Evolving Electrification Policy and Program Design in the Pursuit of Decarbonization

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ABSTRACT

Decarbonization through residential electrification is a central strategy in climate policy, yet the economics of electrification vary dramatically across states and households. While traditional programs have solved many first-cost barriers through rebates, analysis shows that full electrification can increase utility bills, particularly in regions with high electric rates relative to natural gas rates. These cost increases risk burdening the low- and moderate-income households that other policies aim to protect, as well as posing a significant barrier to mass market adoption. At the same time, partial electrification strategies, such as hybrid heat pumps, can deliver carbon reductions at lower cost and with fewer risks to affordability. This paper examines the cost and emissions tradeoffs of heat pump adoption across the U.S. The authors highlight the tension between customer cost-optimal outcomes and maximizing societal carbon savings, identifying characteristics leading to positive or cost-prohibitive outcomes, and guide policymakers on where electrification can proceed broadly and where caution is warranted. The authors show there are significant additional cost-efficient carbon savings available above the current customer cost-optimal operation in most places. To address affordability risks, the authors have outlined the following programmatic and policy solutions, which have been proposed in different jurisdictions: hybrid system incentives, weatherization-first requirements, energy cost impact tools, targeted income eligibility, rate design reform, and broader cost-effectiveness frameworks. The paper emphasizes the importance of aligning customer economics with climate goals through targeted interventions and policy “nudges” that close the gap between bill savings and carbon savings.

Introduction

Decarbonization through electrification of residential buildings has become an increasing focal point for federal, state and local policy makers. As of 2025, 26 states (plus Washington DC and Puerto Rico) have established or recommended state-level greenhouse gas (GHG) reduction targets (Sierra Club 2025), with an average reduction goal of 45% by as early as 2030. To achieve these aggressive goals, governments and utilities are developing programs across all sectors, including residential buildings. Fully converting residential households to electricity is often costly, with high upfront costs of equipment purchases and installation. While traditional energy efficiency programs have mostly solved the initial cost problem through rebates, analysis and case studies reveal that full residential electrification across many parts of the country frequently results in higher overall utility bills (LBNL 2024), mainly in regions where electric rates are high relative to other energy sources. In some cases, like New England, electrification could cause utility bills to rise as much as 30% (Utility Dive 2024). Policies focused on full electrification could place an increased energy burden on many of the households and communities that these policies are intending to support, including low- and moderate-income households. At the opposite end of the spectrum, studies have shown that almost all households could save money on their bills with partial electrification of heating (LBNL 2024). How is it possible that most homes fully electrifying their space heating would increase customer bills, while almost all homes could save money electrifying part of their heating? This paper examines the operating costs of decarbonization of heating, providing insights on how to estimate cost impacts to program participants across the country. The authors then offer recommendations on the circumstances where residential electrification does not risk increases in bills to households and the circumstances where the risk of bill increases should be considered and implemented when supporting policies and infrastructure exists. Finally, the authors explore offer recommendations for program design, cost effectiveness methodology and policy structures.

Reducing Heating GHG Emissions with Heat Pumps

Electrification reduces (saves) GHG emissions through two main pathways: conversion of the fuel source and equipment installed within buildings, and changes in the energy distribution system (e.g., reduced methane leaks from eliminating leaky natural gas infrastructure). This paper focuses on source emissions reductions, inclusive of all upstream and downstream impacts (though some may be excluded for simplicity). The paper refers to the "energy system," defined as all aspects of energy production, delivery, and consumption for all energy sources being considered. This paper focuses on conversion of equipment, operating cost tradeoffs, and GHG emissions savings. The GHG emissions reductions from a heat pump depend on the GHG intensity of the electric grid when the heat pump is running, the efficiency of the heat pump, and the amount and type of heating fossil fuel being displaced. When comparing energy system changes, the analysis should weigh the added costs of expanding electric distribution, transmission, and generation against the costs of maintaining the existing natural gas distribution network, while also accounting for GHG savings from reduced methane leakage. This includes evaluating the difference between operating heat pumps with electric backup versus gas backup.

Tradeoffs Between Heat Pump Operating Costs and GHG Emission Savings

Although heat pumps are generally understood to reduce GHG emissions when replacing fossil fuels, there are instances where emissions actually increase over the baseline equipment. Figure 1 below shows the change in customer operating cost and GHG savings, both normalized to units of heat delivered (MMBtu), for an all-electric ducted high efficiency (HE) cold climate air source heat pump (HP)[1] installed in place of an 80% efficient natural gas furnace baseline, modeled in Denver, CO. The costs use gas and electricity rates as of fall of 2024. The heat pump is assumed to use electric resistance heat to meet any remaining unmet load. As the outdoor air temperature gets colder, the GHG emissions savings decrease. Savings become negative at some point below outdoor temperatures of zero degrees Fahrenheit, in this example, using electric GHG emissions from ResStock[2] for the medium electric emissions case (roughly equivalent to

[1] The modeled HP is based on performance data for the Carrier Infinity line of HPs.
[2] ResStock - NLR

50% carbon-free and 50% natural gas generation). This drop in GHG emissions savings is driven both by the dropping efficiency of the heat pumps and by a change in grid electricity emissions intensity as temperatures get colder. In this example, the greenhouse gas emissions are assumed to be a function of time and month, loosely correlated with temperature. A more granular examination of emissions may show a higher or lower correlation with temperature, depending on the grid scenario modeled.

