liability. Source: https://www.statista.com/statistics/242138/percentages-of-us-households-that-pay-no-income-tax-by-income-level/#:~:text=In%20total%2C%20about%2059.9%20percent,paid%20no%20individual%20income%20tax.

Table 8. *Cost of heat pumps and heat pump water heaters (including both equipment and installation costs), and available federal and state incentives. Note that there is some uncertainty whether the tax credits will apply to all standard heat pumps; if tax credits do not apply, the incremental cost for all customers will be equal to the costs shown for customers with no tax liability.*

Efficient Electric Appliance	Capital and installation cost*	Federal Tax Rebate – heat pumps (25C) (30%, up to $2,000)	State Tax Rebate (2024 - 2025)	Total Cost, customers with no tax liability (2024 - 2025)	Total Cost, customers with full tax liability (2024 - 2025)	Sources
SFR Cold Climate Air Source Heat Pump (4 ton)	$24,000	$2,000	$1,500	$24,000	$20,500	Midpoint of references (LBNL 2021, SWEEP 2023, discussions with contractors)
SFR Air Source Heat Pump (4 ton)	$16,500	$2,000	$1,500	$16,500	$13,000	SWEEP 2023
Heat Pump water heater	$3,900	$1,170	$500	$3,900	$2,230	SWEEP 2023
All electric new home (including CC ASHP and HPWH)⁺	$28,100	$2,500	$2,000	$23,600	$23,600	SWEEP 2023

** Capital and installation costs include all wiring and related costs.*

⁺ Equipment cost includes $1,000 modification to enable all-electric (SWEEP 2022); assumes an all-electric new home would qualify for federal Energy Star Residential New Home Construction credits ($2,500); assumes the new home developer would be able to take advantage of all available federal and state tax credits.

Table 9 shows that the incremental costs of heat pumps and heat pump water heaters vary considerably, depending on the replacement scenario and customers' eligibility for federal and state rebates.

- First, for all households, replacing an air conditioning unit with a standard heat pump offers cost savings or only modest incremental costs. This suggests that once a robust market for heat pumps is established, utilities will likely not need to provide significant incentives for standard air source heat pumps.

- Second, replacing a standard gas tank water heater with a heat pump water heater incurs incremental costs of approximately $1,500 for households with no tax liability; for households that can take advantage of state and federal tax credits, the incremental cost of a heat pump water heater is lower, at just over $400.

- Third, the incremental costs of cold-climate heat pumps vary significantly, depending on the replacement scenario. For households that are replacing both a gas furnace and an air conditioner, installing a cold-climate heat pump can offer cost savings. However, for most households, both appliances do not fail at the same time. For households that need to replace a gas furnace only, the incremental cost of installing a cold-climate heat pump is between

$12,600 and $15,500, depending on the household's tax liability. In this situation, many households will choose to replace a failing gas furnace with a new gas furnace, even if the air conditioner is also nearing its end of life. For households whose air conditioner fails, replacing it with a cold-climate heat pump incurs an incremental cost of $5,100 to $8,000, depending on the availability of tax credits. The significant up-front cost of cold-climate heat pumps serves as a major barrier and underscores the potential importance of financing mechanisms, such as on-bill financing.

- Finally, because the federal and state tax credits are available only to households with tax liability and are not transferrable from one year to the next, the up-front cost to households without tax liability is significantly higher. This emphasizes the need for robust utility incentives for low-income households.

Table 9. *Incremental capital and installation cost for heat pumps and heat pump water heaters, compared to gas-fired furnaces, water heaters, and conventional air conditioning units, assuming the customer can take advantage of all federal and state tax incentives. Note that utility rebates are not included in the calculation.*

Efficient Electric Appliance	Conventional Equipment Replaced	Total Incremental Cost, customers with no tax liability (2024 - 2025)	Total Incremental Cost, customers with full tax liability (2024 - 2025)
SFR Cold-Climate Air Source Heat Pump (4 ton)	Gas furnace and AC (3.5-4.5 ton)	($500)	($2,800)
SFR Cold-Climate Air Source Heat Pump (4 ton)	Gas furnace *only*	$15,500	$12,600
SFR Cold-Climate Air Source Heat Pump (4 ton)	AC unit *only*	$8,000	$5,100
SFR Air Source Heat Pump (4 ton)	AC *only*	$500	($2,400)
Heat Pump water heater	Gas storage tank water heater	$1,500	$430
All electric new home (including CC ASHP and HPWH)	Mixed fuel home, including a gas furnace, gas storage tank water heater, and air conditioner	($5,600)	($5,600)

The goal of the federal and state tax incentives and utility programs is to incentivize customers to purchase efficient appliances, consistent with federal and state climate goals. Even in the case where state and federal tax incentives eliminate most or all of the incremental costs of the electric appliances, such as standard air source heat pumps, additional utility incentives may still be necessary to catalyze the industry, and to incentivize contractors to keep the efficient electric equipment in stock and retain trained employees, such as electricians or contractors skilled in installing heat pumps. Therefore, this analysis models incentives for that equipment in the near term.

Investments Needed to Achieve Emissions Reduction Goals

The Clean Heat Standard directs the utilities to file a clean heat plan with several portfolios, including, among other portfolios, one that meets the Clean Heat Standard, regardless of the rate cap. In this analysis, we demonstrate a potential budget for a portfolio of electrification and efficiency measures that would reduce emissions, consistent with the Clean Heat Standard. The actual budget will depend on the level of incentives provided and the level of uptake of clean appliances and energy efficiency. The following paragraphs present illustrative budgets for incremental beneficial electrification, incremental energy efficiency measures, and contractor training, education, and awareness. Of note, the clean heat plan costs are *net* of the gas energy efficiency budget and the beneficial electrification plan budget. Part 4 of this section outlines the funding sources and overall clean heat plan costs.

Neither Colorado nor Xcel have a robust market study indicating adoption levels of efficient electric appliances at different incentive levels. Additionally, new federal and state incentives, market availability, and customer familiarity with the technology may change quickly. The Public Utilities Commission and Xcel will need flexibility to adjust incentives in interim years between clean heat plan filings in response to adoption rates, while maintaining consistency in incentives to provide certainty to contractors.

BENEFICIAL ELECTRIFICATION

To spur the market, we assume the utility offers higher incentives in the early years of the period (2024-2026) and reduced incentives in subsequent years if adoption rates are consistent with achieving the 2030 goals. Because the incremental cost of a cold-climate heat pump is significantly higher and it provides higher levels of emissions reductions, we model higher incentives for cold-climate heat pumps that can displace both a furnace and an air conditioner, and lower incentives for standard heat pumps that replace air conditioning units and meet a portion of the household's heating demands. As noted in Chapter 3, we assume any standard heat pump meets 80% of the building's heating load; consistent with the state tax incentives, the Commission could consider making this a requirement for any heat pump that receives utility incentives. While we model heat pumps that serve the entire residence (either cold-climate heat pumps or standard heat pumps that displace at least 80% of gas usage), the heat pump incentives could be provided on a per-ton basis. That is, the utility could provide incentives for heat pumps on a per-ton basis, so long as the heat pump can be shown to displace a portion of a customer's gas demand and reduce the utility's emissions.[76]

Additionally, we model the cost of higher incentives for income-qualified households. Deploying electric devices to these households remains paramount, to protect low- and moderate-income customers from potentially volatile bills, improve indoor air quality, and ensure that, if low- and moderate-income customers depart the gas system, they do not face rising utility bills.[77] The federal High-Efficiency Electric Home Rebate Act program provides robust incentives for low- and moderate-income households, but Colorado's HEEHRA funding is limited to $70 million. While it is not known at

[76] For example, a customer who installs a heat pump on a new addition would need to demonstrate that the addition would otherwise be heated with natural gas.
[77] See, e.g. California Energy Commission, 2020. The Challenge of Retail Gas in California's Low-Carbon Future: Technology Options, Customer Costs, and Public Health Benefits of Reducing Natural Gas Use. Prepared by Dan Aas, Amber Mahone, Zack Subin, Michael Mac Kinnon, Blake Lane, and Snuller Price, Energy and Environmental Economics, Inc.

this time how Colorado will disburse these funds, they will likely cover only a portion of the income-qualified program needs over the 2024-2030 period. For example, assuming incentives are deployed in Xcel's service territory proportionate to its share of Colorado gas customers (55%), roughly 3,700 heat pumps and 3,700 heat pump water heaters could be installed in Xcel's service territory. This federal funding can provide a valuable jump-start and can complement utility efforts to deploy efficient electric appliances in income-qualified households.

