Debunking the Myths of Hybrid Heat Pumps

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ABSTRACT

Building electrification (BE) has proven itself to be a critical pathway towards economywide decarbonization, through its reduction in greenhouse gas emissions and improvements in system efficiency. As heat pump adoption rises across the country, BE will pose new and unforeseen challenges including significant increases in peak demand, in addition to equity and affordability concerns regarding access to electrification and rising gas rates. One potential solution to these challenges is the use of “hybrid” heat pumps for retrofitting the existing building stock. This would entail pairing an all-electric heat pump with a building’s fuel-based heating equipment, to operate during the coldest hours of the year. This strategy has the potential to mitigate peak electric load impact, reduce upfront costs, alleviate customer bill effects, and ease equity concerns. Although hybrid heat pumps have become somewhat of a taboo topic amongst environmental advocates, this presentation aims to debunk the myths around this technology and provide an in-depth evaluation of their role in achieving long-term decarbonization goals. This study will compare the performance of hybrid heat pumps for a variety of building typologies in different climate zones to that of their counterpart technologies, including standard heat pumps, cold-climate heat pumps, and gas furnaces. Metrics of upfront cost, peak electric load, utility bills, gas rates, and emissions will be compared. Additionally, this study will provide insight into the performance impact of different hybrid heat pump configurations, including design parameters such as heat pump cutoff temperature and heat pump/backup system shared load percentage.

Introduction

BE has proven to be a critical pathway towards achieving GHG reduction goals. The most significant energy demand in buildings is for space heating, which can be electrified using heat pumps. Generally, heat pumps can be retrofitted to provide space heat for residential buildings more simply than for commercial buildings, due to the wide heterogeneity of heating distribution systems and building structures that exist in the commercial sector. Heat pumps are usually very efficient, since they can transfer more heat energy from outdoor air to indoor air than they consume in electricity. When combined with low carbon electricity generation, this presents a meaningful pathway to greenhouse gas emission reductions.

Hybrid heating (HH) is a form of electrification that pairs an electric heat pump with fuel-based heating equipment. Since a heat pump’s efficiency and heating capacity decline at lower temperatures, a fueled backup system meets peak heating needs during the coldest hours of the year. HH is an alternative to backup electric resistance heating, which can substantially increase peak electric loads in cold weather.

HH has many advantages relative to all-electric alternatives for many use cases. However, it remains a controversial technology among some advocates of electrification who argue for a full electrification approach. Using the findings of several studies conducted by Energy and Environmental Economics (E3), we review the benefits and challenges of hybrid electrification and argue that in some situations, HH has the potential to achieve substantial decarbonization faster and more economically than an all-electric approach. Much like how plug-in hybrid vehicle sales have not hampered the battery electric vehicle sales trajectory, we see HH as complementary to all-electric heat pump installations. We also review the cases where we have found HH to be more or less likely to be a suitable solution relative to full electrification.

Methods

E3 has studied the implications of various building decarbonization pathways in a variety of regions. Two models used extensively in these analyses are E3's BE-Toolkit and RESHAPE model. More detailed methods for each project can be found in the referenced project reports.

BE-Toolkit is a suite of tools that E3 has developed to characterize building stocks and produce corresponding aggregated end-use load profiles, perform benefit cost analyses of end-use technology switching, and forecast equipment adoption. E3's BE-Toolkit extensively utilizes NREL's ResStock and ComStock databases to create energy end-use load shapes of many modeled buildings across the building stock.

RESHAPE simulates heating demands and heat pump operations for a variety of building typologies across the residential and commercial building subsectors. Individual building typologies are gathered from RECS and CBECS survey data from the EIA. Using 40 years of weather data from the National Oceanic and Atmospheric Administration North American Reanalysis dataset and heat pump performance curves, RESHAPE predicts heating loads for regions of interest at an hourly resolution. The counterfactual gas demand of building typologies currently heated by gas is benchmarked against monthly residential and commercial natural gas sales to ensure consistency.

Benefits of Hybrid Heating

HH has numerous advantages when properly implemented at scale. Hybrid systems reduce greenhouse gas emissions compared to status quo systems and significantly reduce electric peak capacity requirements compared to all-electric systems. They also can be less expensive and less complex to install for households than all-electric systems and are generally cheaper to operate than all-electric system in cold-climates. Lastly, retaining large shares of hybrid systems could prevent gas utility "death spirals" and the associated equity concerns for remaining customers, who are most likely to be low-income.

Reduced Greenhouse Gas Emissions

Hybrid heat pumps can enable substantial emission reductions compared to status quo heating systems. As shown in Figure 1, E3 analyses in Seattle, New York City, and Minneapolis show that hybrids achieve 40% to 90% of the emission savings in 2035 compared to all-electric options, when considering upstream emissions from electric generation (E3 2022a, E3 2023b, E3 2021). These reductions vary primarily with the installation climate, renewable penetration of regional electric grids, and hybrid cutoff temperatures. Given the challenges in many buildings to fully electrify, the emission reductions achievable with hybrids could represent a substantial contribution to meeting emission reduction goals.

