Xcel Energy's Electric Space Heating Rate: Using Rate Design to Support Building Electrification in a Cold Climate

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ABSTRACT

Electric space heating rates are a valuable tool for accelerating the shift toward efficient, low-carbon heating. By recognizing the utility system benefits of dual-fuel air-source heat pumps (ASHPs), these rates can improve customer economics, supporting increased adoption of advanced heating technologies. Xcel Energy Minnesota's recently revised electric space heating rate, which took effect in fall 2025, is expected to significantly improve the customer cost-effectiveness of ASHPs. In this paper we analyze Xcel's new rate as a case study, demonstrating the rate's modeled impact on customer economics as well as a cost-to-serve analysis suggesting that these customer cost savings can be achieved without jeopardizing utility cost recovery or subsidy from other customers, and bringing additional system benefits including reduced overall emissions. We also examine customer bill data indicating that modeled customer benefits are indeed materializing in the form of lower annual electricity costs.

Introduction

Prioritizing increased electric consumption over fossil fuels like natural gas and propane helps promote decarbonization by decreasing fossil fuel use and associated carbon emissions, particularly in geographies with relatively low-carbon electricity supplies. Supplanting fuels used in space heating is a prime opportunity for this, given space heating offers a key opportunity for residential energy savings in Minnesota in the current decade (CEE 2018). One of the primary barriers to increased electric use for space heating is cost – unit for unit, electricity is more expensive than natural gas (CEE 2022). One tool that can address the customer cost discrepancy is an electric space heat (ESH) rate structure, which is the focus of this paper. Well-designed ESH rates combined with dual-fuel air-source heat pump ("ASHP") configurations offer several benefits, including cost saving opportunities for customers and more efficient cooling compared to air conditioners (lowering summer peak demand for utilities), which can help states meet their emissions goals and accelerate the shift toward low-carbon heating while mitigating customer affordability impacts.

Electric space heating rates are discounted electric rates available (typically during winter months) to homes using electricity as the primary heating source. Exact requirements vary by utility, but in general the rate may be applied to some or all electric usage in the home and up to several cents cheaper than the standard rate. ESH rates sometimes vary with the time of day.[1] Though a customer could potentially qualify for an ESH rate via various space heating equipment options like electric baseboards and boilers, pairing ESH rates and air-source heat pumps presents a special opportunity for customers because ASHPs are more efficient than the

[1] For a more general discussion of ESH and specific examples in different parts of the U.S., see Malinowski *et al*. 2025.

former technologies as well as traditional furnaces (CEE 2022). In particular, dual-fuel ASHP configurations using a previously-existing furnace for supplemental heat (e.g., replacing an existing air conditioner with an ASHP) will be lower cost than an all-electric configuration and may offer customers more control by allowing them to configure switchover temperatures to manage winter peaks and associated costs as needed.

This paper will focus on Xcel Energy Minnesota's ESH rate structure, which was recently modified with new winter rates taking effect in October 2025. While Xcel's ESH rate has existed for many years, one goal of the recent rate modifications was to recognize the utility system benefits of modern electric heating systems, such as ASHPs, which use energy in the off-peak periods and lower summer cooling load. We will first review modeling completed by the Center for Energy and Environment (CEE), an energy efficiency nonprofit based in the Twin Cities, to estimate annual operating costs for ESH rate customers compared to the default 1-period rate. We will then outline additional societal and utility benefits of ESH rates, including a cost-to-serve analysis and bill analysis for actual customers who have adopted Xcel Minnesota's ESH rate. We conclude by summarizing the benefits of ESH for large-scale decarbonization, as well as highlighting areas for further consideration and future research.

Modeled Bill Impacts

In late 2023, Xcel Energy proposed new time-of-use (TOU) general residential rates for Minnesota electric customers, along with an update to its previously-existing ESH; the proposal was subsequently modified in August of 2024 (Xcel Energy, 2024b). To determine the impact of Xcel Energy's proposed rates on its electric space heating customers, in October 2024 CEE analyzed the annual operating costs of different air-source heat pump models and system configurations using Xcel Energy's new proposed rates (CEE 2024). CEE then compared the modeled annual heating and cooling costs of the different ASHP systems to the annual cost to heat exclusively with an efficient natural gas furnace (95% AFUE) and cool with a standard central air conditioner ("CAC"). Here, we present those portions of CEE's filed analysis that compare the proposed single-period ESH rate with the Company's standard single-period residential rate.[2] (CEE also analyzed the three-period TOU rate proposal but our focus here is the ESH rate.)

Methodology

To estimate customers' all-in cost of electricity under the proposed rates, CEE first included the Company's August 16, 2024 proposed residential base rates (CEE 2024, 3) which are displayed in Table 1.

CEE then added various per-kWh and fixed charges to reflect the cost of applicable riders and fixed charges, as well as estimated fuel costs, representing an additional $0.036/kWh year-round. The resulting total rates are shown in Table 2. The ESH in winter months represents a discount of nearly five cents per kWh vs. the standard rate in winter, and nearly seven cents per kWh compared to summer rates. Standard rates feature a winter discount of about two cents per kWh vs. summer

[2] The Minnesota PUC approved the ESH portion of Xcel Energy's petition for earlier implementation than the TOU rates. Implementation of the latter remains pending as of this writing.