Historically, many DSM programs cover the entire cost of an efficient appliance or measure for income-qualified households, and Commission precedent is to cover the full cost of the measure. Assuming that 24%-28% of each year's residential funding is dedicated to income-qualified households,[78] this results in approximately 3%-5% of appliances (heat pumps and heat pump water heaters) incentivized in income-qualified households in each year. While this modeling approach is consistent with Commission precedent, it results in very few appliances being deployed in income-qualified households, which is inconsistent with the need to prioritize these households to ensure low-income customers and renters do not face increasing costs of maintaining the gas system and to address existing air quality issues in disproportionately impacted communities. We recommend the Commission evaluate whether lower incentives, paired with on-bill financing, can enable the utility to deploy higher numbers of electric appliances in income-qualified households. This analysis also underscores the need for complementary programs at the state or local level to deploy efficient electric appliances in income-qualified households. For example, Denver's Healthy Homes program provides building upgrades and incentives for electrification to low- and moderate-income households that qualify.[79] Denver estimates the average cost of upgrades for each household will be $30,000 - $50,000.[80]

Finally, we model incentives for all-electric new homes. As shown in Table 9, an all-electric new home is less expensive to build than a dual-fuel home, and local building codes and changes to utility line extension allowance policies expected in late 2023 will likely align incentives for developers to increasingly build all-electric new homes. However, most developers currently build dual-fuel homes, and incentives are needed in the near term to shift the market. Therefore, we model high incentives in the near term, consistent with the approved settlement in Xcel's 2023 DSM Plan, and phase out incentives by 2029.

For all incentives, we model step-downs in incentive levels throughout the period, which reflects an assumption that the market for space and water heating successfully transforms, and lower incentive levels are effective at spurring customers to purchase heat pumps and heat pump water heaters. For example, utilities began to phase out incentives for LEDs when market penetration achieved 70%.[81]

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[78] **For reference, utilities are required to dedicate 20% of beneficial electrification plan expenditures and 25% of gas DSM residential expenditures to IQ households § 40-3.2-109(2)(b)(II) and § 40-3.2-103(3)(a)(II), C.R.S.**

[79] **Denver, Healthy Homes Program, available at https://denver.prelive.opencities.com/Government/Agencies-Departments-Offices/Agencies-Departments-Offices-Directory/Climate-Action-Sustainability-Resiliency/High-Performance-Buildings-and-Homes/Electrify-Your-Home/Healthy-Homes-Program.**

[80] **Denver, Healthy Homes Overview for Single Family Homes – English. Available at https://denver.prelive.opencities.com/files/assets/public/climate-action/documents/hpbh/renewable-hampc/healthy-homes-one-pager-english.pdf.**

[81] **A U.S. Department of Energy lighting market report noted in 2020 that "although utility programs have begun to phase out LED incentive programs due to the currently cost-competitive LED pricing (compared to conventional technologies), the pace of LED installations has yet to decline." In that year, LEDs had reached 75% of A-line lamp sales. See U.S. Department of Energy, 2020, "Adoption of Light-Emitting Diodes in Common Lighting Applications," available at https://www.energy.gov/eere/ssl/articles/2020-**

However, these step-downs should be contingent on successful deployment of efficient electric appliances. The exception to this is for income-qualified households, for which we assume the programs continue to cover the full cost of the appliance. The modeled incentive levels are shown in Table 10. Note that incentives do not include panel upgrades, because we expect that many homes may be able to install electric equipment without panel upgrades, as described in the section below on grid investments. However, panel upgrades are covered by federal incentives, and may be included as an eligible cost for state tax rebates.

Table 10. *Modeled incentive levels for efficient electric appliances.*

Appliance	2024	2025	2026	2027	2028	2029	2030
SFR Cold climate HP	$4,000	$4,000	$3,500	$3,000	$2,500	$2,000	$2,000
SFR standard ASHP replacing AC	$1,500	$1,000	$1,000	$500	$300	$ -	$ -
SFR Cold Climate HP – IQ Customers	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000
HPWH with smart controls (SF or MF)	$800	$800	$800	$600	$600	$400	$400
HPWH w/o smart controls (SF or MF)	$600	$600	$400	$200	$200	$ -	$ -
HPWH with smart controls - IQ Customers	$3,900	$3,900	$3,900	$3,900	$3,900	$ 3,900	$3,900
All-electric new home	$10,000	$6,000	$6,000	$3,000	$2,000	$ -	$ -
Multifamily and commercial cold-climate air source heat pump ($/ton)	$1,000	$1,000	$875	$750	$625	$500	$500
Multifamily and commercial standard air source heat pump ($/ton)	$375	$250	$250	$125	$75	$ -	$ -
Multifamily standard air source heat pump - IQ Customers ($/ton)	$4,125	$4,125	$4,125	$4,125	$4,125	$ -	$ -
Multifamily cold-climate air source heat pump - IQ Customers ($/ton)	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000
Commercial standard ground source heat pump ($/ton)	$2,000	$2,000	$1,750	$1,500	$1,250	$1,000	$1,000

Using the appliance adoption levels developed in Chapter 3, we estimate an annual budget for beneficial electrification incentives, illustrated in Figure 4. By 2028, the total budget needed for

led-adoption-report; see also National Electrical Manufacturers Association, "NEMA Lamp Indices," available at https://www.nema.org/analytics/lamp-indices.

electrification incentives approaches $230 million. In the early years, the higher incentive levels are applied to a smaller number of devices. As the market develops, we model low or zero incentive levels for standard heat pumps and all-electric new homes, reflecting the assumption of no incremental costs and widespread market development. Finally, a significant portion of the budget incentivizes cold-climate heat pumps in residential and commercial applications, which are an essential component of meeting the clean heat goals, in the long term. Note that this is the budget for *all* electrification; only a portion of this budget will be included within a clean heat plan cap, while a portion will likely be included in the electric utility's beneficial electrification plan.[82]

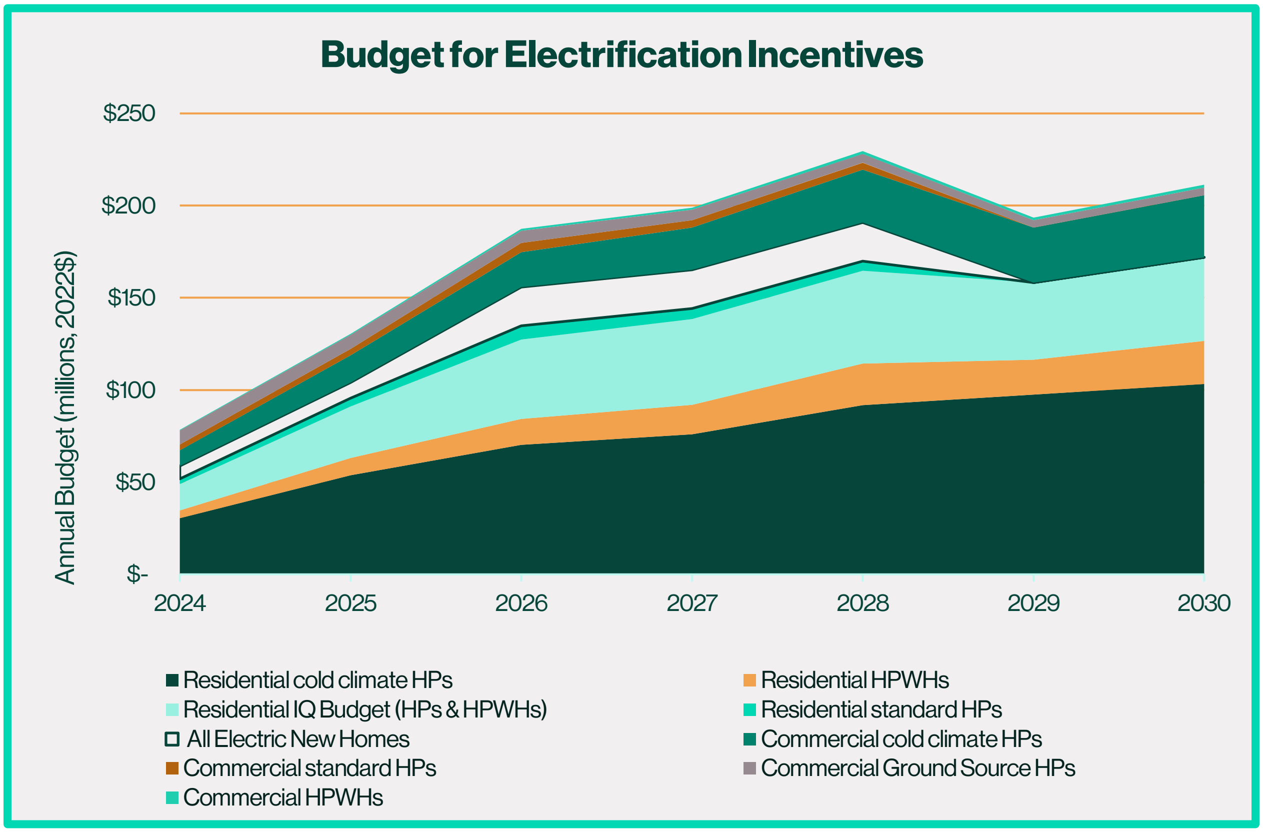

Figure 4. *Budget for incentivizing beneficial electrification measures. Residential measures include appliances in both single family and multifamily homes.*