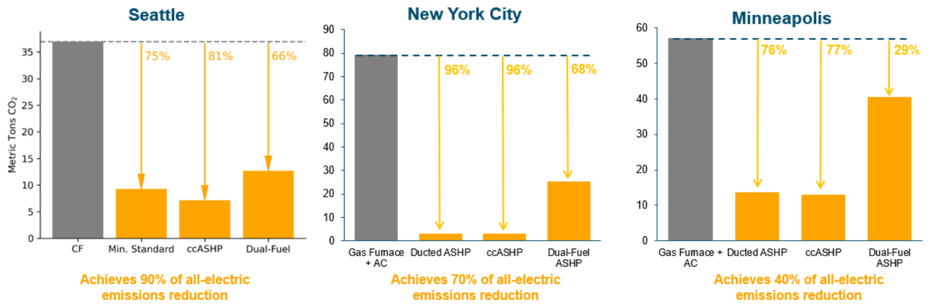

Figure 1. Emission reductions of heat pump installation types compared to status quo heating systems. Hybrid heat pumps create substantial emission reductions relative to status quo heating equipment. *Sources*: E3 2022a, E3 2023b, E3 2021.

Lower Peak Electric Load Impacts

A significant challenge of decarbonizing building heat with all-electric heat pumps is the increase in electric system peak loads, which would require increasing the capacity of the electric system at all levels. Further, the marginal generator that meets peak demand is typically fossil generation. This is true in heating-dominated climates, where heat pump loads are coincident with the electric system peak (Figure 2). There are two components to this increase in peak demand. The first is fuel switching from fossil fuels to electricity. The second is that heat pump efficiency and capacity decline at lower temperatures, as heating service demands increase. Electric resistance is often required at design low temperatures to meet the heating demand. This causes a non-linear increase in electric load as temperatures decline.

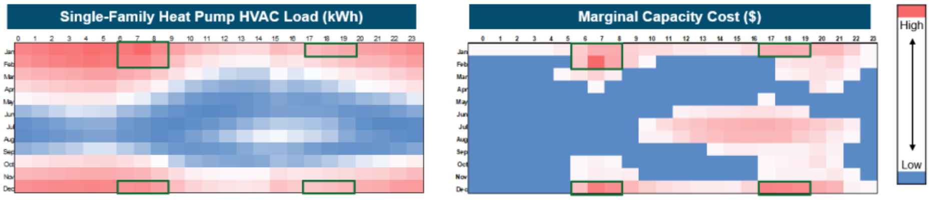

Figure 2. Example load shape analysis from Washington State fuel conversion study. *Source*: E3 2022a.

Since HH pumps switch to backup fuel during the coldest periods of the year, this substantially reduces the electric system capacity required to meet peak heating demands, which could often be met with fossil generation anyway. Peak electric capacity is the primary driver of costs on the electric transmission and distribution systems and will increasingly drive costs on the generation system as fueled generators supply less of the annual generation mix. Therefore, mitigating significant increases in electric system capacity can substantially reduce the cost of building decarbonization.

For example, E3 estimates that the 1-in-10 electric peak load would increase by approximately 60% in Washington State if buildings were converted to standard efficiency heat pumps (Figure 3, E3 2022a). A 1-in-10 electric peak refers to the peak demand that is statistically expected to be reached 1 in every 10 years, largely based on weather events, and is the design reliability standard for electric grid supply. Peak load increases from best-in-class heat pumps are a more modest 22% but remains higher than the 14% increase from HH. In other jurisdictions, the difference in peak load between even best-in-class all-electric heat pumps and hybrid heat pumps can be even higher, with hybrids reducing 1-in-10 electric peaks by 60% in Nova Scotia (E3 2023a).

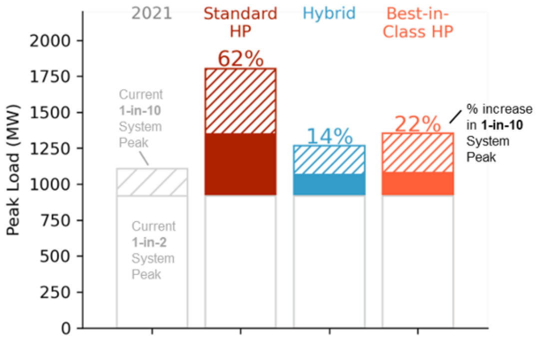

Figure 3. Change in electric system peak loads by heat pump installation type for Washington. *Source:* E3 2022a.

Figure 4 shows how a hybrid gas-electric heating future would lead to lower winter peak electric loads in Minnesota.

