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Charting Space Heating Futures: Toward a Blend of Electrification and Renewable Gas

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Key messages

- Full electrification of residential space heating by 2050 substantially increases electrical grid capacity requirements.
- Hybrid heating systems that switch from electric to gas heat during cold weather events reduce peak electricity demand.
- Hybrid heating systems using renewable gas avoid grid infrastructure expansion while meeting emissions limits.

Importance: Space heating electrification in cold climate regions may drive non-linear electricity demand increases

Electric heat pumps are considered a key solution for decarbonizing space heating. However, their performance decreases during colder weather offsetting efficiency gains relative to traditional electric resistance heaters. This reduced efficiency can lead to non-linear increases in electricity demand during cold snaps (White et al., 2021). Hybrid heating systems – where a heat pump is backed-up with a gas furnace – switch from electric to gas heating during cold temperature events. These systems have the potential to reduce peak electric loads while, at the same time, significantly reducing annual fossil fuel demand for residential space heating and associated emissions (Smillie et al., 2024). This Brief presents an overview of our recent study on residential space heating decarbonization, where heating demand is served by either electric heat pumps or hybrid heating systems. We examine how these technologies may impact system infrastructure, energy demands and emissions.

In this study, we generate electricity demand profiles for residential space heat with varying heating technology mixes using 20 years of historical ambient temperature data for four regions in British Columbia (BC) (Knittel et al., 2024). In projecting heating demands we account for increases in building area and assume envelope improvements aligning with the BC STEP code for all new buildings and renovated stock. Two scenarios are modelled: (1) an *Electric Heat* Scenario which assumes 76% of residential space heat demand is served by high efficiency air-source heat pumps (ASHP) while the remaining 24% is served by baseboard heaters; and, (2) a *Hybrid Heat* scenario where 60% of residential space heat demand is served by hybrid heating systems, 24% by baseboard heaters, and 16% by ASHPs. Hybrid heating systems switch from heat pump mode to gas furnace mode at a defined temperature switch-over point (TSP). To examine the effect of TSP in the *Hybrid Heat* scenario, six potential TSP are examined, ranging from -6°C to +4°C, in 2°C increments. Our analysis considers capacity and energy requirements for each scenario. For the *Hybrid Heat* scenario, we determine the volumes of renewable gas (RG - gas mixes meeting a carbon intensity limit of 30.8 gCO_2eq/MJ) needed to meet hybrid fuel demands for each TSP.

Findings: Hybrid heating systems reduce demands on the electricity system during high stress periods

Figure 1 summarizes regional peak electricity demand for the *Electric Heat* scenario and two TSPs in the *Hybrid Heat* scenario in the year 2050. Regional peak electricity demand (including other sectors and loads) are plotted with the distributions capturing the variations due to the 20 different weather years. Results show the *Hybrid Heat* scenario leads to reduced peak electricity demand relative to the *Electric Heat* scenario for all four regions of BC. A maximum of 1.4 GW of electric capacity can be avoided in the Lower Mainland in the *Hybrid Heat* scenario with a TSP of +4°C, relative to the *Electric Heat* scenario. This is equivalent to a regional peak electricity demand reduction of 20% in the Lower Mainland relative to the January 2024 weather event where a multi-day cold-snap affected the Pacific Northwest (Powerex, 2024). For comparison, this avoided capacity is greater than the peak generation available from the Site-C hydroelectric facility (BC Hydro, 2023). Comparing switch-over points for the *Hybrid Heat* scenario, an increase in TSP from -6°C to +4°C does not achieve additional capacity reduction in Northern BC, the coldest region in the province of BC. However, in the Lower Mainland and on Vancouver Island, a 5% reduction is achieved when increasing TSP from -6°C to +4°C. In the Lower Mainland, this avoided demand is equivalent to a generation capacity of 0.6 Site-C's.