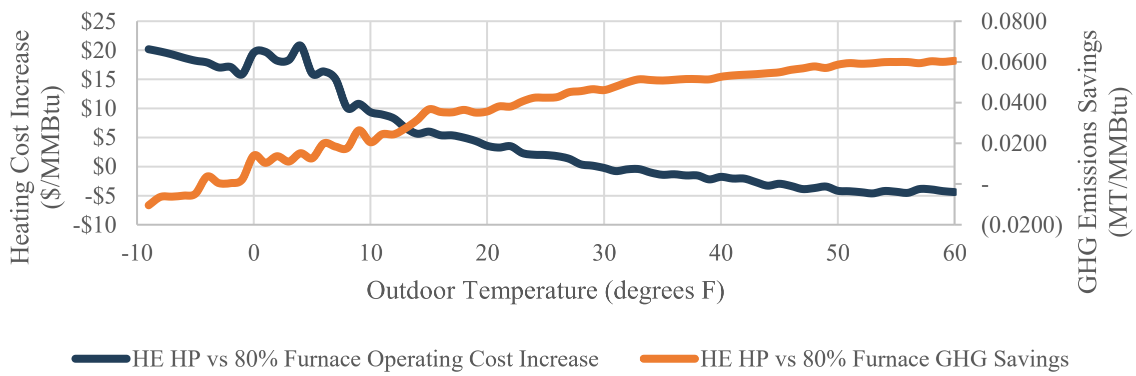

Figure 1. High efficiency heat pump operating cost and GHG emissions impacts in Denver, CO.

Heating costs decrease at warmer outdoor temperatures, with the blue line crossing the zero cost increase line at 30 degrees in the above example. This outdoor temperature represents the customer cost-optimal switchover point. As the outdoor temperature gets colder, the heating costs increase rapidly, driven by dropping heat pump system efficiency. For the high efficiency heat pump, this is driven by dropping efficiency[3] and increased thermal load on the heat pump, which results in further efficiency reductions, and increasing use of electric resistance backup heat at extremely cold temperatures. While a zero emissions grid would guarantee carbon efficiency savings associated with all electrification of fossil fuel end uses across all conditions, engineering studies of what a future fully decarbonized grid will include point to difficulties with eliminating the emissions from the last 2-10% of fossil-fueled electricity production (NREL 2022). The main options for solving this difficult problem all have cost-related complexities, and include continued use of fossil-fired generation with decarbonized fuels, carbon capture, or decarbonized long duration storage (e.g., iron air batteries). Even with an aggressive pursuit of decarbonization, on days with high grid loads and low renewable output, the emissions of the electricity grid may be non-zero. As a result, full-electrification heat pumps in many places will not save GHGs during operation at cold temperatures for the foreseeable future, meaning that a high displacement dual fuel HP system with a low switchover temperature is likely to have lower annual emissions than a full-electric HP system in these places. In many places, full electrification of heating increases customer costs, due to the following reasons:

[3] All heat pumps lose efficiency as the temperature spread between the cold and hot sides of the heat pumps increases – this is driven by the Carnot efficiency dropping. As a result, as the outdoor temperature drops, the efficiency drops. In addition, as the load on the heat pump increases, a larger temperature difference is required at each heat exchanger, resulting in a larger spread in refrigerant temperatures, which also drives the Carnot efficiency down.

1. For many utility service territories, the per unit cost of energy (per MMBtu) is higher for electricity than for other fossil fuels currently in use. In these cases, the incremental cost of electricity is high enough to offset the overall reduction in site energy use.
2. For a home with fully electrified heating that utilizes backup electric resistance heat, the electric resistance backup heat also increases costs and typically increases greenhouse gas emissions.

As a result, a home fully electrifying their heating system may increase energy bills. Recognizing this growing issue, advocates and researchers across the country are conducting analysis and providing recommendations. Many of these reports include recommendations for changes to program design, changes to rate design[4] (time of use rates, demand-based rates, or an equipment-specific rate (Faruqui, 2024)), or providing additional bill subsidies/incentives to households that participated in electrification programs. However, rate design and bill subsidies are complex initiatives involving regulators, utilities, stakeholders and may take years to implement. And while rate design may be an effective long-term solution, a suite of viable near-term approaches also exists and should be considered.

Partial Electrification with Hybrid Heat Pumps

As described above, the efficiency and economics of operating a heat pump decline for all types of heat pumps as temperatures drop[5]. Also as noted above, households with temperatures below the participant heating cost-optimal switchover temperature will face increases in heat pump operation costs. Given this, in locations with high operating costs for full electrification, partial electrification can decrease customer operating costs and may be a viable and cost-effective alternative. For a home with partially electrified heating that uses the participant heating cost-optimal switchover temperature to determine heat pump operation, the heat pump saves money and typically saves GHGs relative to a baseline fossil-fueled heating system. For a home with partially electrified heating that maximizes use of the heat pump, the heat pump operation below this cost-optimal switchover temperature increases customer costs. If these cost increases are higher than the cost savings above the optimal switchover temperature, then the home operating with maximum heat pump operation has higher total heating bills, but it may still be saving GHGs, depending on the marginal electric GHG emission rate and the efficiency of the heat pump.

The Costs and Benefits of Decarbonization with Heat Pumps

Central cooling should be included in the baseline. The total cost of heating with heat pumps relative to baseline equipment is driven by 1) the sum of the upfront incremental cost of

[4] For example, in April 2025, ACEEE published a report recommending discounts and rate design to keep bills down after electrification: Revised_Electricity Rates that Keep Bills Down after Electrification of Home Heating | ACEEE

[5] While capacity and efficiency at cold temperatures have improved over time, Carnot's law of thermodynamics dictates that moving heat against a larger temperature difference will take more energy than moving heat against a smaller temperature difference.

equipment and installation and 2) the ongoing operating cost of the equipment. When calculating incremental costs, it is frequently appropriate to assume a central air conditioner (CAC) as part of the baseline (e.g. HP vs baseline CAC + gas furnace) for comparing costs and benefits of heat pumps relative to baseline equipment, since a heat pump delivers central cooling, just like a CAC, while displacing the use of a furnace. This central cooling amenity is a primary benefit to a customer, so the CAC should be included, both in the calculation of the incremental cost of equipment and installation and in the calculation of incremental operating cost.