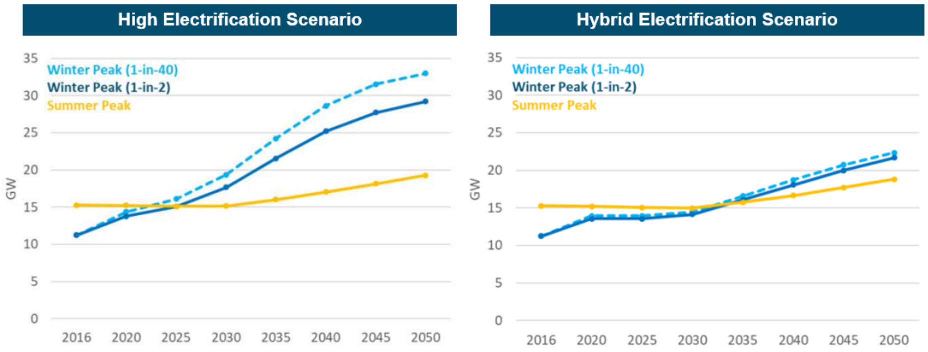

Figure 4. Modelling Electric Load Impacts of Hybrid Electrification in Minnesota. With a gas backup system that meets the heating load during the coldest hours, the impact on the electric grid can be mitigated. *Source:* E3 2021.

Electric grid emissions also tend to be higher during peak load hours due to a greater reliance on fossil fuel generators for capacity, decreasing (and in some cases negating) the emissions benefits of full electrification. Relative to an 80% backup gas furnace, an all-electric heat pump would need to operate above a coefficient of performance (COP) of 2.0 to exceed the efficiency (and result in lower emissions) if the marginal electric generator is a 40% efficient gas peaking generator. Further, relative to a newer gas furnace with an efficiency of 90% or above, the COP would need to be even higher. At design low temperatures, this threshold would not be met for many all-electric heat pump installations.

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Reduce Installation Complexity and Costs

In some circumstances, HH pump installations can be lower cost than cold-climate heat pump installations, which could enable faster electric heating adoption in cold-climates. HH allows the customer to purchase a less efficient but cheaper heat pump, with a lower capacity that is not sized to meet the entire heating load, since the existing fueled heating equipment would meet the peak heating demand (Figure 5). This is particularly true when the existing fueled heating equipment can remain in place as backup heat. Further, hybrid heat pumps can be cost-competitive with combined costs of a new furnace and air conditioner units, a configuration that many heat pumps would replace. Malinowski et al. (2020) have proposed incentivizing heat pump replacements of AC units to encourage hybrid configurations as the fastest path to electrification. As consumers tend to be more price sensitive to upfront costs than to operating costs, these lower costs could in theory allow faster adoption of HH heat pumps than all-electric pumps. This faster adoption could enable greater or equal emission reductions across the building stock despite all-electric installations having greater emission reductions for an individual building.

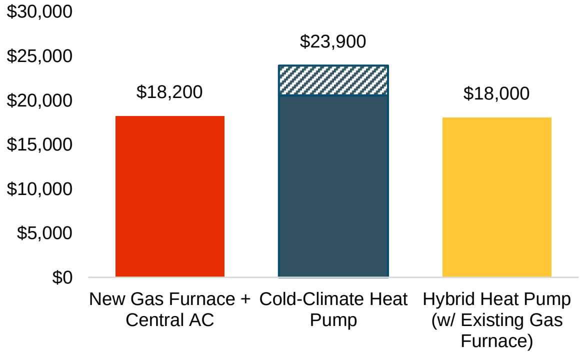

Figure 5. Installation costs for HVAC equipment for retrofits in Minnesota. Hatching represents electric panel upgrade costs. *Source:* E3 2021.

HH pumps can offer other upfront cost savings in addition to the heat pump equipment cost. A smaller heat pump in a hybrid configuration is less likely to require electric panel and service upgrades than all-electric options with electric resistance backup. The additional cost and time associated with panel and service upgrades can be prohibitive for many customers. This is especially true given that 85% of heating equipment replacements are emergencies when the existing equipment fails (Malinowski et al. 2022). In these situations, replacements must be made within hours or days, while panel upgrades can take days or weeks, and service upgrades can take weeks or months. Unless a home is made fully electric ready before their existing heating equipment fails, HH pumps could be the only available electrification option that does not lead to installation of status quo equipment types.

Further, in the short-term, workforce training for heat pump installation is a major issue, as heating equipment installers must rapidly transition to a completely different technology to meet state-level deployment targets. Installing all-electric heat pumps could initially present a reputational and financial risk as the workforce transitions, as poor installations will result in bad reviews and callbacks. Therefore, a hybrid heat pump approach could allow for heating installers to gain heat pump installation training alongside existing technologies and could result in higher heat pump sales in the short-term.