When hybrid systems operate in gas mode they remove electricity demand by consuming gas. Figure 2(a) shows the total renewable gas volume needed to serve hybrid heating systems as a function of TSP. At lower TSPs, less gas is consumed. Depending on the TSP, the maximum amount of renewable gas for residential space heating varies between 5 PJ for a TSP of -6°C and 26 PJ for TSP of +4°C. Figure 2(b) shows the resulting greenhouse gas (GHG) emissions for the *Hybrid Heat* scenario as a function of TSP.

Over 20 temperature years, all TSPs between -6°C and 0°C meet the provincial emission reduction target by 2050 (grey shaded area) while for a TSP of +2°C and +4°C, certain temperature years meet the emission reduction target. GHG emissions are calculated assuming a maximum carbon intensity for renewable gas of 30.8 gCO_2eq/MJ and an electricity emissions intensity factor of 11.3 gCO_2eq/kWh (FortisBC, 2025; Province of British Columbia, 2025). Achieving a lower carbon intensity for renewable gas by 2050 will result in meeting provincial GHG emission reduction targets for all TSPs.

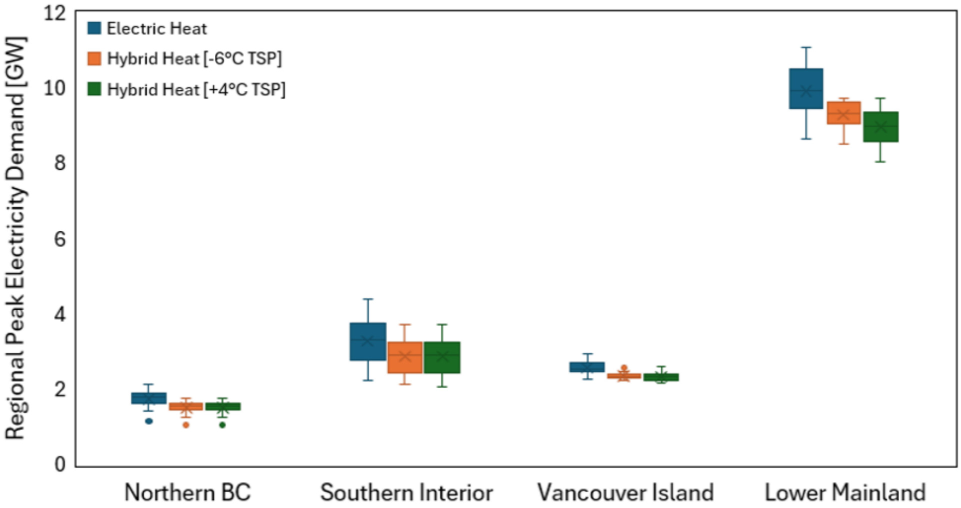

Figure 1: Distribution of regional peak electricity demand for the Electric Heat relative to the Hybrid Heat scenario for two switch-over temperature points based on 20 years of ambient temperature data. The box is described as the interquartile range (IQR) between the 25th and 75th percentile, the 'x' represents the mean value, and the line inside the box represents the median value. The bottom whisker represents the 25th percentile times 1.5 times the IQR while the top whisker represents the 75th percentile times 1.5 times the IQR. Outliers are outside of the 25th and 75th percentile times 1.5 times the IQR.

Opportunities and barriers: Hybrid heating systems in warmer regions reduce grid capacity requirements

The increased peaking capacity requirements for electrified space heating pose a challenge for system operators during critical hours of the year and may require increased capacity for firm generation, transmission and distribution infrastructure (Smillie et al., 2024). As we show, hybrid heating systems have the potential to mitigate these capacity requirements. Previously, hybrid heating systems have been viewed as a key technology for cold climate regions; however, our results show that significant capacity savings arise with hybrid system deployed in warmer regions of BC - the Lower Mainland and Vancouver Island - due to large populations and periodic low-temperature events. Our results indicate that increasing the TSP from -6°C to +4°C leads to additional reductions in grid capacity requirements in warmer regions; however, increasing TSP lead to larger volumes of RG needed to operate hybrid heating systems in gas mode. The increase in RG demand for hybrid heating systems with a higher TSP may pose challenges to gas system planners with regards to the availability of RG in BC. Given the correlation of peak electricity demand with cold-temperature events in BC and the need for firm capacity to satisfy reliability at peak demand, hybrid heating offers system value with low-emissions potential.