GHG savings and customer cost savings are frequently in opposition. As the heating use of the heat pump increases, over greater portions of the heating load, covering more costly portions of the heating load, the amount of GHGs saved increases, as long as the heat pump is more carbon-efficient than the alternative. At the same time, the operating cost increases as a heat pump is controlled to operate at less cost optimal conditions, which may include lower temperatures or times with more expensive electricity (e.g. on-peak during time-of-use rates).

Both high upfront costs and high operating costs act as barriers to the adoption of heat pumps. As an example, Figure 2 below shows the results of a recent analysis in Denver, Colorado, with electricity and gas rates as of winter of 2024-2025.

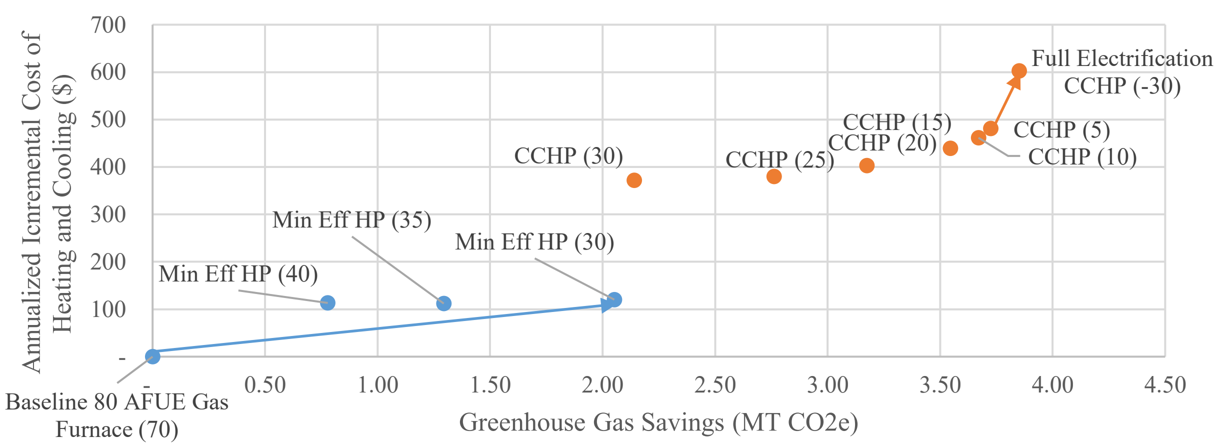

Figure 2: Annualized customer heat pump electrification cost vs GHG savings (Denver, CO).

Two three-ton heat pump options were modeled over a range of switchover temperatures, both with a baseline of a new central air conditioner and 80 AFUE gas furnace and assuming the gas furnace is kept if needed. One is a high-efficiency cold climate heat pump (CCHP) with an upfront incremental cost of $6,600 above baseline CAC equipment and the other is a minimum efficiency heat pump with an incremental cost of $2,000.[6] Each point on the graph represents one heat pump being modeled in Denver, with the switchover temperature in parentheses. Each point

[6] These incremental costs reflect the agreed upon assumptions used in the Colorado heat pump code study, which were arrived at using a combination of secondary research and stakeholder feedback.

has an incremental annualized cost[7] and an annual GHG saved[8] relative to the baseline. Each point's label indicates the type of heat pump and the switchover temperature in parentheses. The slope of any line on the graph between two points shows the effective marginal cost of GHG emissions associated with moving from one point to another. For example, going from Baseline 80 AFUE Gas Furnace with CAC to Minimum Efficiency HP (30) (blue arrow) saved GHGs at a cost of approximately $60/MT CO2e (($120-$0)/(2.05-0)). Going from CCHP (5) to Full Electrification CCHP (orange arrow) saved GHGs at a cost of approximately $1,000/MT CO2e (($602-$481)/(3.85-3.73)). The steeper the line between points, the higher the marginal cost for each pound of carbon saved. Building a cost-optimization curve like this one can help policy makers and program designers understand which options have the highest carbon savings per dollar spent. Table 1 below shows the same cost and savings data as Figure 2 above, for the minimum efficiency heat pump points.

Table 1. Summary of costs and GHG savings for minimum efficiency HP equipment in Denver, Colorado

Equipment	**Switch over Temp (degrees F)**	**Incremental Cost of Heating ($/year)**	**GHG Savings (MT/year)**	**Incremental Cost of GHG Savings vs Baseline ($/MT)**	**Incremental Cost of GHG Savings vs Line Above ($/MT)**
80 AFUE Furnace + CAC		$ 0	0	NA	NA
Min Eff HP + Furnace	40	$ 113	0.78	$ 145	$ 145
Min Eff HP + Furnace	35	$ 112	1.29	$ 87	$ -2
Min Eff HP + Furnace	30	$ 120	2.05	$ 59	$ 11

In this example, the incremental cost of heating and cooling with a heat pump relative to a furnace and CAC is lowest with a minimum efficiency HP operating at a switchover temperature of 35 degrees. Customers in Denver, CO have cost disincentives to use their heat pump below this temperature, because their bills will go up. Below 30 degrees, minimum efficiency heat pumps still work, but they deliver lower temperature supply air (due to dropping capacity) that may cause comfort issues for some but not all people (in fact, one of the authors uses a minimum efficiency heat pump with a switchover temperature of 20 degrees in his home in Colorado). While lower switchover temperatures could possibly be achieved for some customers, there are extremely cost-efficient carbon savings to be had by pushing the switchover temperature down to 30 degrees, if customers disincentives can be overcome. Moving the switchover temperature from 35 degrees to 30 degrees costs the customer an extra $8/year, but save an extra 0.8 MT of CO2e/year, an incremental cost of GHG savings of $11/year. Table 2 below shows the costs and

[7] The incremental annualized cost include both an annualized version of the upfront incremental equipment and installation cost and the change in operating cost.
[8] An electricity GHG emissions rate of 0.23 MT CO2e/MWh was used in this example, which is roughly equivalent to a grid with 50% zero carbon generation and 50% natural gas generation. This is approximately equal to the near-term grid mix in Colorado.