Alleviate Bill Impacts

HH can reduce customer bills compared to full electrification. For commercial customers, Figure 6 shows that hybrid heat pumps substantially reduce costs compared to all-electric options by significantly reducing the demand charge. Since most residential customer rate design does not include demand charges, residential customers tend not to realize the system benefits of reduced electric peaks, as further discussed in future sections. For residential customers to benefit from a hybrid solution with today's rates, only those in regions with low natural gas, fuel oil, or propane rates and relatively higher electric rates would see bill reductions (Figure 7). One specific case of residential customers seeing benefits from a hybrid solution are multifamily tenants in building with central heating and hot water that is provided by the landlord. If these customers are responsible for their electric bills post-electrification, the heating and hot water bills would shift from landlord to tenant, thus making a hybrid solution significantly cheaper for those customers, mitigating the shift of costs.

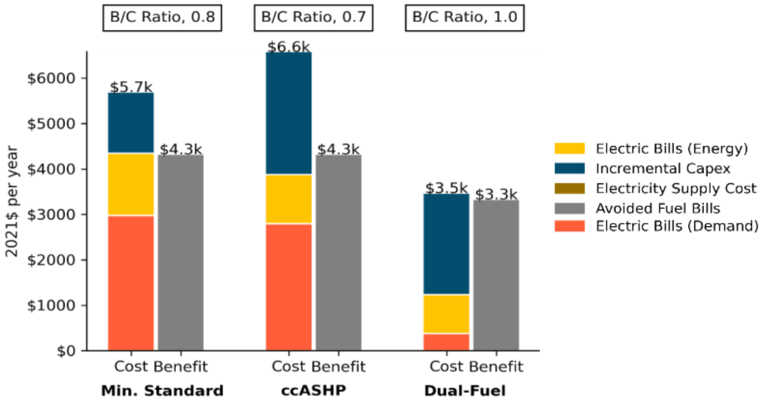

Figure 6. Benefit cost calculations for electrification for minimum standard efficiency all-electric heat pumps, all-electric cold-climate heat pumps, and hybrid (dual-fuel) heat pumps in Washington State. *Source:* E3 2022a.

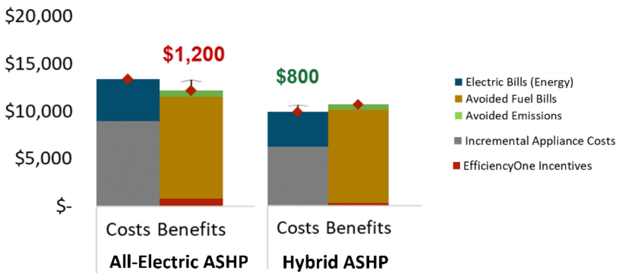

Figure 7. Benefit cost calculations for all-electric and hybrid electrification compared to status quo energy systems in Nova Scotia. *Source:* E3 2023a.

Prevent Gas Utility "Death Spiral" and Associated Equity Concerns

Full electrification of buildings would cause a gas utility "death spiral", which can be alleviated if a large share of customers adopt HH pumps. Much of the costs of gas infrastructure are fixed, and do not change regardless of how many customers there are. A utility "death spiral" occurs when many customers leave the system, forcing a declining base of remaining customers left to pay for a system built to serve a much higher number of customers. This forces the payments of remaining customers to increase substantially to cover system costs, raising concerns of distributional equity. This will be particularly pernicious unless a targeted electrification approach is taken since the full gas system would have to remain in operation. Since heat pumps currently cost more than gas furnaces to install, it's likely that people with low incomes would be the most likely to be saddled with these high gas rates, adding to the energy poverty burden.

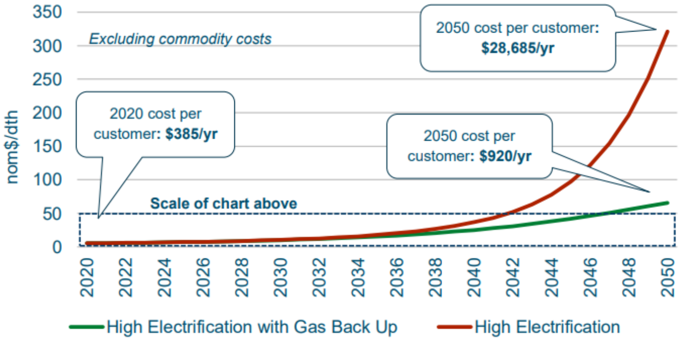

Figure 8. Gas delivery rates under hybrid and all-electric heat pump scenarios. Gas rates remain much lower under the hybrid heat pump scenario. *Source*: E3 2022a.

Since HH pumps require a connection to the gas system to be maintained, system costs would remain spread out across a larger number of customers, even as gas consumption declines significantly (Figure 8). In hybrid scenarios, the delivery rate per unit of gas still increases significantly from status quo (though much less than under full electrification scenarios), pointing towards potential for gas rate reforms.