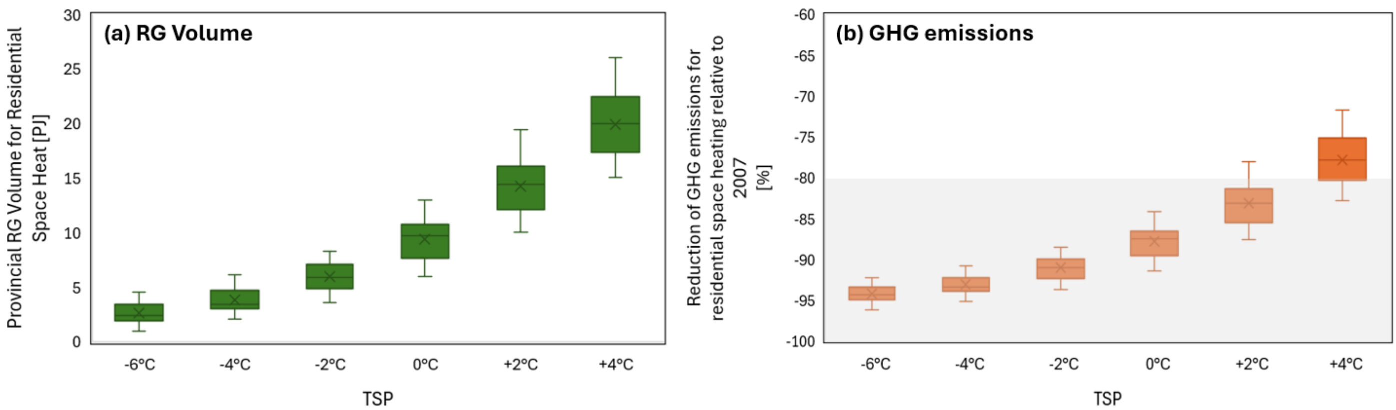

Figure 2: (a) Distribution of provincial Renewable Gas (RG) Volume by 2050 for six switch-over temperature points (TSP) in the Hybrid Heat scenario over 20 temperature years. (b) Distribution of GHG emissions by 2050 for six switch-over temperature points (TSP) in the Hybrid Heat scenario over 20 temperature years. The grey shaded area shows the GHG emission reduction target in BC by 2050 (Province of British Columbia, 2022)*. The boxes are described as the IQR between the 25th and 75th percentile, the 'x' represents the mean value, the line inside the boxes represents the median value, and the whiskers represent the minimum and maximum values.*

Next steps: Examining the impact of decarbonization across other end-uses

Electrification of residential space heating in BC by 2050 appears increasingly likely, particularly given that the City of Vancouver has recently mandated a ban on gas heating systems in new residential buildings (Suarez & Brockman, 2024). However, further electrification of end-use demands in the transportation and industrial sectors is also anticipated, which will place additional pressure on provincial grid capacity requirements (Province of British Columbia, 2021). By 2050, large volumes of renewable and low-carbon gas are potentially feasible in BC (Envint Consulting & CBER, 2022). Our results indicate that hybrid heating may require between 6% and 26% of projected renewable and low-carbon gas supply. While residential space heating is comparatively easier to electrify than heavy-duty transportation or high-temperature industrial processes, achieving provincial greenhouse gas emission reduction targets across all sectors will likely depend on the strategic use of renewable gas for end-use demands that are less amenable to electrification. Further analysis is required to assess the implications of end-use decarbonization across all sectors of the economy.

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