DEMAND SIDE MANAGEMENT

Expanding and enhancing demand side management programs is the second essential strategy for meeting Xcel's 2030 clean heat emissions goals. In developing the modeling assumptions, we focus on measures that provide emissions reductions and customer benefits while a household still relies on a natural gas furnace and water heater, and after a customer installs efficient electric appliances. Specifically, we analyze expanded investments in building weatherization, such as insulation and air

[82] **According to the Clean Heat Plan statute and rules, approved budgets for beneficial electrification and DSM plans do not count against the Clean Heat Plan cost cap.**

Ray Bowman, right, a Home Energy Professionals (HEP) Certifications Energy Auditor with Arapahoe County's Weatherization Division, performs a Blower Door Test, during an audit of a Thornton, Colorado home. (Photo by Dennis Schroeder / NREL)

Weatherization measures provide emissions reductions in the near term, while a household relies on natural gas, and are a key complement to heat pumps. An efficient, well-insulated home is less likely to require an over-sized heat pump or supplemental electric resistance heating, which in turn minimizes up-front costs for customers and, in the case of electric resistance heating, the impact on peak demands and the electric grid. In addition, weatherization lowers customer bills and improves comfort. In fact, Mass Save requires customers to certify their homes meet weatherization requirements prior to heat pump installation; receiving a full rebate for a heat pump is contingent on this certification.[83] In Xcel's 2023 DSM plan settlement, the company committed to providing customers a $500 bonus rebate for installing a weatherization measure within six months of installing a heat pump.

For this cost analysis, we assume Xcel provides rebates for weatherization consistent with the reported costs in the 2022 DSM Plan Status Report. Specifically, two of Xcel's existing programs, Insulation & Air Sealing and Whole Home Efficiency, reduce annual gas usage at an estimated cost of $20/Dth.[84] A third program, Energy Star New Homes, is projected to reduce annual energy use at a cost of $30/Dth.[85] Finally, in Xcel's 2022 DSM Status Report, Xcel estimates the cost of weatherization in income-qualified households is approximately $25/Dth.[86] We assume at least 20% of savings (25% of annual costs) are realized in income-qualified households. The weatherization costs are applied to the estimated reductions in gas usage in Chapter 3; over the 7-year period from 2024-2030, the average annual budget is $15 million. While this budget reflects current costs per unit of gas saved, to achieve deep energy efficiency retrofits and achieve the efficiency savings goals, the budget may need to be higher.

CONTRACTOR TRAINING AND CUSTOMER OUTREACH

As described throughout this report, workforce development and customer education are crucial to success. Federal and state funding can help build and maintain the necessary workforce: through the federal Home Energy Efficient Contractor Training program, grants are available to states to provide training and education to contractors.[87] As an added incentive, contractors may receive up to $500 for qualifying electrification projects under the HEEHRA program, and up to $200 for each qualifying efficiency project under the HOMES program. Similarly, Colorado's state tax law allows an eligible contractor to retain a portion of tax credits to "support the industry-wide adoption and deployment of heat pump technologies in the state."[88] These programs will provide important support to workforce development. However, Xcel will likely need to invest in additional workforce training, as well as customer education and outreach, particularly focusing on helping customers replace gas water heaters and furnaces before burnout.

[83] Mass Save Whole Home Heat Pump Verification Form. Customers can meet the requirements if 1) their home was built during or after 2000, 2) a home energy assessment report estimates less than $1000 worth of weatherization investments needed, or 3) they have completed weatherization improvements from a home energy assessment report since 2013.
[84] Calculated based on data in Proceeding No. 20A-0287EG, March 31, 2023. 2022 Demand Side Management Annual Status Report. Table 10d: 2022 Natural Gas Participation.
[85] The 2023 DSM Plan Settlement provides an enhanced incentive of up to $10,000 for all-electric new homes under the utility's Energy Star New Homes program. This is not reflected in the estimated cost/Dth calculation.
[86] Calculated based on Proceeding No. 20A-0287EG, March 31, 2023. 2022 Demand Side Management Annual Status Report. Table 10d: 2022 Natural Gas Participation.
[87] The federal program has a budget of $200 million; Colorado's pro-rata share of this would be approximately $3 million.
[88] § 39-22-554(4), C.R.S. The specific percentage an eligible entity can retain is set by the Colorado Energy Office annually.

To estimate a reasonable budget for workforce development and customer education, we reviewed other leading programs. Mass Save, which has ambitious goals to deploy heat pumps, budgeted over $11 million for workforce development and $2-$3 million for customer education. In Xcel's 2023 gas demand side management plan, customer education and advertising was approximately 6% of program costs. Applying this rate to the total cost of clean heat measures (including both electrification and energy efficiency) results in an average annual budget for contractor training and customer education of $11 million. While we model this as a strict percentage of total budgets, the utility may want to frontload these costs, so that the majority of contractor training and workforce development occurs in the early years, in order to ensure the workforce is available to install the vast number of appliances in the latter part of the decade. In the latter years, the primary costs may be associated with customer outreach and education.

Designing Robust Programs for Income-Qualified Customers

Making homes more efficient and electric can provide critical benefits, particularly for income-qualified households and those living in disproportionately impacted communities. Heat pumps can provide cooling in the summer, which is important for residents who rely on fans, particularly in communities with poor outdoor air quality, and with the increasing frequency of wildfires and attendant impacts on air quality. It is crucial that income-qualified households can take advantage of utility rebates.

There is a risk, however, that households in certain areas may see higher monthly bills if they electrify their heating with the installation of a heat pump. This is particularly true for households served by electric utilities with higher rates, such as Black Hills Electric.[1] Several measures can help mitigate these impacts:

- Ensure that in areas with high electric rates, installations of heat pumps in IQ households are accompanied by deep energy efficiency retrofits. For example, for a household in Black Hills' service territory that replaces a gas furnace with a cold-climate heat pump, we estimate that a deep energy retrofit that reduces space heating energy use by 40% would likely maintain bill parity.

- Geotarget deep energy retrofits and electrification in communities with lower outdoor air quality, to maximize the air quality benefits of electrification.

- Consider providing incentives for induction stoves, along with heat pumps and heat pump water heaters, to enable an IQ household to go all-electric and eliminate the monthly fixed gas charge. This measure would provide additional indoor air quality benefits if an induction stove replaces an existing gas stove.

- Pair installation of heat pumps with a subscription to a community solar garden, which can reduce monthly electricity bills.

Finally, as described throughout this analysis, the initial cost of a heat pump, even with incentives, may be prohibitive. On bill financing is critically important to enable low- and moderate-income customers to invest in heat pumps. In sum, it is critical that the utility and Commission adopt additional measures to ensure the benefits of electrification incentives can accrue to all households.

[1] **SWEEP, 2022. "Benefits of Heat Pumps for Colorado Homes."**

GRID INVESTMENTS

Electrifying buildings could require upgrades to customers' service panels, the distribution system, and electrical generating capacity. We address each of these potential upgrades, in turn, along with measures that can mitigate grid upgrades.