Table 1. Xcel Energy's August 16, 2024 proposed residential rates

Rate	Base Rate ($/kWh) – Summer (June-Sept)	Base Rate ($/kWh) – Winter (Oct – May)
1-Period standard	$0.13069	$0.11364
1-Period ESH	$0.13069	$0.06537

Table 2. Xcel Energy residential cost of electricity with applicable riders and fuel cost charges[3]

Rate	Base Rate ($/kWh) – Summer (June-Sept)	Base Rate ($/kWh) – Winter (Oct – May)
1-period standard	$0.18112	$0.16011
1-period ESH	$0.18112	$0.11137

CEE's analysis was designed not to demonstrate the customer benefit of the ESH relative to the standard rate in terms of electric costs alone, but rather to understand whether and to what extent the proposed ESH would improve the overall customer economics of ASHP systems relative to traditional furnace/AC systems. This requires estimating natural gas prices in addition to electric rates.

CEE conducted two sensitivities for the cost of natural gas using natural gas price data, specific to Minnesota, from the U.S. Energy Information Administration (EIA n.d.). The lower bound is based on a five-year average of Minnesota's monthly residential natural gas price, weighted by heating degree days, which came to $0.82 per therm. The upper bound is based on a two-year average of Minnesota's monthly residential natural gas price, weighted by heating degree days, which came to $1.06 per therm. The five-year average cost of natural gas captures lower historical pricing, while the two-year average reflects the relatively higher natural gas costs of recent years.

CEE modeled five different HVAC systems, including three dual fuel systems with different types of ASHPs, an all-electric system, and a "base case" natural gas furnace with a standard CAC. The dual fuel systems include a range of ASHP models with different switchover temperatures.[4] Below is a description of the different HVAC systems included in the analysis.

- **Base case system**: 95% AFUE natural gas furnace provides 100% of home heating. A standard efficiency CAC 100% of space cooling.
- Ducted dual-fuel ASHP systems: [5]
    - **Single-Speed ASHP**: Entry-level ASHP (2 tons) that provides heat in mild weather and 100% of space cooling
    - **Variable-speed ASHP** (3 tons) with good space heating performance across a broad temperature range, provides 100% of space cooling.

[3] The monthly fixed customer charge is included in CEE's bill impact analysis but is not reflected in Table 3.
[4] The switchover temperature is the lowest outside air temperature at which the ASHP provides space heating. The switchover temperature is programmed into the dual fuel system and does not indicate a technical limitation of the ASHP. The backup heating source provides space heating when outside air temperatures are at or below the switchover temperature.
[5] All dual fuel systems assume a 95% AFUE natural gas furnace for backup heating.

- **Variable-speed cold-climate ASHP** ("ccASHP") (2.5 tons) provides nameplate space heating capacity and 100% of space cooling. A ccASHP is defined as an ASHP that has high efficiency at colder temperatures (1.75 COP at 5°F) and can provide heat when outdoor temperatures drop to 5°F or lower.
- **All-electric system**: Ducted, variable-speed ccASHP (2.5 tons) that provides 100% of space cooling and nameplate space heating capacity down to 5°F with electric resistance for auxiliary heating.[6]

Model Limitations

CEE conducted its analysis using analytical models developed for a 2022 study of ASHPs, completed through the Minnesota Department of Commerce's Conservation Applied Research and Development grant program. Model limitations of this analysis include the following:

- The analysis was limited to HVAC energy loads and excludes all non-HVAC gas and electric loads. For this reason, CEE wasn't able to compare the total winter utility rate charges for electric space heating and non-space heating customers. This paper comments on non-HVAC electric load usage and costs below.
- The analysis assumes a single, model single-family home located in the Twin Cities. The effects of different home sizes and ages, number of occupants, and location within Xcel Energy's territory were not considered.
- The dual fuel systems included in the analysis assumes the heat pump is sized for the cooling load and not the heating load.[7]
- Performance assumptions are derived from manufacturer-reported data, which may differ from installed efficiency and capacity.

Results

This analysis shows that Xcel Energy's proposed electric space heating rates could result in lower operating costs for space heating and cooling for customers with dual fuel systems, compared to customers with the base case natural gas furnace and CAC. The operating costs of the base case and dual fuel systems are sensitive to natural gas costs, while costs for dual fuel and all-electric systems are also sensitive to the price of electricity.

Figure 1 shows the modeled operating costs for the different HVAC systems and switchover temperatures using Xcel Energy's ESH rates and the five-year average cost of natural gas ($0.82 /therm). Values on the x-axis are the switchover temperatures for each scenario. Figure 2 shows the same analysis using a two-year average cost of natural gas ($1.06/therm).

[6] All-electric systems (ASHP and electric resistance) operate differently than dual fuel systems (ASHP and natural gas furnace). In all-electric HVAC systems, the electric resistance heating typically turns on at a certain temperature and modulates along with the heat pump to provide supplemental heat. The heat pump does not turn off, as it would with a natural gas back up heating source.

[7] HVAC contractors in Minnesota typically size dual fuel heat pump systems to the cooling load. This sizing practice best aligns with the up front and operational cost economics, capabilities of ductwork in existing homes, and maximizes runtimes and reduces humidity levels during the cooling season. In greater Minnesota, systems may be sized slightly larger than the cooling load to displace more costly fuels such as propane.