GHG savings for a high efficiency cold climate heat pump in Colorado relative to a baseline furnace and CAC, for the same points as in Figure 2.

Table 2. Summary of costs and GHG savings for high efficiency HP equipment in Colorado

Equipment	Switch over Temp (degrees F)	Incremental Cost of Heating ($/year)	GHG Savings (MT/ year)	Incremental Cost of GHG Savings vs Baseline ($/MT)	Incremental Cost of GHG Savings vs Line Above ($/MT)
High Eff HP + Furnace	30	$372	2.14	$174	$174
High Eff HP + Furnace	25	$380	2.76	$137	$13
High Eff HP + Furnace	20	$403	3.17	$127	$56
High Eff HP + Furnace	15	$439	3.55	$124	$97
High Eff HP + Furnace	10	$462	3.67	$126	$182
High Eff HP + Furnace	5	$481	3.73	$129	$351
High Eff HP - All Electric	-30	$602	3.85	$156	$961

As the table shows, the minimum incremental cost of heating occurs at a switchover temperature of 30 degrees. However, while this switchover temp is cost-optimal from a bill perspective, there are still relatively low cost GHG emissions savings available at lower switchover temperatures. In looking at Figure 2, after the blue arrow showing the lowest incremental cost of GHG savings for the minimum efficiency HP options, the next cost-optimal point (the one with the lowest incremental cost of GHG savings cost point) should be a cold climate heat pump running with a switchover temperature of 10 degrees. Incremental customer costs of GHG savings increase faster at higher levels of decarbonization. Because a relatively small change in heat pump customer operating economics can result in much higher GHG savings, a small policy intervention may be able to make a big difference in the greenhouses gases saved. Figure 3 has the same data shown as Figure 2, with two additional optimization surfaces drawn in.

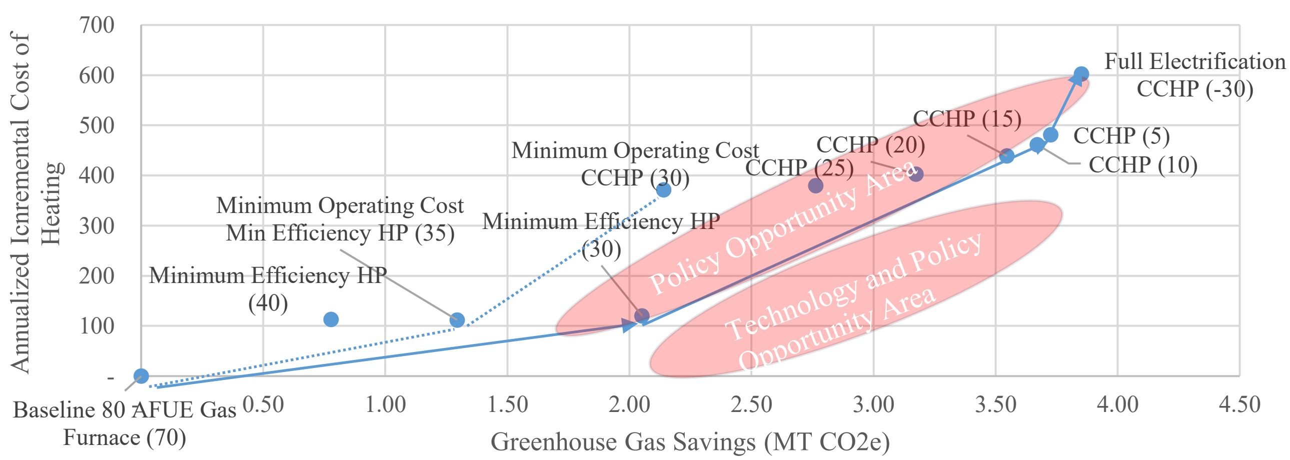

Figure 3. Annualized customer heat pump electrification cost vs GHG savings.

The dashed line represents the minimum customer costs of heating at increasing GHG savings, while the dark solid line shows the minimum cost of GHG savings. A relatively small policy nudge could save a large amount of GHG emissions between these two lines, within the area marked as "Policy Opportunity Area." The incremental operating cost per ton of GHG saved at any point is a function of the emissions savings and incremental operating cost increases at that point. It varies as a function of the equipment efficiency, emissions rates, and fuel and electricity cost. Anything that increases HP efficiency, reduces emissions rates of electricity, increases cost of fuel, or decreases electricity cost will cause a reduction in the operating cost increase per MT of CO2e saved. Furthermore, to reduce the cost of GHG emissions even more, new technology solutions are needed that fit into the area down and to the right from the existing minimum cost GHG savings curve. These solutions need to allow customer cost-effective usage of heat pumps at lower temperatures without having high incremental costs. The cold climate heat pump options used in the graphic are priced relatively aggressively compared to other costs in the literature, with an incremental cost over CAC of $6,600 for a 3-ton system.

Measuring the Cost and Emissions Gap

The analysis above represents the savings and costs for Colorado, but electrification economics vary greatly across the country. In Figure 4 below, states are divided into categories based on their full electrification of residential customer operating economics and statewide average costs of natural gas and electricity from EIA, with an assumed fixed charge by census region for natural gas and a single nationwide average fixed charge for electricity.