Reduced Societal Costs of Building Decarbonization

E3 analyses show that HH could be the lowest societal cost approach to building heat decarbonization (Figure 9). This includes costs for households, the gas system, the electric system, and low carbon fuel for remaining hybrid gas use. This finding is also robust to the input sensitivities assessed; not only does the HH scenario have the lowest costs across all scenarios with optimistic cost assumptions, but it also has the lowest cost under conservative cost assumptions as well. While there are considerable uncertainties about future costs in all scenarios, as indicated by the substantial overlap in costs, HHn remains the low regret technological pathway to building heat decarbonization.

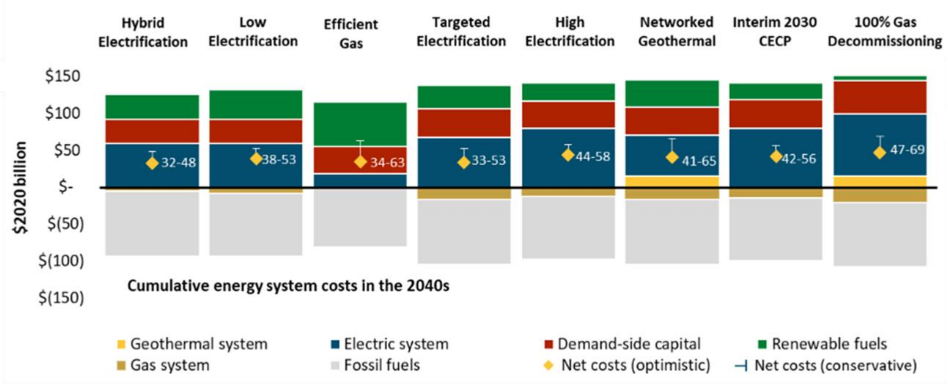

Figure 9. Massachusetts cumulative energy system costs in 2040s under eight technological pathways. The Hybrid Electrification scenario was found to have the lowest optimistic and conservative net system costs. *Source:* E3 2022b.

Challenges and Uncertainties with Hybrid Heating

Despite its many advantages, there remain many challenges and uncertainties associated with widespread deployment of HH pumps. In addition, in some situations other approaches may be more appropriate.

All-Electric Options Particularly Cost-Effective for New Construction

HH pumps may have limited applicability for new construction, as the cost-effectiveness of all-electric options is much higher compared to retrofits. In new construction, all-electric options avoid gas connection costs, and the electrical system and HVAC ducting can be right-sized initially for the all-electric heat pumps. New construction also typically has a tighter building shell than older buildings, with less air leakage and more insulation, which allows for smaller heat pumps and less peak electric demand impact. Therefore, the use of hybrid heat pumps could be largely limited to retrofit applications (E3 2022a).

Full Decarbonization Through HH Relies on Speculative Renewable Fuels

While HH pumps already achieve significant emission reductions, some emissions remain if using fossil fuels during peak heating periods (Figure 1). To achieve full decarbonization requires a significant ramp up of low carbon fuels like renewable natural gas (RNG) or biodiesel (Figure 10). The feasibility and costs associated with producing these fuels at scale are still speculative (Figure 11), though the industry is currently expanding rapidly (EPA Landfill Methane Outreach Program 2022). In addition, emissions associated with RNG can still be substantial, and more work will be needed to lower emission along the gas fuel supply chain (Grubert 2020). On the other hand, full decarbonization of all-electric heat pumps requires substantial increases in low carbon electric generation capacity to meet electric demands during the coldest days of the year. It remains unclear which challenge will be easier to solve as technologies and business models evolve over the next decades, potentially justifying a diversified approach.

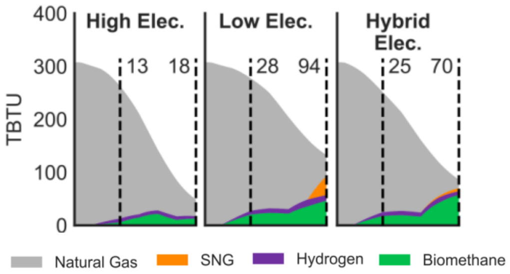

Figure 10. Gaseous fuel composition in Massachusetts in three scenarios. Hybrid electrification requires significant expansion of the low carbon fuel supply chain. *Source:* Energy and Environmental Economics 2022b.

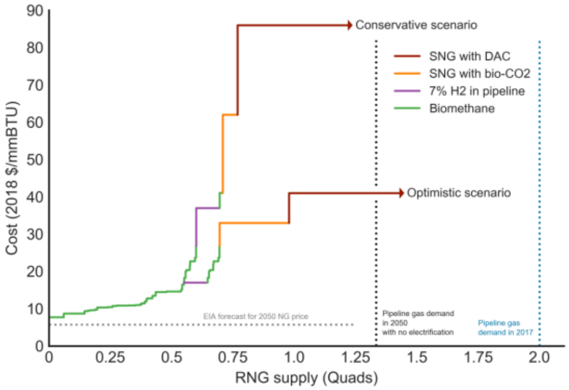

Figure 11. Renewable natural gas supply curve in California. This does not include competition for feedstock from other sources (e.g. transportation fuels). *Source:* E3 2019.