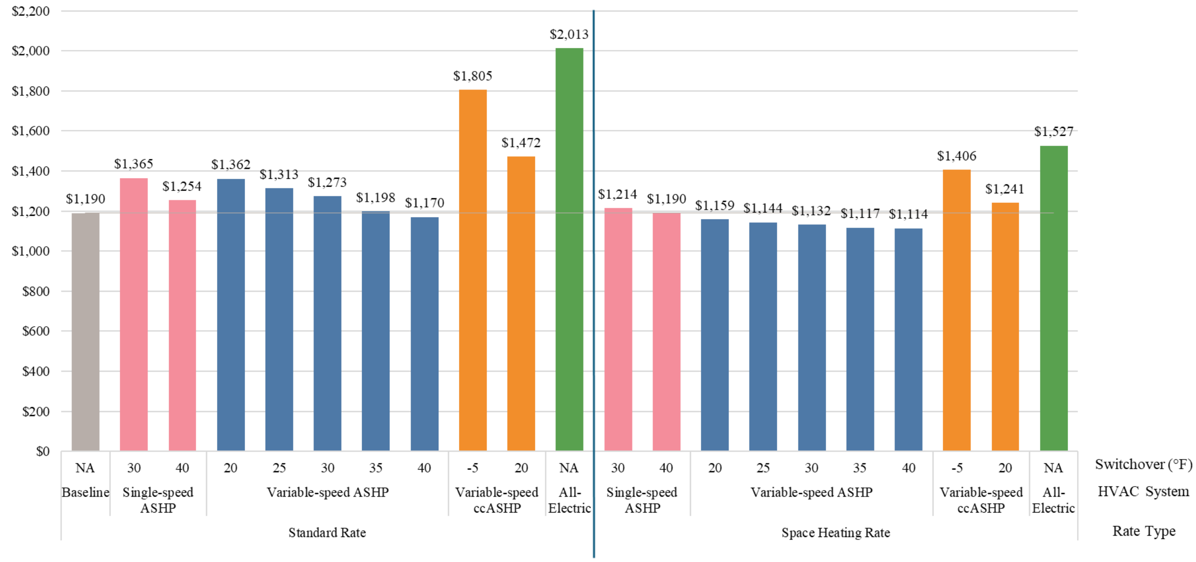

Figure 1. HVAC System Operating Costs Under Xcel Energy's Proposed ESH Rate, with Natural Gas Cost of $0.82 per Therm. *Source*: CEE 2024.

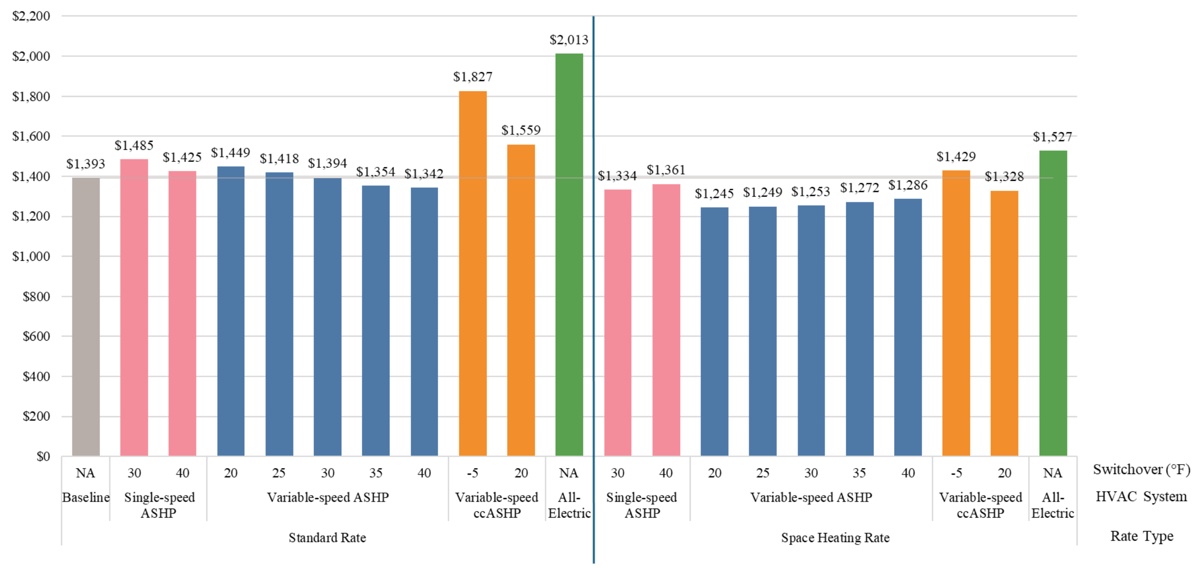

Figure 2. HVAC System Operating Costs Under Xcel Energy's Proposed Rates, with Natural Gas Cost of $1.06 per Therm. *Source*: CEE 2024.

As shown, using the five-year average gas cost ($0.82/therm, Figure 1), on the standard rate all heat pump systems have an operating cost higher than or equivalent to (within ±$50/year) the base case system. Under the ESH, all dual-fuel HVAC systems analyzed have lower or equivalent (within ±$50/year) operating costs than the base case, except for the ccASHP systems. The modeled annual operating costs for the ccASHP systems are between 4 and 18 percent higher than the base case. The modeled operating costs for the all-electric system are higher than the operating costs of the base case system regardless of rate, but the on the ESH the increase is much smaller at 28% vs 69%, representing savings of nearly $500 per year.

As noted, the operating costs for the dual-fuel and base case systems are dependent upon the assumed cost of natural gas. Additionally, the relative difference in operating costs between the all-electric and base case system is sensitive to both the cost of natural gas and the cost of electricity.