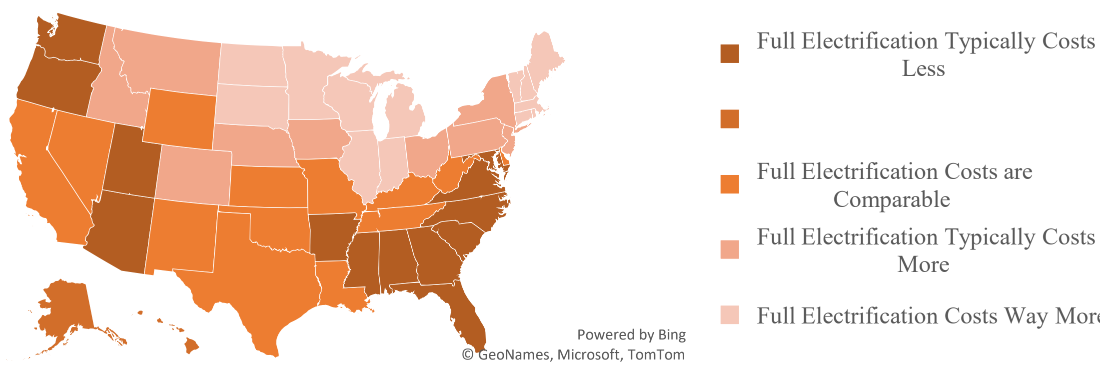

Figure 4. Full Electrification Heat Pump Residential Customer Economics by State Compared to Gas Furnaces

States where "full electrification typically costs less" show average full electrification costs lower than cost of heating with natural gas, even for minimum efficiency heat pumps compared to high efficiency (96 AFUE) furnaces. These states, that include most states in the southeast and a few in the west, do not have problems with heat pump customer economics, because of a combination of low electricity prices, high natural gas prices, and mild heating temperatures. These states also tend to have significant adoption of traditional (non-variable speed) heat pumps. States where "full electrification costs are comparable" (e.g., Texas, Nevada, Tennessee) show operating cost *savings* for high efficiency heat pumps compared to 80 AFUE furnaces but show operating cost *increases* for minimum efficiency heat pumps compared to 96 AFUE furnaces. Customer economics present some barriers for these states. In the remaining states (e.g. northeast and northern climate states), customer operating costs are higher with full electrification heat pumps with 80 AFUE gas furnaces. In some states (e.g., New England states, Illinois, Michigan), "full electrification costs way more" than heating with gas, with annual customer costs increasing by $400 or more relative to 80 AFUE gas furnace. There can be a large spread in heat pump economics within each state, based on different fuel costs, electricity cost, and climate across the state. When considering the results from the costs and benefits of decarbonization analysis in the prior section, the states where full electrification costs are comparable, typically cost more, or typically cost way more are where significant GHG savings can be achieved in the 'policy opportunity space' in Figure 3, by improving the customer operating economics and convincing them to use heat pumps more.

In general, heat pump economics are better in places with more mild climates and with electricity prices that are relatively low compared to natural gas prices. In more mild climates, the cost of heating with electricity is lower when holding electricity rates constant, because the heat pump operates more of the time during higher efficiency outdoor temperature conditions. In almost all climates, most residential space heating fuel consumption happens in conjunction with outdoor temperatures between 20- and 45-degrees F. If the switchover temperature is at 20 degrees or below, most of the heating will be electrified and most of the potential GHG savings from fuel switching from a gas furnace to a heat pump will be realized. If the switchover temperature is 45 degrees F or above, then the large majority of heating will not be electrified and most of the potential GHG savings will not be realized.[9] When the switchover temperature is set according to what is optimal for the customer bills instead of what is optimal for attaining cost-effective GHG savings for society, an emissions gap emerges between what saves the customer money and what saves GHGs cost-effectively. In Figure 5, each line represents the average relationship between residential customer annual energy bill savings per ton of CO2 saved and switchover temperature, for a given state.

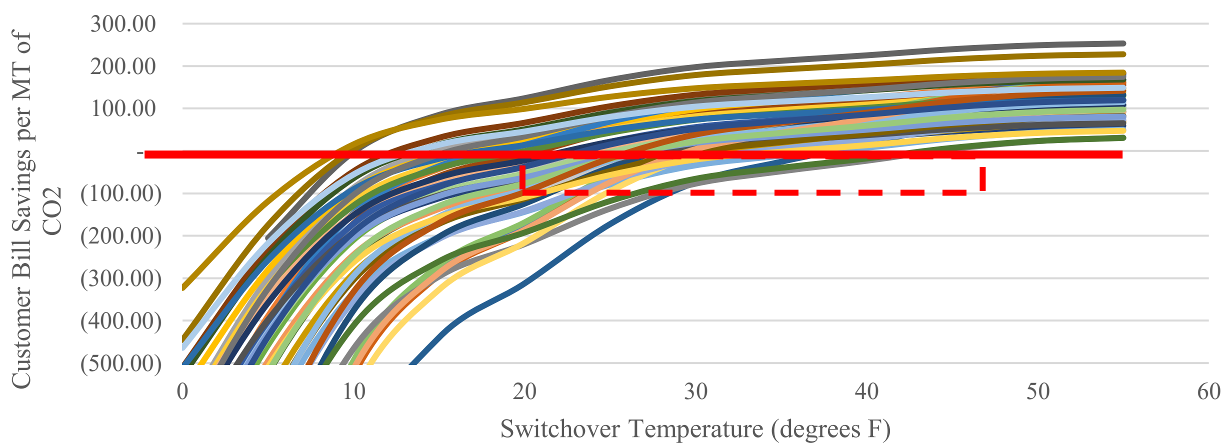

Figure 5. High efficiency heat pump vs 80 AFUE gas furnace operating cost savings per ton of GHG saved, medium emissions.

[9] In mild marine climates (like coastal California), most of the heating load may occur between 45 and 60 degrees, so this will not be true.