Panel Upgrades

Many older homes may have 100-amp panels. Conventional wisdom has been that to electrify a home, including a level 2 electric vehicle (EV) charger, a household requires a 200-amp panel. The costs of upgrading an existing panel can be expensive, on the order of $6,000 - $10,000,[89] and takes additional time to complete, which may be a non-starter if a resident is trying to replace a failing furnace. However, several recent analyses and case studies have demonstrated full electrification using an existing 100-amp panel.[90] One strategy includes installing devices that allow two loads to share one circuit; these devices can be installed at a fraction of the cost of a panel upgrade. Some devices, such as the SimpleSwitch, are hardwired and prioritize one load over the other, while other devices are programmable, allowing the customer to prioritize loads based on the time of day or week.[91]

The Policy Case focuses on installing heat pumps in place of air conditioners on burnout. Because AC units will typically have a comparable electrical load as a standard heat pump, it is unlikely that customers installing a standard heat pump will need panel upgrades. Recent case studies have demonstrated that even customers with 100-amp panels can install cold-climate heat pumps, particularly if paired with the novel technology described above.[92] Efficiency measures can reduce peak electricity demands and the need for electric resistance back-up, which is the key driver of panel upgrades associated with cold-climate heat pumps. Finally, federal and state tax credits are available for panel upgrades; accordingly, we do not include additional utility incentives in the Policy Case.

While 100-amp panels may be compatible with electrification, we recommend that new homes be constructed with a 200-amp panel, because the incremental cost of installing a larger panel during construction is only a few hundred dollars.

Distribution System Grid Upgrades

To support electrification of buildings and transportation, the distribution system grid will likely need to be upgraded over the next 20 years. We expect, however, that, system-wide, impacts on the distribution system grid between now and 2030 will be modest, and primarily driven by transportation electrification. In our modeling, most heat pumps replace conventional air conditioning units, which would have similar peak capacity requirements and therefore should have no incremental impact on

[89] Elephant Energy, "Home Electrification Solutions – A Success Story", https://elephantenergy.com/home-electrification-solutions-a-success-story.
[90] Ibid; see also Redwood Energy, "A Pocket Guide to All Electric Retrofits of Single Family Homes," available at https://www.redwoodenergy.net/research/a-pocket-guide-to-all-electric-retrofits-of-single-family-homes.
[91] Canary Media, "New tools and tech to prep your electrical panel for an all-electric home" (Feb. 22, 2022), https://www.canarymedia.com/articles/electrification/new-tools-and-tech-to-prep-your-electric-panel-for-an-all-electric-home
[92] *See, e.g.*, Elephant Energy, "Home Electrification Solutions – A Success Story", https://elephantenergy.com/home-electrification-solutions-a-success-story.

distribution grid needs, although peak demands for those households are likely to occur in both summer and winter. Of the households that install cold-climate heat pumps, and assuming up to 40% also install electric resistance back-up heat, consistent with the experience of Colorado contractors who specialize in heat pumps, roughly 9% of residences (or approximately 117,000 households) would have incremental, additional peak demands due to space heating in 2030. Importantly, the standard electric resistance "heat kits" that accompany a cold-climate heat pump are variable-speed and able to moderate power demands. In short, consistent with studies in other jurisdictions[93], over the next seven years, transportation electrification is likely to be a larger driver of distribution grid upgrades than building electrification.

While we do not expect distribution system upgrades to be widespread, Xcel may need to upgrade the distribution grid in parts of its service territory between now and 2030. For example, utilities may geotarget certain neighborhoods, which can provide important benefits, particularly if geotargeting electrification enables the utility to avoid capital investments in the existing gas system or helps electrify households in disproportionately impacted communities. Xcel may also geotarget housing developments that were constructed 15-20 years ago, where furnaces and air conditioning units are nearing end of life and houses have similar design and construction. If a large number of homes in these neighborhoods install heat pumps and EV chargers, there may be distribution system grid impacts in the near term.

Strategy of well-integrated window and door flashing with house-wrap (IBACOS).

[93] **See, e.g., New York Independent System Operator, Inc., 2022. 2022 Load & Capacity Data Report. This analysis finds that while the winter load contribution from electric heating is higher than the load contribution from transportation, transportation contributes more to the summer peak in 2030.**

In the Policy Case, we do not include potential costs associated with distribution grid upgrades, primarily because we expect that the additional electric utility revenue from increased sales due to electrification will cover most, if not all, of the incremental upgrade costs. In addition, the additional electricity sales that result from electrification will also likely put downward pressure on electricity rates by significantly increasing sales, providing benefits to all electricity customers by spreading the Company's revenue requirement over a greater sales volume. This is evidenced by Xcel's evaluation of the cost of all-electric new homes scenarios in its recent DSM-BE Strategic Issues proceeding. In that case, the Company estimates that an all-electric new home will generate more electric revenue than incremental costs, putting downward pressure on rates.[94] Xcel projects these cost savings on the electric side, even while modeling peak electric capacity demands based on high levels of electric resistance heat. Finally, this approach is consistent with Xcel's proposed Transportation Electrification Plan (TEP), in which Xcel proposes significant investments in the distribution system, and notes that the revenue from additional retail sales for charging electric vehicles has historically exceeded the costs of the TEP and is projected to continue to do so.[95]

In sum, because we expect that new electric load will likely cover the full cost of any needed distribution system upgrades as well as the benefits to electricity customers from the downward pressure on rates from new electric load, we propose any distribution system costs – which are driven by both building and transportation electrification – be borne by electricity customers and, thus, not included within the clean heat plan budget modeled in the Policy Case.

Generating Capacity Additions

The third impact of electrification is on overall peak demands and capacity needs. Electrifying space and water heating is likely to shift peak demands to the winter, rather than summer, over the long term. While the total impact is likely to be relatively modest in 2030, the incremental load growth will, over time, necessitate additional generating capacity. Between now and 2030, we expect the overall impact on peak demand to be manageable. In its 2021 Electric Resource Plan (ERP), Xcel projected its summer peak day demands to be approximately 7,000 MW in 2025, while the winter peak day demands are less than 5,500 MW. Additionally, under the "Roadmap" scenario in Xcel's ERP, which includes high adoption of transportation and building electrification, Xcel's system does not become winter-peaking until 2041.

Studies from other jurisdictions have similar findings. In New York, which has similarly ambitious transportation and building electrification goals and a cold climate, the New York State Energy Research and Development Authority (NYSERDA) projects the system to become winter-peaking in 2034. To estimate the potential order-of-magnitude impact of installing cold-climate heat pumps, we apply the findings of a recent study in New York and Massachusetts to the Policy Case. The study, by Cadmus, measured peak hourly and sub-hourly (2-minute) heating demands during a cold weather event. During the event in Massachusetts, temperatures dropped to approximately 5° F, and the average temperature over the three-day period was 12.9° F. The researchers compared peak heating loads between homes with whole-home (cold-climate) heat pumps, and homes with both a heat pump and back-up heating source (gas, propane, or oil). During the weather event, the average hourly

[94] **Proceeding No. 22A-0309EG, Hearing Exhibit 108, Supplemental Direct Testimony of Nick C. Mark, at 43.**
[95] **Proceeding No. 23A-0242E, Hearing Exhibit 108, Direct Testimony of Derek S. Klingeman, at 20. Xcel proposes approximately $50 million in proactive distribution system upgrades, or roughly 11 percent of the total plan expenditures of $439 million.**

demand among homes served exclusively with a cold-climate heat pump peaked at 4 kW in the early morning hours, whereas the average hourly demand among homes with a heat pump and back-up heating source peaked at 2 kW. The maximum peak demand, measured in 2-minute intervals, was approximately 6 kW for whole-home systems, and 3.5 kW for homes with heat pumps and back-up heat.[96] Applying the incremental average 2-minute peak heating demand (2.5 kW) to the number of households modeled to have cold-climate heat pumps in 2030, we estimate an incremental additional peak winter demand of approximately 730 MW.[97] Based on this rough calculation, we expect the increased demand for winter heating load between now and 2030 will still fall well below Xcel's systemwide summer peak. Over the long term, however, it will be critical for Xcel to accurately project and incorporate additional heating loads into its electric resource planning.