Using the higher two-year average cost of natural gas ($1.06/therm, Figure 2), again the dual fuel systems mostly cost more or roughly the same amount (±$50/year[8]) to operate as the base case system when using the standard electric rate. Using the ESH rate, all dual-fuel systems have lower or similar annual operating costs compared to the base case. The ccASHP system with a -5°F switchover temperature is the only dual fuel system that does not have a lower operating cost than the base case under the space heat rate (and the increase is modest at $36/year, or about 2.6%). The all-electric system operating costs remain higher than the base case system, with modeled operating costs between nine and 45 percent higher than the base case HVAC system.

As shown by this modeling, the revised ESH rates can improve cost-effectiveness for ASHP systems compared to traditional furnace and air conditioner systems. Operating costs depend on several factors, including ASHP model and switchover temperature. All else being equal, cost-effectiveness (vs the base case) increases as gas prices increase. In either gas price scenario, however, for lower upfront cost systems (single-speed and non-cold-climate variable speed) the savings from ESH rates can be sufficient to bring operating costs below those of the base case system, and are significant even for the higher-first-cost configurations (ccASHP and all-electric).

Cost-to-serve Analysis

To assess the impact of ESH rates on Xcel Energy's cost recovery requirements, we compared total customer electric costs (HVAC and non-HVAC) with Xcel's estimated cost-to-serve, both for one year and over 18 years, the latter being the system lifetime for an ASHP unit as prescribed by the State of Minnesota (2025, 55).

Methodology

The CEE modeling outlined above was used to quantify HVAC consumption for this analysis. The model focuses on HVAC energy use, but the Xcel's ESH rate applies to whole-home electric consumption. For a more comprehensive overview, we also considered non-HVAC electric use, which is informed by home energy use profiles. CEE developed several non-HVAC consumption archetypes (based on the quantity of non-HVAC electric use) using 1300 8760 electrical profiles for Minnesota single-family homes from ResStock; this paper focuses on the median energy usage archetype and associated costs. We calculated total customer electric costs as the sum of the electric HVAC costs outlined in the CEE modeling section and non-HVAC electric costs for the 50th percentile home usage profile. The ESH was assumed for all HVAC systems except the base case (which used the standard rate). We then compared these customer costs with estimated utility costs, as follows:

- Transmission and distribution (T&D) costs, calculated as: $/PCkW at generator * kW on summer peak day at generator

[8] The variable-speed ASHP with a 40°F switchover point saves $51 vs the base case.

- Generation capacity costs, calculated as: $/PCkW at generator * kW on summer peak day at generator
- Marginal energy costs, calculated as: $/kWh at generator * total HVAC and non-HVAC load at generator

Peak consumption was approximated as the weekday hourly load on the hour with the highest outdoor air temperature. This approximation assumes the Xcel Energy peak is primarily weather driven, and therefore, coincides with the hottest hour.

Meter consumption values were converted to generator-level values using T&D loss factors from Xcel Energy's 2024–2026 Energy Conservation and Optimization (ECO) Plan filing.[9] Utility system costs were also sourced from this filing (Xcel Energy 2024a). Customer costs were escalated using the Chain Price Index and discounted at 3.3% (Minnesota Department of Commerce 2023, 49), while utility NPVs were calculated using Xcel's 5.38% discount rate for Minnesota energy conservation projects (Minnesota Department of Commerce 2023, 51).

This cost-to-serve analysis does not capture all costs embedded in retail rates – such as certain fixed operations and maintenance expenses – and therefore may slightly underestimate the full cost of service. However, it remains informative as a measure of the marginal cost of adding load to the existing system.

Results

Figure 3 below presents the difference between first-year total customer electric (HVAC and non-HVAC) costs and cost-to-serve estimates, both as a dollar value (bars showing total customer costs minus cost-to-serve) and a percentage (cost-to-serve divided by total customer costs, shown in circles).

As shown in Figure 3, the difference between first-year total customer costs and utility cost-to-serve ranges from roughly $650-$1400 depending on the HVAC configuration, with larger differences as electric consumption increases. First-year cost-to-serve is roughly 35% of total customer electric costs across the modeled switchover temperatures but is slightly higher for less efficient HVAC configurations (i.e., the single-speed ASHP and the variable-speed system with higher switchover temperatures).

[9] Xcel Energy, 2024a. "ECO" is the term given in Minnesota to utility demand-side management programming, including energy efficiency, demand management, and fuel-switching programs.

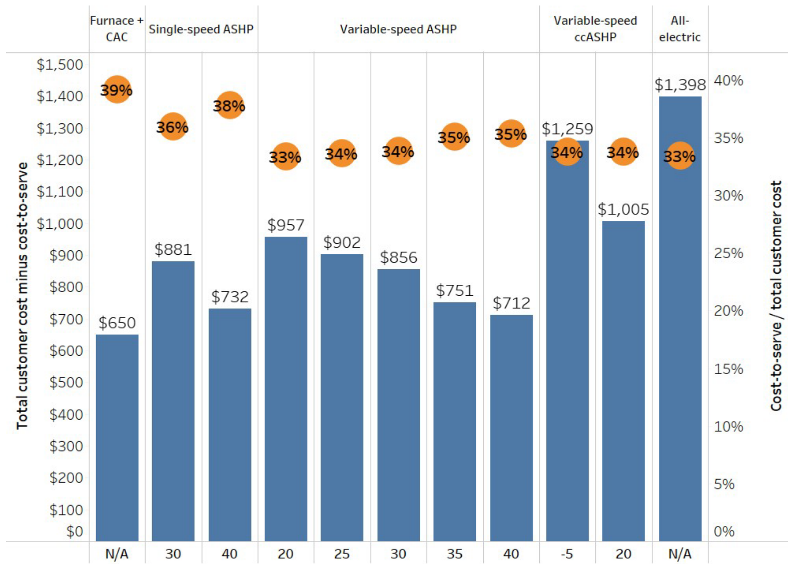

Figure 3. First year customer electric costs compared to utility cost-to-serve estimates for the modeled ASHP archetypes.