The point at which each line crosses the bold red line is the cost-optimal switchover temperature. When above the red line, bills are reduced. The scenario shown is for a high efficiency heat pump compared to a minimum efficiency furnace, with medium electricity GHG emissions. Other scenarios have similar characteristics. States with better heat pump operating economics are higher on the graph and people save money and carbon at the same time. In states that are lower on the graph, using heat pumps costs people more money. The red dashed box in the figure shows the area where interventions can be made most cost-effectively. If customers can be provided with additional operating incentives that implicitly match or exceed relatively modest GHG costs, then they can be incentivized to increase their use of the heat pump and increase their GHG savings, by continuing to operate their heat pump at a lower temperature, saving additional GHGs in the process. If this can be achieved, then the societal interests of increased carbon savings can be aligned with customer interest in saving money on their bills. For each of the cases with a switchover temperature above 10-20 degrees adding an implied operating incentive of \$50/ton CO2e would shift each line up by \$50/ton, which would move down the point at which the x-axis is crossed to a lower temperature, which would significantly increase the amount of GHGs saved while savings customers money on their bills, because much more of the heating load would be displaced.

Saving Greenhouse Gases by Closing the Cost Gap

The authors analyzed the GHG savings that are available in each state operating a hybrid or all-electric heat pump to maximize bill savings. This corresponds to running the heat pump at all temperatures above the red line in Figure 5 above. In states with better operating economics, this may cover all heating loads for some cases. The authors ran a sensitivity of 12 heat pump upgrades, each of a minimum efficiency and high efficiency cold climate heat pump compared to an 80 AFUE gas furnace or 96 AFUE gas furnace, for each of three electric emissions scenarios, high emissions, equivalent to a 100% gas-fired electric grid (0.46 MT/MWh), medium emissions (0.23 MT/MWh), equivalent to 50% zero emissions, 50% gas-fired, and low emissions (0 MT/MWh), equivalent to a zero emission grid. Figure 6 below shows the GHG savings associated with a high efficiency heat pump compared to a 80 AFUE Gas Furnace, for the high and medium electric emissions cases.

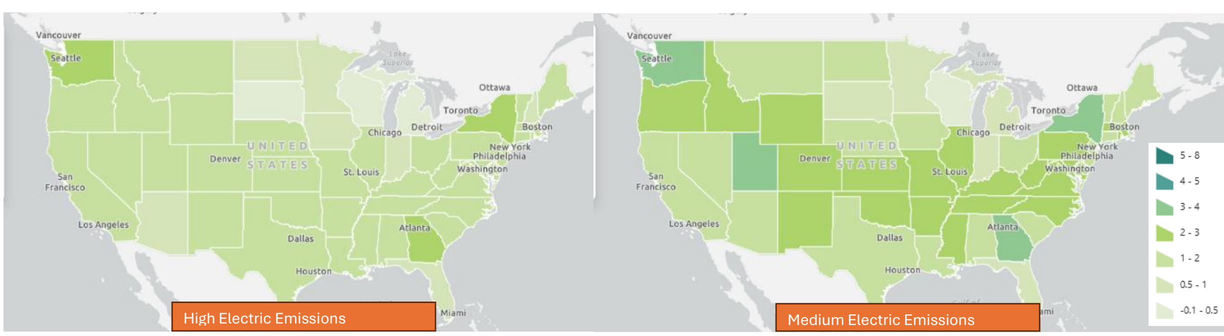

Figure 6. GHG Savings (MT) for High Efficiency Heat Pump vs 80 AFUE Gas Furnace with Max Bill Savings

In the case of high electric emissions, it’s difficult to save significant GHGs, with the highest states saving about 2.5 tons/household and most states saving 1 to 2 tons per household. In the medium emissions case, the heat pump saves more, with many states saving 2 tons per household. The low electric emissions case (not shown) continues this trend. In all cases of electric emissions, there are a handful of states (MI, SD WI), with especially poor heat pump economics and minimal GHG savings as a result. After running these scenarios, the authors explored adding an improvement to heat pump operating economics equivalent to $50/ton of carbon and $100/ton of carbon, simulating a generic policy/program incentive able to deliver this level of operating economics improvement. Figure 7 below shows the results of this analysis for the same high efficiency heat pump compared to 80 AFUE furnace. As the electric grid emission drop (down in rows) and the operating economic incentive paid increases from left to right, the increase in GHG savings associated with the heat pump goes up, especially in states with high heating loads and poor initial heat pump economics.