Notably, two of the 11 monitored homes in Massachusetts had back-up electric resistance heat; those homes' 2-minute peak demand was significantly higher than the peak demand of homes without electric resistance heat (average peak 2-minute heating demand of 17 kW versus 5 kW). This further underscores the importance of minimizing reliance on electric resistance heat, through complementary weatherization measures and right-sizing equipment. A recent study by the Center for Energy and Environment, the National Renewable Energy Laboratory, and the U.S. Department of Energy demonstrated that basic weatherization measures such as air sealing and attic insulation in homes in Minnesota nearly doubled the percentage of homes where a cold-climate heat pump could serve full heating load without electric resistance back-up.[98]

Mitigating Grid Impacts

Complementary measures can reduce the impact of building electrification on the electric grid. Deploying efficiency measures and properly sizing cold-climate heat pump systems can reduce the need to install electric resistance back-up heating, which is likely to have the greatest overall impact on peak demands. Various studies in other jurisdictions have quantified the potential impact of robust efficiency and demand response programs:

- An analysis by Redwood Energy found that at a design temperature of minus 5° F, reducing building leakage by 70%, from 1 air change per hour (ACH) to 0.3 ACH, reduced the required heat pump capacity by approximately 30% and the hourly average peak demand from approximately 6 kW to 4 kW. This minimizes impacts on both the electrical grid and up-front costs for the customer.[99]

- Synapse and The American Council for an Energy-Efficient Economy (ACEEE) modeled peak electricity demands during the 2019 polar vortex across the Midwest to Northeast, assuming all space and water heating is electrified, and found that modeled peak demands could have been reduced by approximately 40% by improving the average building stock efficiency, voluntary demand response (customers setting their thermostats back by 5° F), and modeled

[96] Cadmus, 2022. Residential ccASHP Building Electrification Study. Available at https://www.masscec.com/resources/cold-climate-air-source-heat-pump-building-electrification-study-2020-2021.
[97] We use the data from Massachusetts because all homes surveyed were in climate zone 5. Calculation multiplies 213,000 cold-climate heat pumps by 2.5 kW incremental average hourly peak load.
[98] Quinnell, Josh, Dave Bohac, Lucas Phillips, Nick Cindrich, and Eric Werling, 2022, "It's All About the Envelope: Prioritizing Envelope Upgrades for Electrification of Cold-Climate Homes," available at https://aceee2022.conferencespot.org/event-data/pdf/catalyst_activity_32589/catalyst_activity_paper_20220810191631016_06175f89_3494_46fb_a308_2d5f2ae83b36.
[99] Redwood Energy, 2022. "A Zero Emissions All-Electric Retrofit Single-Family Construction Guide", available at https://www.redwoodenergy.net/research/a-pocket-guide-to-all-electric-retrofits-of-single-family-homes.

improvements in the performance of cold-climate heat pumps. The analysis found that ground-source heat pumps could provide additional grid benefits, particularly in regions that experienced the coldest temperatures during the event.[100] Of note, the modeled scenario assumes that all existing space and water heating is electrified, which is much more extreme than the proposed Policy Case in 2030 but underscores the potential value of complementary efficiency and demand response measures.

- Finally, a study by the Urban Green Council projected that full electrification of buildings in New York City would roughly double peak demands from a summer peak of roughly 11 GW today to a winter peak of approximately 23 GW; however, a combination of energy efficiency and demand flexibility reduced the winter peak demand significantly, to approximately 15 GW. The analysis included efficiency measures, load shifting, thermal storage for hot water, and battery storage.[101]

Along with efficiency, there may be additional opportunities to manage grid impacts by replacing existing electric resistance appliances with efficient heat pumps. For example, E3's Roadmap analysis indicates that roughly 10% of Colorado residences rely on electric resistance heat, and over one-third of homes have electric resistance water heating. An analysis in Oregon found that simultaneously replacing electric resistance space and water heaters with heat pumps caused a net reduction in residential electricity demand and peak load over the 2020-2050 period, even when sales of gas-fired appliances were banned in either 2025 or 2030.[102] While replacing electric resistance heat with heat pumps would not contribute to reducing Xcel's gas sales and meeting the clean heat emissions goals, it should be part of a comprehensive effort to cost-effectively and efficiently electrify space and water heating.

SUMMARY OF INVESTMENTS

Achieving the 2030 Clean Heat Standard emissions reduction goals will require significant investments and program expansions. Figure 5 illustrates the total investments in beneficial electrification, weatherization, and contractor training and customer outreach. In the following section, we describe the various sources of revenue for achieving the electrification and efficiency goals, and potential modifications to existing DSM programs. The total program cost appears large; however, it is consistent with the challenge of achieving significant emissions reductions by 2030. For reference, Mass Save's 2022-2024 budget for strategic electrification will, as proposed, electrify the equivalent of over 43,000 homes, and has a budget of $800 million.[103] Similarly, in a pending plan, Baltimore Gas and Electric, which delivers approximately half as much natural gas to residential and commercial

[100] Hopkins, A., K. Takahashi, S. Nadel, 2020. "Keep warm and carry on: Electrification and efficiency meet the 'polar vortex'", 2020 Summer Study on Energy Efficiency in Buildings. Summary available at https://www.aceee.org/blog-post/2023/02/coming-electrification-will-require-grid-evolve.
[101] Urban Green Council, 2021. Grid Ready: Powering NYC's All-Electric Buildings.
[102] Takahashi, K., S. Kwok, J. Tabernero, and J. Frost, June 23, 2022. "Toward Net Zero Emissions from Oregon Buildings: Emissions and Cost Analysis of Efficient Electrification Scenarios." The analysis assumed gas appliances were banned in either 2025 or 2030, which represents a more rapid adoption of electric heat pumps and heat pump water heaters than modeled in the Policy Case. However, Oregon has a higher proportion of electric resistance space- and water-heating today.
[103] Massachusetts Joint Statewide Electric and Gas Three-Year Energy Efficiency Plan for 2022-2024, Final Term Sheet. October 25, 2021. p. 6. For reference, Massachusetts' residential and commercial gas sales are approximately half the volume of Xcel's Colorado residential and commercial gas sales in 2021. U.S. EIA, Form 176. Data for 2021.

customers as Xcel[104], proposes a budget of $262 million for building electrification.[105] We are not endorsing the proposed programs, but rather note that the scope of investments by entities in states with carbon reduction goals similar to Colorado's goals is comparable to the scope of investments outlined in the Policy Case.

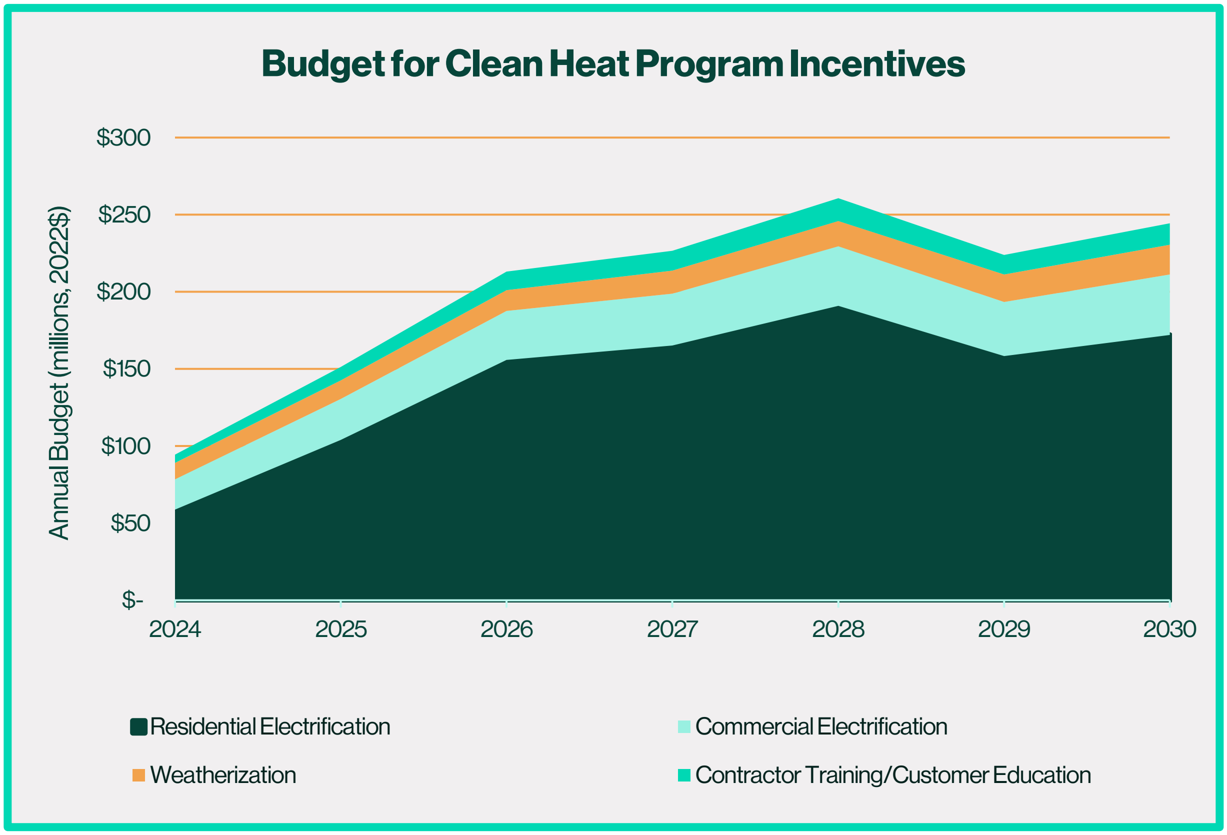

Figure 5. *Budget for clean heat programs, including electrification, weatherization, and contractor training/customer education. Note that only a portion of these expenditures will be included in a clean heat plan budget.*

Sources of Funding

Four potential sources of utility funding can be tapped to achieve the electrification and efficiency goals described above: the utility's beneficial electrification plan, gas demand side management plan, electric demand side management plan, and clean heat plan. We describe the potential funding sources from each of these plans, which are summarized in Table 11.