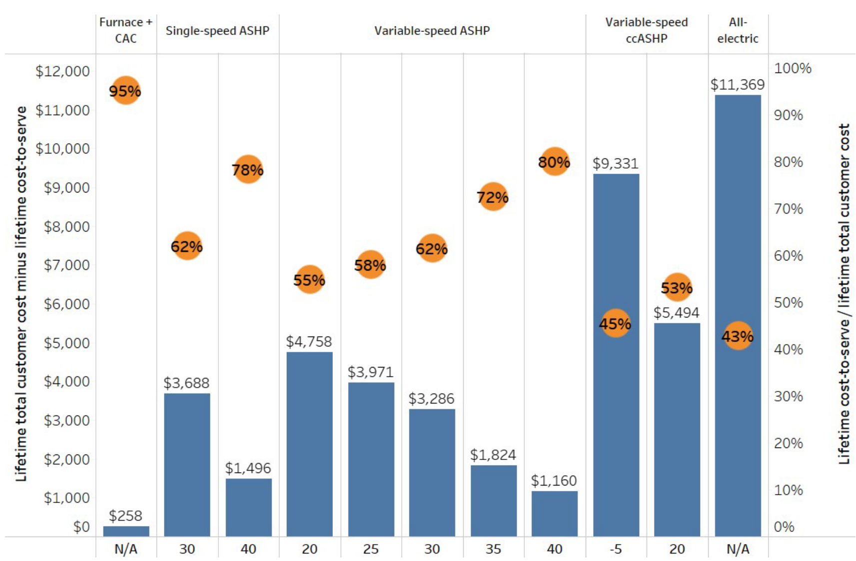

Figure 4. Lifetime customer electric costs compared to utility cost-to-serve estimates for the modeled ASHP archetypes.

Figure 4 shows these same dollar value and percentage differences over the system lifetime. The lifetime difference between total customer costs and utility cost to serve ranges from $250-$11,300 depending on the HVAC configuration. This difference is significantly larger for the cold-climate ASHP unit. Over the product lifetime, cost-to-serve ranges from 43% to 78% of total customer electric costs. For any given system, cost-to-serve represents a larger proportion of customer cost as switchover temperatures increase, reflecting the fact that with higher switchover temperatures, a larger share of the HVAC system's electricity consumption occurs during the more costly summer months rather than during the heating season. These results suggest that customers on the ESH rate are not being subsidized by other customers and that Xcel Energy can offer these rates without jeopardizing its immediate and long-term cost recovery requirements.[10]

We also compared lifetime greenhouse gas (GHG) emissions values for total HVAC and electric non-HVAC loads. We used a natural gas emissions factor of 145.86 pounds CO_2e per dekatherm as prescribed by the Minnesota Department of Commerce (2022, 43). Annual electric emissions factors (lbs/kWh) were provided by Xcel Energy for each of the various ASHP archetypes and switchover temperature combinations.

While electric emissions exceed the baseline in every heat pump scenario, in all cases these increases are more than offset by the reductions in gas-related emissions. These reductions compound over the long term, as shown in Figure 5.

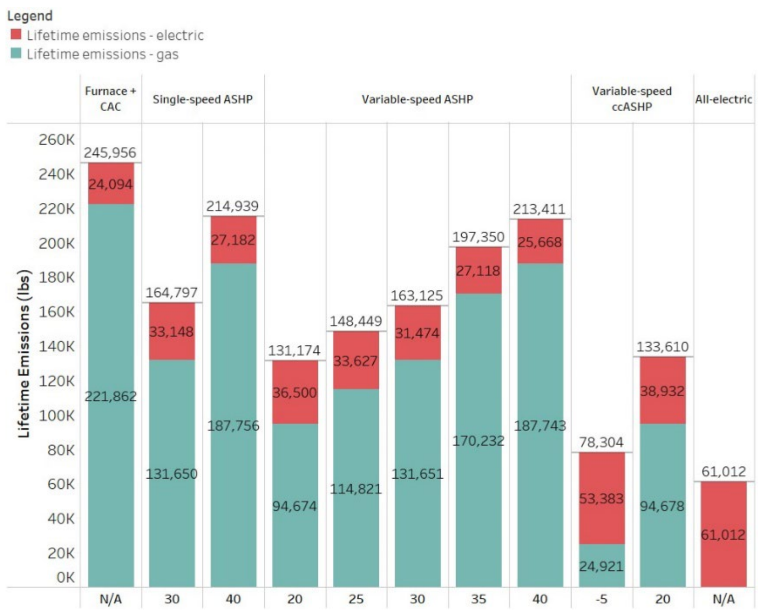

Figure 5. Lifetime electric and gas emissions (in pounds) for the baseline furnace and air conditioner scenario, compared to the modeled ASHP archetypes.

Over the system lifetime, emission increases related to electricity consumption are minimal compared to the steep reductions in emissions from supplanted natural gas consumption. This is because unlike gas-fueled equipment, electric HVAC equipment benefits from the continual "greening" of underlying grid resources as more renewable distributed energy resources come online, which leads to additional electric emissions reductions over time.