Uncertainty of Optimal Cutoff Temperatures

A common HH system control scheme is to switch from the heat pump to the backup fuel heater at an outdoor cutoff temperature setpoint. There is little data available to determine what these setpoints are across the current hybrid heat pump stock, and what method was used to determine this setpoint. Further, there remain questions as to what the right method is to determine the “optimal” cutoff temperature. Cutoff temperature selection is important as lower temperatures lead to higher avoided annual natural gas consumption but also higher peak electric loads.

Anecdotally, there are reports that installation contractors are often setting cutoff temperatures at or above freezing. As shown in Figure 12, in cold climates much of the emissions reduction potential of HH pumps would not be realized at these high cutoff temperatures. This practice may be related to poor past experiences of heat pump performance by some contractors in cold weather, and the contractors’ own incentive to avoid callbacks to troubleshoot. Given improvements in heat pump technology performance, even for less expensive models, contractor education will be essential to realize the environmental benefits of HH.

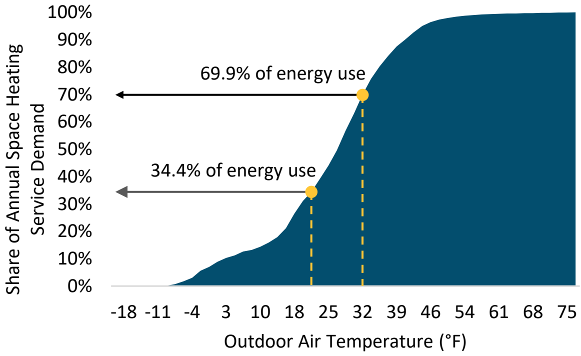

Figure 12. Proportion of annual space heating service demand below a given outdoor air temperature for in Denver. *Source:* E3 et al. 2021.

Determining the right temperature setpoint depends on the perspective of the decision-maker. A household economic decision framework would mean setting the cutover temperature such that the heat pump COP at that temperature is equal to the fueled backup efficiency times the ratio of the electric rate to the fuel cost (Figure 13). However, this may not be the economically optimal setpoint from a societal view, since electric rates and fuel prices (gas rates in particular) typically don’t reflect the marginal system cost of providing energy in colder times of the year. As the marginal cost of providing energy during periods of high demand is much higher than the annual average cost, changes to rate design would be required to align consumer incentives with system-level cost-effectiveness. Further, individual consumers may value additional carbon emission reductions highly, which could lead them to reduce the temperature setpoint beyond their individual financial incentives.

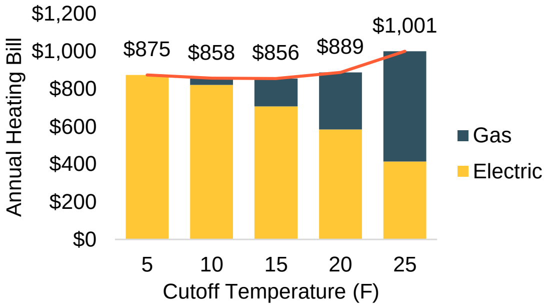

Figure 13. Example cutoff temperature analysis for single-family residential home in New York City. The electric section represents a variable speed heat pump, and the gas section represents a gas furnace backup system. *Source:* E3 2023b.

Interoperability Concerns

Another major practical challenge in deploying hybrid heat pump systems is ensuring that a dwelling's existing legacy heating device effectively works in tandem with the newly installed heat pump. A fully interoperable hybrid system relies on integration of both the primary and backup heating technologies into one software-controlled system, controlled by a single thermostat. In this case, the backup heating device would be called upon to share the heating load with the heat pump below an optimal cut-off temperature. This cut-off temperature would be automatically calculated based on heat pump capacity limits, cost, and/or emissions parameters, as discussed in the previous section. In situations where the backup heating device and heat pump cannot run simultaneously to share load, and must instead switch to the backup system entirely, there is lost potential for emissions reductions. If controls of the heat pump and backup heating system are not integrated at all, forcing heat pumps and fueled equipment to compete to meet the heating load, the fueled heating system would run significantly more often, and the benefits of electrified heating would effectively be lost. Figure 14 shows three different cases of heating device interoperability modeled for a typical single-family residence in New York City.