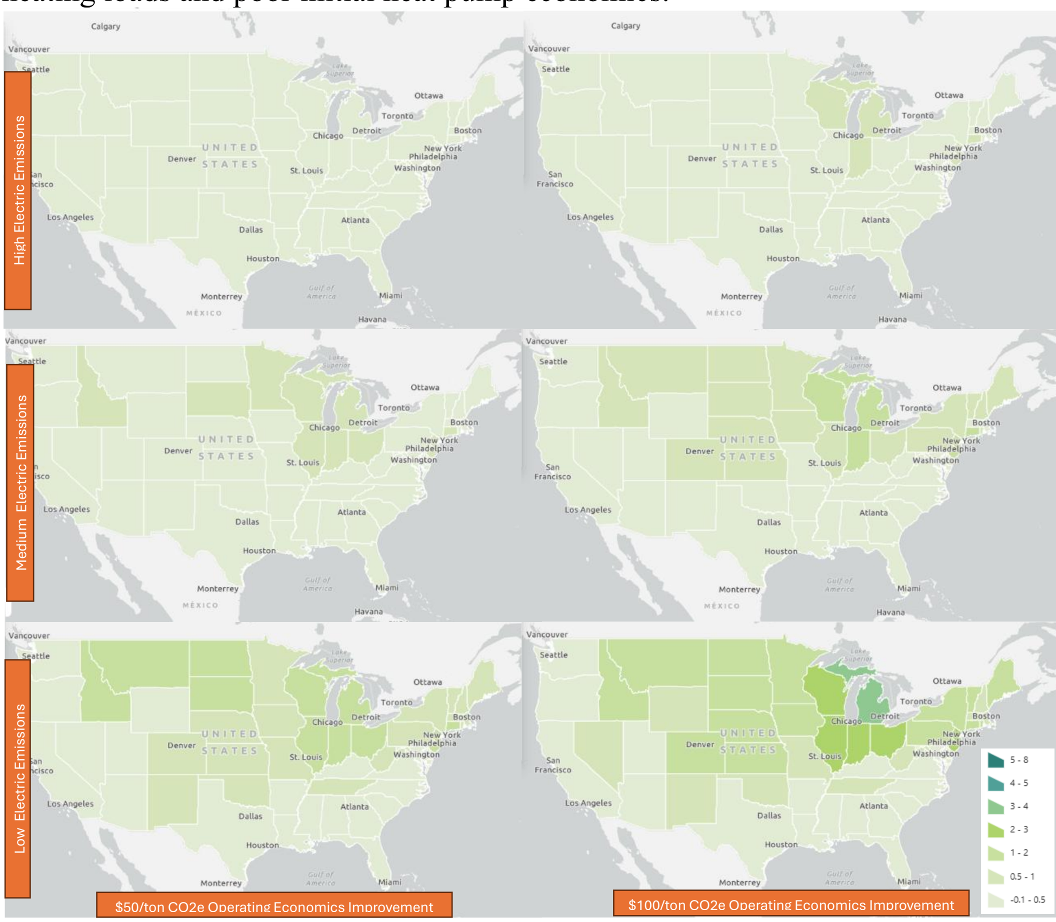

Figure 7. Increased GHG Savings Associated with Operating Economics Improvements

Closing the Cost Gap

As shown above, the varying circumstances of climate, energy costs and equipment operation impact the short- and long-term cost effectiveness of electrification. When assessing these results, themes and trends begin to reveal themselves, and categorization begins to emerge. We define and categorize these results as: Clear Wins, Cost-Prohibitive, and Transitional.

Clear Wins Without Intervention. In some parts of the country (e.g., southeast states), the value of electrification far outweighs both the short-term investment and long-term operating costs to residential ratepayers. As discussed above, these states tend to have mild climates and a low differential between electricity and gas prices in customer power rates. In these states, aggressive electrification programs should be pursued across all sectors and all income levels, regardless of rate design, bill subsidies or tailored program design without risk of higher long term operating costs[10]. It may be worth noting that these states tend to have fewer, or less advanced electrification policies, which could be a reason behind relatively lower electricity rates compared to other states. It may be possible that future analysis would share a wider rate differential as demand and load growth changes over time.

Cost-Prohibitive. Other parts of the country (e.g., North Dakota) hold a combination of circumstances where electrification increases costs and potentially becomes a significant cost burden on low-and-moderate income households, especially if no policies are in place to subsize or limit financial impacts. To promote full electrification programs to residential households without first implementing program, policy, or rate changes places vulnerable populations at risk and opens the industry and the pursuit of decarbonization to backlash and scrutiny. Hybrid electrification in these states may offer better options for the large swath of the market for whom operating costs are important in decision-making. For these states, it may be strategic to wait to electrify until key factors change (e.g. relative energy costs, equipment costs).

Transitional. For some states (e.g., Colorado, New York) the operating costs of electrification may be higher, but opportunities exist to mitigate and support households through the transition, including state or local policies, utility rate design, bill subsidies or other ongoing program support. For states under these conditions, or for states actively exploring significant program or policy changes in support of mitigating ongoing costs, a suite of options exists to lessen the financial burden on households. One, some, or all options can be explored and pursued. In many cases, utilizing a combination of options may result in compounding benefits and accelerated ability to reduce ongoing costs. As described in the next section, these options include programmatic design changes, regulatory changes in cost effectiveness methodology, and utility rate design reform. Each option has benefits and considerations and should be considered in the order they are presented (e.g. it may be more cost effective to optimize program offerings before providing bill subsidies).

Solution Options for Increases to Customer Bills

The risk of bill increases in certain states is significant and impactful to consumers and may put at risk the pace of the electrification transition across the country. There is also growing opinion across the country that the average household may not be willing to individually bear the cost of

[10] Assuming consistency in relative energy rates

decarbonization at rates once considered reasonable (Klein 2025). Fortunately, a broad mix of programmatic and policy solutions are possible and, in some states, already being pursued.

For any state where heating system electrification is not a 'clear win', moving forward with an electrification program without implementing at least one of the options below will likely result in bill increases for consumers. States, utilities, and policymakers should consider limiting full electrification policy offerings prior to identifying and implementing solutions that reduce the risk of increased bills. To move forward without appropriate guardrails leaves programs open to the risk of affordability backlash and locking consumers into a long-term commitment of higher energy bills. The following list of possible solutions may be considered.

Incentives for Hybrid Systems. The customer economics of hybrid gas and heat pump systems are frequently dramatically better than the customer economics of all-electric heating systems. As explained above, the customer economics and GHG savings both decline as the efficiency of the heat pump goes down. As a result, heat pumps frequently deliver cost savings at 30-40 degrees F, while delivering cost increases and smaller GHG savings (or negative GHG savings) at 0-10 degrees. Offering rebates for hybrid systems can provide support for households best economically suited to retain their original heating system for use during times when electric equipment would result in an increase in operating costs.

Weatherization First Requirement. The most effective and beneficial electrification sits on the foundation of energy efficiency, where reducing the overall need for energy through weatherization and air-sealing is a required prerequisite to become eligible for any electrification rebate. Many states have already adopted this approach, including the MASS Save Program where 'sufficient weatherization' must be demonstrated by meeting a set of criteria[11]. The Department of Energy, through the Home Energy Rebate Program, also recommended that states take a 'weatherization-first' approach when providing rebates for heat pump conversions to eligible households. Reducing the overall electric load provides an additional layer of mitigation against bill increases. When also prioritizing electrification for low-income households, additional programs (e.g., Weatherization Assistance Program) may be layered to provide additional funding. On the flip side, a weatherization-first requirement may slow or delay equipment installation and deter contractors from participating in programs as complexity in program requirements grow.