Customer Bill Analysis

While the modeled HVAC operating cost savings from an ESH rate is encouraging, we were also interested in understanding the extent to which cost savings are realized in actual customer bills. To explore this question, we examined actual electric and gas bill data from Xcel Energy customers both before and after installation of a heat pump. Because we used the customer's utility bill as the source of data, we were not able to isolate the energy usage of the

[10] The longer-term cost to serve of the base case system is 95% of total customer costs, likely reflecting that the base case usage profile is the closest to the assumptions used to design the standard residential electric rate.

HVAC system. However, the ESH rate applies to the customer's entire electricity consumption, not solely to HVAC usage. This creates an opportunity for non-HVAC usage to create customer savings above and beyond savings from HVAC, potentially further improving the economics of heat pump adoption for customers switching from a fossil-fueled heating system. The analysis of the full customer bill allows us to explore this potential while avoiding the need to develop a methodology for separating HVAC and non-HVAC usage.[11]

Methodology

We reviewed electric and gas billing data for Xcel Energy customers in Minnesota who received rebates for heat pumps installed between 2022 and 2024 through the company's ECO programs. Roughly two thirds of Xcel's residential electric customers in Minnesota receive their gas from another utility, typically CenterPoint Energy, which provides gas to Minneapolis and much of the western Twin Cities metro area while Xcel's gas utility serves St. Paul and the eastern metro.[12] The share of customers in our dataset taking both fuels from Xcel was roughly consistent with the overall residential customer breakdown. We did not have access to gas billing or consumption data for non-Xcel gas customers.

From rebate records, we were able to identify whether customers installed a ducted or non-ducted heat pump and whether the system installed was cold-climate rated.[13] Billing records indicated whether the customer was enrolled in the ESH rate. We did not have direct visibility to various potentially relevant factors including (among others) the system's switchover point between heat-pump and backup operation or other major electric loads or sources (including, importantly, whether the home had cooling before the heat pump was installed). All customers included in the analysis had at least 12 months of usage prior to the recorded date of heat pump installation; only customers who installed their heat pump between 2022 and 2024 were included in order to ensure at least 12 months of post-installation usage data. We removed customers who were identified in Xcel's billing system as having self-generation (such as solar PV) on-site.

Customers were assigned to groups based on which utility service(s) they received from Xcel: Group A represents customers who have gotten heat pump rebates and receive electric service; Group B is a subset of Group A which includes those electric customers who moved to the ESH rate within six months of heat pump installation. Group C represents customers who have gotten heat pump rebates and receive gas service from Xcel, while Group D is a subset of Group C including gas customers who moved to the ESH rate within six months of heat pump installation. In order to be in Group D, the customer would need to receive both gas and electricity from Xcel; the other groups could contain customers who receive only one fuel from Xcel. Table 3 indicates the number of customers in our dataset by heat pump installation type and utility service grouping.

Table 3: Customer counts by utility service and heat pump installation

[11] There are of course trade-offs with this approach, as it potentially masks the impact of other factors affecting the customer's overall usage and bills. We see this analysis as seeking to supplement the modeled operating costs and suggest whether there is reason to believe that expected savings are being realized in practice, rather than supporting a conclusive determination about HVAC operating cost specifically.
[12] Both utilities also provide gas in non-metro portions of Minnesota.
[13] Xcel Energy's heat pump program considers a heat pump to be a cold climate system if it achieves a COP of 1.75 or greater at 5 degrees F and the heating capacity at 5° F is at least 70% of the rated capacity at 47° F.

Heat Pump Type	Group A: Customer receives electricity from Xcel Energy	Group B: Customer receives electricity from Xcel Energy on the ESH Rate	Group C: Customer receives gas from Xcel Energy	Group D: Customer receives gas from Xcel Energy and is on the ESH Rate
cc HP (Ducted)	1,700	173	810	62
cc HP (non-ducted)	1,165	34	576	18
cc HP (all)	2,865	207	1,386	80
Standard HP (Ducted)	1,334	41	590	18
Standard HP (non-ducted)	1,927	21	923	9
Standard HP (all)	3,261	62	1,513	25
Ducted HP (all)	3,034	214	1,400	78
Non-Ducted HP (all)	3,092	55	1,499	27

We constructed a regression model that sought to compare a customer's consumption and bills prior to heat pump installation against their usage after installation. We used a fixed-effects model to isolate how usage changed within each premise. We also included a control group with similar usage behaviors and demographics to capture usage patterns relative to heating degree days that were common to all customers, regardless of heating technology.[14] Our regression model used annual heating degree days and the presence of a heat pump to model the difference in premise-level energy usage. We removed outlying customers whose usage (either gas or electric) was more than three standard deviations from the mean for this group. Because Xcel Energy implemented new general (gas and electric) rates during our period, we included a dummy variable to account for the impact of new prices on customer cost.

Because some customers (such as those using baseboard electric resistance) may have been enrolled in the ESH before installation of a heat pump, for our analysis we only included customers in the ESH categories (B and D) if they switched to the ESH within about six months of installing their heat pump.

Results

Table 4 indicates the average change in electric energy use and bills for customers in each category; Table 5 gives the average change in gas usage and bills. All figures are annual; the 95 percent confidence interval for the difference in the average consumption or dollars billed for customers who installed a heat pump is shown in parentheses; true consumption and billing variability was much larger. Positive numbers indicate an increase and negative numbers represent a decrease.

Table 4: Change in annual electric consumption and cost after heat pump installation

[14] We identified control group customers by identifying customers with similar usage statistics, premise size, age, and value, along with purchased demographic information including factors such as whether a household is likely to have children.