[104] U.S. EIA, Form 176. Data for 2021.
[105] Maryland Public Service Commission, Case No. 9692. Direct Testimony of K. Takahashi on behalf of the Office of People's Council. June 20, 2023.

Contractor blowing insulation into an attic.

BENEFICIAL ELECTRIFICATION PLAN

In Xcel's Demand Side Management and Beneficial Electrification Strategic Issues proceeding (DSM-BE SI), the Public Utilities Commission approved steadily increasing beneficial electrification budgets over the 2024-2026 period. Those investment levels are shown in Table 11. We assume that beyond 2026, the annual budgets continue to increase by approximately $13 million each year, which is roughly consistent with the trajectory approved in Xcel's Strategic Issues proceeding.[106]

GAS DEMAND SIDE MANAGEMENT PLAN

To estimate the potential budget and goals for traditional gas DSM, we rely on the approved levels in the DSM-BE Strategic Issues case. In that proceeding, parties testified to the need to shift investments from traditional gas appliances, such as standard tank water heaters and gas furnaces, to heat pumps and heat pump water heaters. In its oral deliberations, the Commission supported phasing out incentives for gas appliances in new construction, starting in 2024; limiting incentives for gas-fired space heating in existing homes, starting in 2024, and ending those incentives at the end of 2026; ending incentives for gas-fired water heating in 2024; and limiting incentives for Energy Star New Homes to all-electric buildings, starting in 2024.[107] Based on that decision, the incentives available through the current gas DSM programs are likely to shift to be in line with the clean heat goals, focusing primarily on weatherization and building envelope measures. We assume the entire approved gas DSM budget is a source of funding to meet the clean heat program investments.

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[106] **Proceeding No. 22A-0309EG, Decision No. C23-0413, ¶¶ 52-53 (setting annual BE budgets for 2024-2026 of $9.5, $21, and $37 million, respectively).**
[107] **Proceeding No. 22A-0309EG, Decision No. C23-0413, ¶¶ 226-233.**

ELECTRIC DEMAND SIDE MANAGEMENT PLAN

The electric DSM plan provides a suite of important programs; we recommend modifying and re-purposing funding from the Residential Heating & Cooling program, a small portion of which currently supports heat pump deployment, to exclusively support heat pumps. In 2022, this program had a budget of approximately $9.1 million;[108] under the 2023 DSM Plan, it will have a budget of $7.4 million.[109]

Table 11. *Budget sources, other than the clean heat plan, for the investments needed to achieve Xcel's gas utility emissions reduction goals. Projected budgets, not approved by the PUC, are shown in red. All values are in millions.*

	2024	2025	2026	2027	2028	2029	2030
Beneficial Electrification Plan (millions)[110]	$9.5	$21	$37	$50	$63	$76	$89
Gas DSM Plan (millions)[111]	$21	$21	$21	$21	$21	$21	$21
Electric DSM - Rebates for AC Units (millions)[112]	$7.4	$7.4	$7.4	$7.4	$7.4	$7.4	$7.4
Total (millions)	**$37.9**	**$49.4**	**$65.4**	**$78.4**	**$91.4**	**$104.4**	**$117.4**

CLEAN HEAT PLAN BUDGET

The clean heat plan is the fourth budget source to fund the necessary investments in measures to reduce Xcel's gas system emissions. Under the Policy Case, the remaining costs of beneficial electrification and energy efficiency – the clean heat plan budget – rise from approximately $56 million in 2024 to $169 million in 2028. With slightly lower incentive levels in 2029 and 2030, the annual clean heat budget levels out between $119 and $127 million.

In approving a clean heat plan, the Public Utilities Commission can consider a number of factors in determining whether a plan is in the public interest, including, at a minimum,

- Whether the plan uses clean heat resources that maximize greenhouse gas emissions reductions.
- Implementation costs and rate impact.
- Air quality, environmental, and health benefits.
- Benefits to income-qualified customers and disproportionately impacted communities.

[108] Proceeding No. 20A-0287EG, March 31, 2023. 2022 Demand Side Management Annual Status Report. Table 8a: 2022 Electric Program Costs by Category (Budget).
[109] Proceeding No. 22A-0315EG. Hearing Exhibit 101, Attachment NCM-1. Table 4b: Public Service's 2023 Electric DSM & BE Costs by Category.
[110] Proceeding No. 22A-0309EG for 2024-2026; projections using a similar trajectory for 2027-2030.
[111] Proceeding No. 22A-0309EG for 2024-2026; projections using a similar trajectory for 2027-2030.
[112] Proceeding No. 22A-0315EG, Hearing Exhibit 101, Attachment NCM-1. Table 4b: Public Service's 2023 Electric DSM & BE Costs by Category.

- Ability to mitigate risk of market volatility and stranded investments.
- Workforce impacts.
- System safety and reliability.

In determining whether the plan can be implemented at the lowest reasonable cost and rate impact, the Commission must consider fuel costs, non-fuel direct investment associated with the plan, gas infrastructure costs, gas system operation costs, the social cost of carbon and methane, and any other costs and benefits the Commission identifies.[113] The Policy Case presents a clean heat plan budget that would likely exceed a 2.5% rate cap, if the rate impact is calculated purely on additional costs and does not consider avoided costs. However, when avoided costs are considered over the 2024-2030 period, the benefits of the Policy Case outweigh the costs. For example, in 2030, when estimated clean heat plan costs are $127 million, the quantified benefits include:

- **Gas infrastructure costs and annual operations costs:** The avoided gas infrastructure costs depend on how beneficial electrification and efficiency measures are deployed. For example, if Xcel geotargets investments in certain areas where the utility is likely to see system growth and capacity expansion, the utility may be able to avoid certain capital investments. Quantifying the avoided costs associated with reducing gas demand across the system is difficult; however, it is useful to quantify, at a minimum, the likely avoided gas infrastructure costs associated with all-electric new homes. In 2022, Xcel estimated the average additional costs associated with gas system infrastructure for a new home is $3,645.[114] Applying this cost to the new, all-electric homes modeled in our portfolio results in avoided gas system costs of approximately $51 million in 2030. As a conservative approach, we only present the avoided infrastructure costs associated with new homes, not potential avoided costs associated with annual operations or maintaining the existing system, which are uncertain over the modeling period. Our approach also does not examine how reducing gas demand in fast-growing geographic areas could mitigate the need for additional capacity or reliability investments on the gas system. However, it is critical that over the long term, beneficial electrification and energy efficiency investments are deployed strategically and enable Xcel to minimize ongoing capital investment into the existing gas distribution system.

- **Social costs of carbon and methane:** Xcel's reduced gas consumption leads to significant greenhouse gas emissions reductions, relative to the Reference Case. Based on the social cost of carbon using the 2.5% discount rate, the emissions reductions in 2030 have an avoided value of almost $200 million (2022$).[115,116] This calculation does not assume any avoided methane leakage; if electrification reduces behind-the-meter methane emissions or leakage from the

[113] Colorado Public Utilities Commission Rules, 4 CCR § 723-4: 4732(b).
[114] Proceeding No. 22A-0309EG, Hearing Exhibit 108, Mark Supplemental Direct, Table NCM-SD-8. Figure reflects the "system average" costs; estimated costs are approximately $2,000 higher under the "concentrated greenfield" scenario, and $2,400 lower under the "minimal impacts" scenario.
[115] Calculation uses the 2022 value under the 2.5% discount rate. https://www.whitehouse.gov/omb/information-regulatory-affairs/regulatory-matters/#scghgs.
[116] Consistent with the framework of the Clean Heat Standard, this figure reflects avoided emissions on the gas system, not net emissions impacts, inclusive of electricity use.

distribution system (for example if, through geotargeting, the utility removes some nodes of its distribution system), the emissions reductions and social benefits would be even greater.