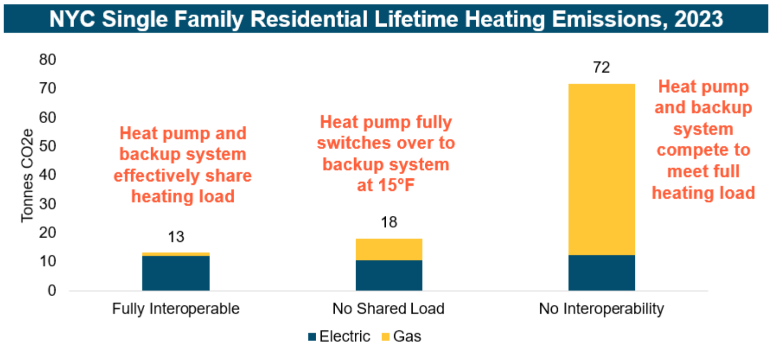

Figure 14. Example interoperability analysis for single-family residential home in New York City. *Source:* E3 2023b.

Limited Incentive Access for Hybrid Heating

Some regions limit access to incentives for HH electrification, such as offering fewer incentive dollars for a heat pump that only covers partial load versus a home's full load. For example, the New York State (NYS) Clean Heat Program previously provided lower incentive amounts for partial load cold climate heat pumps than full load cold climate heat pumps; the impacts are seen below in Figure 15. In some cases, incentives for partial load heat pumps are unavailable altogether. NYS Clean Heat recently discontinued incentives for partial load heat pumps for several utilities, including National Grid and New York State Electric & Gas (NYSERDA 2023).

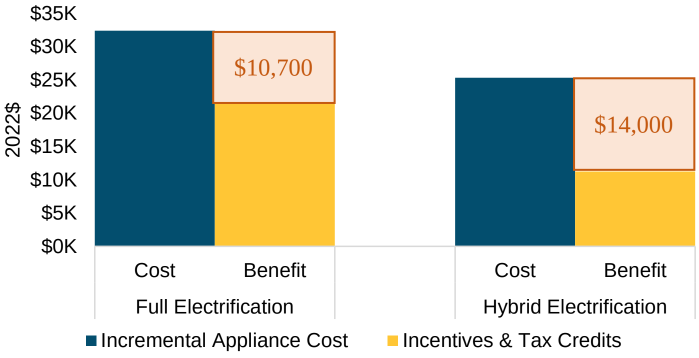

Figure 15. Cost and benefits of full and hybrid electrification. Due to ineligibility for incentives, the cost gap is larger for hybrid heat pumps. *Source:* E3 2023b.

Hybrid Heating Requires Gas Infrastructure to be Maintained

Another major challenge for large-scale deployment of HH pumps is the need to maintain the extensive natural gas distribution system decades into the future. The need to maintain natural gas connections to dwellings while their actual gas consumption decreases poses a financial problem for gas utilities and ratepayers. As heat pumps shift most of the heating load from the gas system to the electric system, gas utility revenues decline, putting upwards pressure on rates to meet capital maintenance requirements. These costs are significant – typically a large portion of gas utility spending is on distribution and transmission system maintenance, such as replacing high-risk leak-prone pipes. Costs per mile of pipeline mains replacement vary but is generally between 1 to 5 million dollars per mile of main (US DOE 2017).

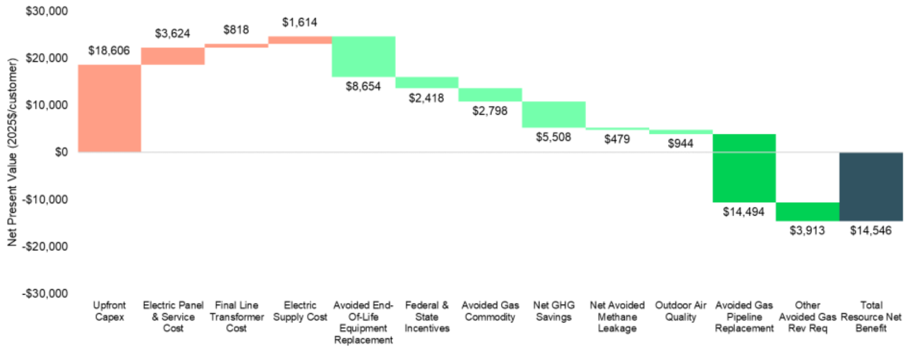

Figure 16. Total Resource Cost test for CEC pilot study. The inclusion of avoided gas pipeline replacement makes targeted electrification economically viable. *Source:* E3 2023c.

One possible solution to this problem is targeted electrification paired with gas decommissioning, also known as zonal electrification with avoided pipeline replacement. Under this strategy, gas and electric utilities would coordinate to electrify entire areas served by the same gas mains, in order to completely phase out gas service to these customers. Benefit-cost analyses can be performed to identify which sections of a given utility service territory would be most economically efficient and hydraulically feasible to electrify. Based on recent work in California, it has been demonstrated that full electrification at this scale can be cost-effective when considering avoided gas pipeline replacements (E3 2023c). Therefore, in certain jurisdictions, targeted electrification may be a more cost-effective solution than maintaining the gas grid and deploying HH pump systems. However, practical challenges in implementing targeted electrification, including the legal “obligation to serve” for utilities and the requirement of 100% customer buy-in, will need to be addressed to make this solution viable going forward.