Heat Pump Type	Group A (all electric customers) Electric Consumption, (kWh)	Group A Electric Bills	Group B (only electric customers on ESH rate) Electric Consumption, (kWh)	Group B Electric Bills
cc HP (Ducted)	+ 1,032 (913-1,151)	+ $117 (104-130)	+ 1,523 (1,112-1,933)	*
cc HP (non-ducted)	+ 1,132 (985-1,279)	+ $207 (183-230)	+ 3,810 (2,794-4,825)	+ $310 (148-472)
cc HP (all)	+ 1,074 (981-1,167)	+ $191 (176-206)	+ 1,845 (1,464-2,262)	+ $83 (22-133)
Standard HP (Ducted)	+ 850 (739-1,279)	+ $152 (134-171)	+ 2,020 (1,229-2,701)	+ $131 (22-240)
Standard HP (non-ducted)	+ 611 (521-700)	+ $88 (73-103)	*	*
Standard HP (all)	+ 690 (620-760)	+ $114 (102-126)	+ 2,258 (1,702-2,814)	+ $164 (75-253)
Ducted HP (all)	+ 922 (841-1,003)	+ $163 (150-177)	+ 1,646 (1,297-1,995)	+ $69 (13-125)
Non-Ducted HP (all)	+ 711 (636-786)	+ $117 (104-130)	+ 3,175 (2,485-3,865)	+ $263 (153-373)

Table 5: Change in annual natural gas consumption and cost after heat pump installation

Heat Pump Type	Group C (all gas customers) Gas Consumption, (therms)	Group C Gas Bills	Group D (only gas customers on ESH rate) Gas Consumption, (therms)	Group D Gas Bills, ESH rate
cc HP (Ducted)	-195 (-209 - -180)	- $192 (-210 - -175)	-230 (-284 - -177)	- $224 (-289 - -159)
cc HP (non-ducted)	-55 (-72 - -38)	-$57 (-78 - -36)	*	*
cc HP (all)	-135 (-146 - -124)	- $135 (-148 - -121)	-211 (-258 - -165)	- $205 (-262 - -148)
Standard HP (Ducted)	-156 (-171 - -141)	- $181 (-200 - -161)	*	*
Standard HP (non-ducted)	-53 (-64 - -41)	-$106 (-121 - -91)	*	*
Standard HP (all)	-88 (-97 - -79)	- $134 (-146 - -122)	*	*
Ducted HP (all)	-170 (-180 - -159)	- $181 (-194 - -168)	-237 (-284 - -190)	- $234 (-291 - -178)
Non-Ducted HP (all)	-49 (-59 - -40)	-$90 (-102- -78)	- 265 (-340 - -189)	- $265 (-357 - -173)

* No statistically significant change

The R^2 values are quite low (not shown but less than 0.3 for electric and less than 0.7 for gas), indicating that total annual heating degree days and presence of a heat pump do not explain the full variability of premise-level gas and electric usage. Despite this, the reported differences in consumption and bills are mostly statistically significant and represent an average change that in the years following the installation of a heat pump. Further studies with additional years of data and more features would allow us to better model the impacts of heat pumps on customer consumption and bills and potentially better quantify these impacts relative to other factors –

including, but not limited to, occupancy, electric vehicle charging, pre-existing air conditioning technology, and pre-existing heating technology.

Electric consumption increased and natural gas consumption decreased among all groups, with costs changing in the same direction as consumption. In all heat pump categories, customers in Group B (the ESH rate) show a larger increase in electric consumption than those in Group A (all electric customers) – in some cases, the ESH customers increased usage by two or more times the increase seen in Group A with the same heat pump configuration. Electric costs, however, are a different story: As expected, both Group A and Group B customers experienced higher electric costs in most heat pump categories. However, Group B customers installing ducted heat pumps (regardless of heat pump efficiency) had a smaller bill increase than customers in Group A who installed the same equipment (despite Group B's larger increase in usage), while Group B customers who installed non-ducted systems had a larger bill increase than Group A(again, regardless of the heat pump's efficiency).

We speculate that the relatively small increase in electricity usage for non-ducted heat pump systems in general is – at least partly – the result of these non-ducted systems being installed to add cooling or to improve comfort in auxiliary spaces, like garages and attics. In contrast, if non-ducted systems are added as a primary heat source (Group B), this may be in older homes that do not have existing ducts. However, the increased cost for Group B customers is not proportional to their increase in consumption, suggesting that they are benefiting from the lower rate at non-summer times of year. Indeed, Group B customers who installed ducted cold-climate heat pumps saw an increase in annual electricity consumption of about 1.5 MWh with no statistically significant change in their annual costs.

It is possible that selection bias plays a role here: customers intending to use their heat pump for a larger share of their heating load may be more likely to opt into the space heating rate, which could account for a larger electric increase. We also tend to see larger declines in gas usage among customers on the ESH rate, supporting the idea that these customers are seeking to replace a larger fraction of their overall heating load.