- **Fuel costs:** in 2030, the Policy Case avoids customer use of approximately 47 million Dth of natural gas, relative to the Reference Case. The value of the avoided gas sales can vary significantly; based on Xcel's 2019 retail gas rate, the value of avoided gas sales is $0.66/therm, or approximately $312 million in 2030 (2022$).[117] Based on Xcel's retail gas rate in February 2023 ($1.01/therm), the avoided gas sales in 2030 are valued at $477 million (2023$). The wide range of values underscores both the magnitude of avoided costs and the potential to mitigate the risk of fuel price spikes.

  While the Clean Heat Standard directs the Commission to consider costs and rate impacts for *gas customers*, it is important to consider broader societal impacts. Beneficial electrification reduces customers' gas fuel costs but may increase customers' electricity bills. As described in the section on grid investments, the additional electricity sales can be expected to put downward pressure on rates. Improving the efficiency of buildings is critical to managing customers' electricity demand and protecting customers against higher electricity bills. However, to ensure customers see net bill reductions (or equivalency) across the two utilities, it is also critical that electrification enables reduced investments in the gas distribution system. Geotargeting DSM and electrification to avoid new capacity investments is one important strategy. A second strategy is ensuring that, over the long term, incentives focus on cold-climate heat pumps to enable all-electric homes, so that Xcel can decommission segments of its distribution system and avoid ongoing operations, maintenance, and capital costs.

To summarize, while the incremental clean heat plan costs are $127 million in 2030, the avoided gas infrastructure costs are, at a minimum, $51 million; the value of avoided GHG emissions are almost $200 million; and the avoided gas costs are $312-$477 million. In addition, the electrification and energy efficiency measures incentivized under the Policy Case drive important but hard-to-quantify benefits: they can improve both indoor and outdoor air quality;[118] improve home comfort, particularly for people who lack air conditioning today; and mitigate the risk of rising or volatile gas prices in the future. And, importantly, the clean heat investments set Xcel on a path to achieve the deep emissions reductions needed to meet Colorado's economy-wide goal of zero emissions by 2050.[119]

Finally, the costs incurred between now and 2030 are an investment in transforming the market, so that efficient electric heat pumps, heat pump water heaters, and all-electric new homes become the preferred choices of customers, and no longer require incentives beyond 2030. For example, in 2030 under the Policy Case, we model no incentives for new all-electric homes, and in 2028, the incentive modeled for a standard, non-cold-climate heat pump is $300, comparable to Xcel's current incentive

[117] Residential retail rate, January 2019. PSCo Natural Gas Rates Summary Effective January 1, 2019. Available at https://www.xcelenergy.com/company/rates_and_regulations/rates/rate_books. The 2019 rate is adjusted to 2022 dollars using the Bureau of Labor Statistics Consumer Price Index calculator, available at https://www.bls.gov/data/inflation_calculator.htm.
[118] Zhu, Y., R. Connolly, Y. Lin, T. Mathews, and Z. Wang. April 2020. Effects of Residential Gas Appliances on Indoor and Outdoor Air Quality and Public Health in California. UCLA Fielding School of Public Health Department of Environmental Health Sciences.
[119] § 25-7-102.(2)(g)(I), C.R.S.

for efficient air conditioners.[120] These investments over the next seven years are essential to enable Xcel to achieve deeper emissions reductions beyond 2030.

Chapter 5 – Conclusions and Recommendations for Xcel's 2023 Clean Heat Plan

Reducing greenhouse gas emissions by 28% from current levels in seven years poses a significant but achievable challenge. To be successful, Xcel will need to leverage federal, state, and local incentives and programs to transform the market for space and water heating rapidly. Nevertheless, meeting the targets with clean heat resources is doable. Based on our analysis, we have the following topline findings and recommendations:

Prioritize electrification of space and water heating, alongside energy efficiency measures, to meet clean heat targets. Of the resources eligible for clean heat portfolios, electrification and efficiency have clear advantages over alternatives like hydrogen and recovered methane. First, they can be deployed at scale, whereas recovered methane and hydrogen are both limited in their capacity to displace gas use in buildings. Second, incentives for electrification and efficiency measures achieve greenhouse gas emissions reductions at a fraction of the cost for gas utility ratepayers compared with blending alternate fuels.

Furthermore, investments in electrification and efficiency are investments in long-term, sustainable market transformation. By 2030, our Policy Case projects that all residential central air conditioners will be replaced with heat pumps upon burnout, even as incentive levels for heat pumps are scaled back or eliminated. In later years, as heat pumps and heat pump water heaters become the default option to replace gas-fired space- and water-heating equipment, greater greenhouse gas reductions can be achieved with decreasing electrification budgets. By contrast, renewable natural gas has an increasing marginal cost – as the resource potential from cheaper recovered methane sources such as landfill gas is exhausted, methane must be obtained from more expensive sources such as animal manure and food waste.[121]

Prioritize air conditioner replacements, which can drive uptake of both standard and cold-climate heat pumps. Air conditioner replacements are the single largest driver of emissions reductions in the Policy Case; by 2030, all air conditioner replacements are standard or cold-climate heat pumps. While a portion of gas furnaces reaching end of life are also replaced with heat pumps, heat pump replacements of ACs largely drive the market.

[120] Standard-efficiency AC units are eligible for a $200 rebate, and high-efficiency AC units are eligible for a $500 rebate. https://co.my.xcelenergy.com/s/residential/heating-cooling/residential-cooling-rebates
[121] Takahashi, K., E. Carlson, P. Eash-Gates, K. Schultz, P. Rhodes, and A. Hopkins. July 2023. "Building Decarbonization Strategies for the Southwest: Analysis of the costs and emissions reduction potential of space and water heating decarbonization." Forthcoming study.

To achieve large-scale electrification, Xcel will need to ramp up contractor outreach and innovative financing and ensure that incentives for heat pumps are easy to access. The current HVAC market in Colorado is not optimized for heat pump adoption. The vast majority of air conditioners and furnaces are replaced on burnout – not before – meaning that homeowners and building managers prioritize quick, like-for-like installs, rather than efficiency, operating cost, or environmental factors. This poses multiple challenges for heat pumps: building owners lack time to research their options prior to replacement; heat pumps can take longer to size, source, and install, leading building owners to opt for a conventional AC or gas furnace replacement; and the up-front costs of cold-climate heat pumps, in particular, can be higher than either a gas furnace or an AC, making the economics of these appliances more challenging if the furnace and AC need to be replaced at different times.

To mitigate these challenges, contractor outreach, combined with innovative financing, will be crucial. Contractor trainings can reduce the perceived risks associated with installing heat pumps and help ensure that heat pumps are a "first option" offered to building owners when an appliance fails. Financing options, including on-bill financing, can mitigate the upfront cost of a heat pump compared with a standard AC or gas furnace, making cold-climate heat pumps a viable option for more families and businesses. Attractive financing can also help encourage a "preventative maintenance" approach, allowing customers to save money by installing a heat pump before their existing appliances fail. Contractor-facing incentives for heat pumps should be easy to access, including streamlined program guidelines and eligibility requirements. This will require coordination across program administrators, including utilities and the Colorado Energy Office.

To achieve the 2030 clean heat goals and minimize grid impacts from electrification, Xcel should accelerate its current gas efficiency savings. We recommend Xcel increase savings from weatherization roughly four-fold from current levels, while increasing savings from behavioral efficiency (measures to reduce gas consumption through behavior changes), and other measures to reduce service demand from space and water heating. While electrification measures are the "heavy hitter" in achieving the 2030 emissions reduction target, energy efficiency measures contribute roughly 13% of the gas savings realized in that year. Moreover, efficiency is crucial to ensuring that heat pump installations are successful and meet customers' needs, reduces the upfront cost of heat pumps (due to smaller sizing), and minimizes their impact on the electric grid. We recommend increasing Xcel's incremental annual gas efficiency savings to 900,000 Dth by 2030, while transitioning the company's gas efficiency portfolio from gas appliance measures to weatherization.