Bill Impacts Estimators and Consumer Awareness. Bill increases are generally assumed to be a deterrent to program participation and customer satisfaction; however, program participants may have different benefit and cost calculations within their decision making. For example, the value to the household of reducing their GHG footprint may far outweigh the potential increase in their bill. In other cases, consumers may value electrification but do not know the impact on their overall cost of energy. Retaining consumer choice may be an important consideration in program design, however, that choice should be made with education and awareness or the potential impacts of their decision. To avoid backlash and retain consumer trust, it is important and worthwhile for programs to provide timely and transparent information to consumers about potential changes to their bills. Providing households with a bill impact calculator or providing

[11] Air Source Heat Pumps | Residential | Mass Save

an estimate of bill impacts[12] based on their homes' historical energy usage, electricity rates, and home characteristics can provide a tool to the consumer to have additional knowledge of potential impacts, offering them the ability to conduct their own willingness-to-pay and benefit/cost assessment. Participants who knowingly accept the potential financial burden may be less likely to become unsatisfied with the implications of their decision.

Limiting Programs to Moderate Income and Above. The most conservative approach to avoiding bill increases for low-income households is to design a program that is only available to higher-income households. This program design shifts the financial burden to those who may be more able to afford the long-term operating cost burden. This approach may be ideal as an interim or temporary offering, provided only until other programmatic or policy mechanisms are in place to provide a barrier or subsidy to cost increases. While simple, this approach has multiple potential downsides, putting at odds the goals of serving low-income households and achieving decarbonization goals. First, prioritizing higher income levels allocates ratepayer dollars to the markets that traditionally receive a disproportionately large portion of energy efficiency program dollars. Next, this approach limits access to the funds provided by households that pay directly into these programs and removes customer choice.

Utility Bill and Rate Design Reform. Currently, perhaps the most discussed and recommended approach to address bill impacts of electrification is rate design reform and utility bill adjustments or discounts. These options can include changes to fixed and variable charges, on-bill discounts, seasonal discounts, and equipment-specific rates. Multiple studies and reports have been published in recent years, conducting bill analysis and providing recommendations to law and policymakers in support of changes to rate design (ACEEE 2024). While these studies all report that rate design reform is a critical component of affordable electrification, the studies also note the importance of integrating energy efficiency in offsetting cost increases. Often ignored in these reports is complexity and the time requirements to implement rate changes or introduce bill discounts. Most utilities require approval from regulators and must work through extensive public processes. An average rate setting process through a public utility commission takes about a year, not including the work within the utility that leads to the initial filing and review process. Rate changes and bill discounts offer immediate relief to those directly impacted by electric conversion, however, utilities are businesses and must still recover their fixed and variable costs and may shift the increased cost burden to non-participating ratepayers. On average across the United State, electricity rates have increased over 25% since 2019 (LBNL 2025). And while a variety of factors not related to bill subsidies contribute to these increases, mounting pressure on utilities slow rate increases leaves limited room for additional costs. Comprehensive analysis and long-term impacts should be considered, which can be available through methodologies like the RIM test, discussed below. This also supports the concept that the complex issue of addressing bill increases should be addressed through a multi-faceted approach[13], rather than through any single option described above.

Regulatory Changes to Cost-effectiveness Design. Sometimes included within this discussion of affordability is how benefits and costs of upgrades are calculated. Historically, the energy

[12] Bill impacts estimation often relies on several assumptions and may provide a broad range or estimate of cost impacts. If providing these tools, consumers may need to also understand that results are on average.

[13] Several other programmatic opportunities exist that were not discussed in this paper, including load shifting and load flexibility programs.

efficiency industry has relied on a total resource cost test, combined or supplemented with utility cost tests (ACEEE 2012). Not used as often are ratepayer impact measure (RIM) tests or non-participant tests. Recently, the industry has started moving towards a more expansive cost-effectiveness metric – total system benefits (TSB). The TSB focuses on setting energy efficiency goals that maximize long duration GHG reductions and grid benefits, transitioning away from setting goals based on savings of kilowatt-hours, kilowatts, and therms. The new "total system benefit" is an expression, in dollar value, of the lifecycle energy, capacity, and GHG benefits of a utility's energy efficiency program portfolio[14]. While the TSB allows programs to capture the additional value provided by decarbonization not captured in energy or demand savings, it only accounts for the first cost of decarbonization and does not account for the ongoing cost to ratepayers to maintain that value over time. This metric also ignores the economic impacts of future system needs or capacity constraints because of increased electric load, which may result in increased market purchases, long-term power contracts, or building of new capacity resources – which can increase power costs and rates. To capture these important additional considerations, states that use a TRC or TSB calculation should also consider applying an expanded[15] RIM and/or Utility Cost Test (UCT) to capture the economic impacts to rate payers and to the utility system. It should be noted that while these tests do not change the short- or long-term impact of electrification, it can be a useful tool in estimating and showing impacts across an array of program participants and non-participants. Given the economics as described above, it may be the case that RIM test results show that these programs are not cost effective. Rather than avoiding the RIM test because of this potential result, these findings may support policy makers in developing and executing programs in ways that produce cost effective results.

Conclusion

The transition to a carbon-free energy system is costly, regardless of the benefits it will accrue. And while this transition is urgent, questions arise about the burden that ratepayers are expected to bear to support this transition, particularly low-income households. Policy and program interventions that improve operating economics have the potential to significantly increase GHG savings from heat pumps operated to maximize customer bill savings. Recently, policy makers and advocates have homed in on changes to rate design and bill subsidies as the most cost-effective methods for mitigating bill increases. However, these pathways are complex and time-consuming, and not a one-size-fits-all solution. Other considerations should be made when addressing bill impacts, including a state's circumstances, existing program design, consumer education, and cost-effectiveness and resource constraints.

[14] CPUC Better Aligns Energy Efficiency Programs To Reduce GHG Emissions, Support Equity, and Increase Grid Stability

[15] In an expanded RIM or UCT, additional non-energy benefits (e.g. GHG) that accrue to the utility or non-participants are included in addition to traditional benefits and costs included in these tests.

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