Because each group of customers may contain individuals who receive only one fuel from Xcel Energy and we do not have access to consumption and cost of non-Xcel-provided fuels, we cannot simply sum the average change in costs to give a precise estimate of the customer's net cost change.[15] However, certain comparisons are informative, if not conclusive: Group D, representing customers who receive both gas and electricity from Xcel and whose electricity is billed on the ESH rate, is a subset of Group B, allowing us to form tentative conclusions about the net cost change for Group D customers.[16] Similarly, we can examine the combined cost impact for Groups A and C, which respectively contain all electric and gas customers in our dataset (though more caution is required here, since there are also likely to be single-fuel customers in both A and C, including customers who started out with electric space heating in group A). Table 6 provides a partial summary of these results.[17]

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[15] For example, a customer may be in Group A (all electric customers) and B (ESH electric customers) but we do not know, on this analysis, whether they receive gas service from Xcel. Similarly, a customer might be in Group C (all gas customers) but receive their electricity from another provider, meaning they would not be in Groups A, B, or D.

[16] These conclusions are tentative because the size of Group D is generally never more than about 50 percent of Group B for a given heat pump configuration, and in some cases considerably less – see the customer counts in Table 3 above.

[17] Table 6 shows only a comparison for ducted ccASHP due to space constraints; similar comparisons can be derived using the data in tables 4 and 5.

Table 6: Estimated net cost change for Groups A and C and Groups B and D for customers who installed ducted cold-climate heat pumps

	Net Cost Change, Group A + Group C (all electric and gas customers)	Net Cost Change, Group B + Group D (all ESH customers plus ESH customers who receive gas from Xcel)
Ducted ccHP	+ $117 (e) + -$192 (g) = -$75	$0* (e) + -$224 (g) = -$224

* Group B customers installing ducted ccHP had no statistically significant change in bills

Because most modeled outputs represent different subsets of customers, we cannot say with certainty that the billing data confirms the modeled results discussed above. However, modeling of total annual bills for customers installing dual-fuel ASHP and switching to the ESH rate suggest that the average impact for these customers will be bill-neutral or better, which is roughly consistent with our review of billed data. In order to rigorously test the HVAC model, we would need a variety of data that is not available, including switchover points, thermostat settings, and equipment characteristics (among others). Because we are relying on overall energy bills, we cannot say exactly how much difference in cost or consumption is due to the home's heating system versus other factors. However, we do see reason for optimism that the expected effect of the electric space heating rate – i.e., a reduction in overall operating costs and improvement in system cost-effectiveness – is indeed being realized by customers. It is also important to note that the billing data we had access to was mostly collected during the period before the most recent change to Xcel's ESH rate. The reduction in the ESH rate, as noted earlier, took effect in autumn of 2025; non-summer usage prior to that time would have been billed at the earlier ESH.[18] We would thus expect that ESH customers are now experiencing greater electric savings than are reflected in the discussion above.

It is also important to recognize that our billing analysis model is descriptive rather than predictive. It allows us to describe historical changes in average consumption (or cost) that are correlated with installation of a heat pump, but it does not allow us to say that the heat pump causes that change or, as the low R^2 values imply, make any predictions about how a customer could expect their bill to change upon installation of a heat pump. This is especially true for the change in electricity consumption and billing where many factors not included in our model could contribute to a premise's energy usage, and could have occurred within the same year a heat pump was installed. A more carefully-specified model of customer consumption could potentially allow such statements, but would require additional customer information to which we did not have access (such as, other loads in the home, occupancy or behavior changes, etc.).

Conclusion

This analysis shows that pairing dual-fuel ASHPs with thoughtfully designed ESH rates can support building electrification in cold climates while delivering benefits for customers, utilities, and the environment. From a customer perspective, the ESH rate improves the economics of heat pumps by lowering the cost of electricity used for heating. Modeled results show that ASHP systems operating under the ESH rate can be cost-competitive with, and in some cases less expensive than, conventional furnace and air-conditioning systems. Analysis of

[18] The cost of non-summer electric usage for ESH customers decreased from $0.08215/kWh to $0.06537/kWh, about 20%, with the implementation of the new ESH winter rate in October 2025.

real-world billing data from Xcel Energy customers supports these findings, with many households that installed ASHP systems and enrolled in the ESH rate experiencing reductions in overall energy bills. From a utility economics perspective, the analysis indicates that the ESH rate structure can support electrified heating without undermining cost recovery. Across the scenarios analyzed, the utility's cost to serve heat pump customers remained below the total electric revenue collected from those customers. This suggests that electric utilities can enable electrification through appropriately designed rates while maintaining revenue sufficiency.

Finally, the emissions analysis demonstrates the long-term decarbonization benefits of this approach. Although heat pumps increase electricity consumption, the reduction in natural gas use leads to net emissions reductions. These reductions are expected to grow over time as the electric grid continues to decarbonize, reinforcing the role of electrified heating as a key strategy for reducing building-sector emissions.

Together, these findings suggest that dual-fuel ASHP systems combined with well-designed electric space heating rates offer a practical pathway for accelerating electrification in cold climates. By improving customer economics, maintaining utility cost recovery, and reducing emissions, this approach can help advance building decarbonization while supporting reliable and affordable energy systems.

Future research could further examine how electric space heating rates interact with heat pump operating strategies, particularly the role of switchover temperatures in shaping customer costs, system load, and emissions outcomes. As electrification grows, increased electric heating load may also contribute to a gradual shift in system demand from summer toward winter peaks, which could affect utilities' long-term planning, capacity needs, and cost projections.

This study also relies on currently available transmission and distribution (T&D) cost estimates, which are based on older studies that do not fully reflect the impacts of electrification, including heat pumps and electric vehicles. Future research should incorporate updated T&D cost estimates and more granular analysis of feeder-level impacts. Because distribution system constraints and upgrade needs are highly localized, improved modeling of feeder capacity and upgrade costs will be important for understanding how electrification may affect long-term utility system planning.

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