To minimize the cost of meeting clean heat goals, leverage other federal, state, and utility program incentives. Our suggested utility incentive levels consider incentives provided through the federal IRA and the State of Colorado, as compared with the incremental installed cost of each measure. This allows our plan to target the largest incentives toward the measures that need the biggest boost and provide the greatest emissions reductions – toward cold-climate heat pumps. Because standard heat pumps with existing incentives are cost-competitive with conventional air conditioning units, we recommend starting with a lower incentive for these appliances and eliminating incentives by the end of the decade. This helps manage the overall clean heat plan budget.

In evaluating clean heat plan budgets, recognize the significant avoided costs of gas infrastructure investments, avoided fuel costs, and avoided carbon emissions. In addition to these quantifiable costs, focusing on electrification and efficiency provides indoor and outdoor air quality benefits, and mitigates the risk of rising or volatile natural gas prices. By 2030, the total annual budget needed for electrification and efficiency incentives is just over $244 million; a portion of these costs will be borne in utility DSM and beneficial electrification plans, and the annual incremental clean heat plan cost for electrification and energy efficiency is $127 million. However, these costs are more than offset by cost savings from reductions in fuel usage and avoided emissions.

Geotarget clean heat investments to minimize new gas infrastructure spending and maximize value to ratepayers. In this analysis, we apply an average avoided gas infrastructure cost to quantify the gas distribution system benefits associated with all-electric new home development. However, we do not quantify the potential for benefits from additional gas demand reductions geotargeted to fast-growing geographic areas, which could also defer or avoid capacity or reliability investments on the gas distribution system. These benefits could be sizeable – and realizing them will require strategic electrification, efficiency, and gas demand response.

Frontload spending to stimulate market development. We assume larger incentives are needed in the next few years to spur distributors, contractors, and building owners to stock, sell, and purchase electric appliances. Therefore, we model higher incentive levels in the early years. As the market develops, we model low or zero incentive levels for standard heat pumps and all-electric new homes, reflecting the assumption of no incremental costs and widespread market development. Additionally, while we model contractor training and customer education costs as a strict percentage of total budgets, the utility may want to frontload these costs, so that the majority of workforce development spending occurs in the early years. This will ensure that a larger workforce is available to install the vast number of appliances required to meet the clean heat targets in the latter part of the decade.

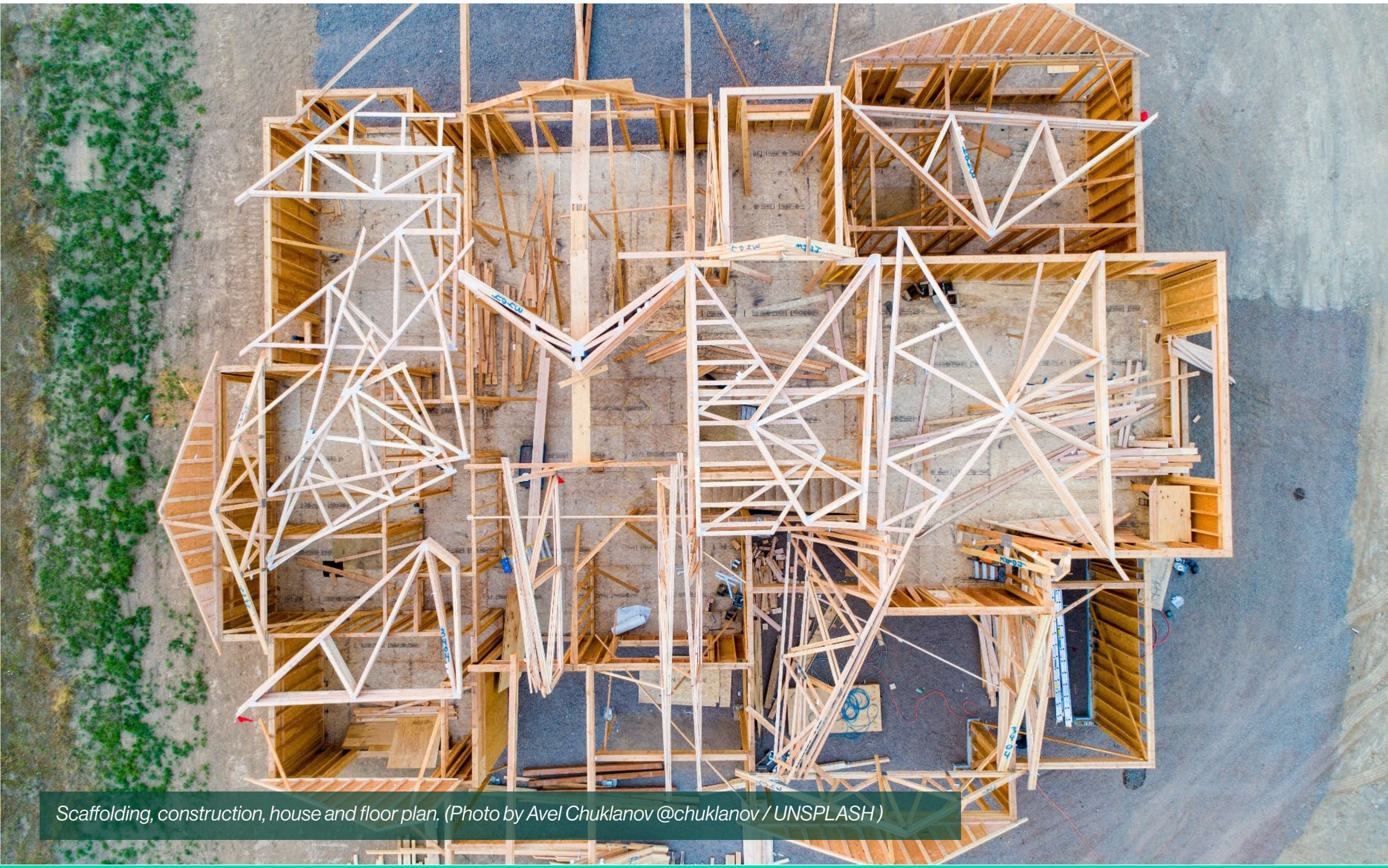
Ensure robust incentives for low- and moderate-income households. Many of the federal and state incentives available for electric appliances are provided in the form of tax credits, which are inaccessible to low- and moderate-income families without tax liability. It is especially critical that low-income families, including renters, be able to access efficient electric appliances. Because low- and moderate-income households are more likely to live in geographic areas with poor outdoor air quality, the indoor air quality benefits of electric appliances are critical, particularly because heat pumps can also help these households access air conditioning during increasingly hot summers. We recommend that at least 20%-25% of clean heat budgets be dedicated toward incentives for Xcel's low-income customers. As the market for heat pumps develops, the Commission should consider increasing the overall budget for income-qualified customers to 40%, in alignment with the federal government's Justice40 initiative. [122]Additionally, for income-qualified households, we recommend pairing electrification with deep energy efficiency retrofits to maximize bill savings and allowing these customers to finance projects using their electricity bills. Importantly, various incentive programs, including utility and IRA rebate programs, should be streamlined to ensure easy access for low-income households.

Complementary policies will help the State of Colorado, and cities within Xcel's service territory, move away from fossil fuels. The pathway to market transformation does not rely solely on new state or local policies or regulations. At the same time, policies such as an appliance standard requiring two-way operation of ACs, all-electric and electric-preferred building codes, and performance standards requiring electrification upon replacement of appliances can reduce the importance of utility incentives in meeting the 2030 emissions reduction target. We assume that by

[122] See, e.g., The White House, https://www.whitehouse.gov/environmentaljustice/justice40. Last accessed July 18, 2023.

2030, with successful market transformation, customer demand sustains high adoption of heat pumps and heat pump water heaters, even with reduced utility incentives. Complementary policies at the state and local level can support or accelerate this transformation and can galvanize the HVAC market toward efficient electric appliances and away from fossil fuels.

To meet Colorado's emissions reduction goals in 2030 and beyond, Xcel Energy must propose and implement a bold, ambitious clean heat plan. The scope of investment needed over the next seven years is significant, but essential. If successful, Xcel's investments in energy efficiency and beneficial electrification will transform the market, reduce customers' exposure to rising and volatile gas prices, and lay the groundwork for achieving deep emissions reductions beyond 2030. Finally, Xcel – and Colorado – can serve as a model for other cold-climate states of strategic, cost-effective, and rapid decarbonization of the building sector.



Scaffolding, construction, house and floor plan. (Photo by Avel Chuklanov @chuklanov / UNSPLASH)

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