Where and When Does Hybrid Heating Make Sense?

The challenges described in the previous section beg the question: how heavily should HH be used in the industry’s efforts to decarbonize heating and meet corresponding sectoral short- and long-term climate commitments? There are four key factors that must be considered to answer this question for a given jurisdiction: regional climate, electric grid carbon intensity, interplay between customer gas and electric rates, and condition of the existing gas distribution system and housing stock.

The heating degree days and corresponding heating load requirement for a jurisdiction is the largest determinant of the feasibility and economics of hybrid heat pumps. In colder regions where design days dip well below freezing, the backup gas unit within a HH system can help electric ratepayers avoid incurring extremely high costs of generation capacity to meet peak loads on the coldest days and hours of the year. On the other hand, regions with milder temperatures generally do not benefit as much from the hybrid approach.

In regions with electric grids that already have low emissions, such as Quebec or British Columbia, HH pumps provide less of an emissions benefit than full electrification. These regions tend to have a large amount of clean, firm resources, such as hydro-electric reservoirs, which result in lower emissions on peak days. With mass adoption of HH, hybrids may still provide substantial cost savings where existing low carbon firm capacity resources cannot be scaled up substantially (i.e. issues constructing new hydro or nuclear generators).

Jurisdictions with cheaper gas relative to electricity are also better candidates for HH pump systems, since customers will face lower net bills. This is especially true for commercial customers that have electric demand charges – under an all-electric heating system they will incur very high charges on the coldest days of the year. Conversely, customers that have high gas rates relative to electric rates will benefit less from hybrid heat pumps.

Finally, the condition of both the housing stock and natural gas distribution system affect whether HH makes sense in a given jurisdiction. For new construction and regions that have a generally new housing stock, all-electric appliances have an advantage over dual-fuel, because new dwellings generally have much better thermal envelopes and therefore much lower peak heating requirements than older dwellings. In a similar vein, gas systems that have a higher portion of very old and more leak-prone pipelines are less suitable for HH, since costs for maintaining service will be very high. These areas are more suitable for targeted electrification and all-electric heat pumps.

Considerations for Hybrid Heating to Succeed

There are a number of barriers to the success of HH that are currently curbing the potential benefits associated with a hybrid electrification future.

As discussed in a prior section, current interoperability issues must be resolved, so that at a minimum, heat pumps and backup fueled equipment can seamlessly switch operation at a set switchover temperature. Preferably, the equipment would communicate with each other so that the fueled equipment supplements rather than replaces the heat pump below this point. Heating equipment manufacturers will need to ensure control equipment is compatible with a variety of third-party devices for this to be achieved and may need to cooperate with control device manufacturers to ensure alignment with the communication protocols of legacy equipment. Going forward, another promising pathway is offering more integrated hybrid equipment options, where both the indoor heat pump and new backup fueled equipment are physically combined. Integrated equipment can ensure control interoperability and could possibly reduce capital costs significantly, if the package can share devices including controls and air handling.

Utilities and regulators will also need to design gas and electric rates that create customer financial incentives that align with system cost incurrence. Most importantly, this would charge capacity costs to customers, particularly residential customers, based on their peak demands rather than almost entirely through volumetric rates. In addition, gas system cost recovery will need to be addressed so that it remains viable as gas throughput declines but peak gas deliveries remain high (E3 2022b).

System planners will also need to determine the optimal cutoff temperature to transition from the heat pump to the backup heater. Planners should consider both cost and emission implications of this temperature, which may vary for different building types and climates. These considerations will need to be extensively communicated to installation contractors to ensure they are appropriately set in building controls. Aligning customer financial incentives with system level incentives, as discussed prior, will likely be a necessary precondition to ensure installation contractors follow these recommendations.

Lastly, policy makers and regulators will need to create sound policies and programs that appropriately enable all forms of electrification. These would consider the electric grid impacts, emission reductions, and potential for avoided gas infrastructure costs. When considering the above factors, HH should have access to similar, though not necessarily identical, incentives as all-electric alternatives.

Conclusion

To conclude, HH pump systems present an opportunity to decarbonize heating load in a relatively cost-effective manner for customers, while reducing the future burden on the electric grid of very high peaking events during the coldest hours of the year. While deploying hybrid heat pumps will come with real challenges, such as interoperability concerns, lack of incentives, uncertain cut-off temperatures, and extended maintenance of gas system, not pursuing hybrid heat pump policy could risk missing out on significant system-level benefits. Through various studies for utilities in jurisdictions across the US and Canada, E3 has shown that HH pumps have the potential to lower bill impacts for customers, reduce installation costs in cold climates and alleviate electric grid peak load.

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