Proceedings of the Canadian Society for Mechanical Engineering International Congress 2022
CSME Congress 2022
June 5-8, 2022, Edmonton, AB, Canada

Decarbonizing British Columbia's building heating and transportation sectors: Comparing electrification and renewable gas portfolios

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ABSTRACT

Decarbonization of building heat and transportation in British Columbia (BC) are examined through electrification and the use of renewable gas. Increasing renewable energy shares and substituting fossil with low-carbon fuels are among the most effective strategies in combating climate change. While numerous technical pathways are possible, preferred energy system transition strategies should reflect regional resource characteristics and existing infrastructure. Effectively utilizing existing energy and power assets can reduce costs, land-use change, and risk. One of the considerations for future energy systems with high shares of variable renewables is storage. In the case of electricity and gas, the costs and value of storage, particularly for long-term balancing, are not well understood. Here, we use a regionally specific electricity system model to examine infrastructure and operational requirements, system costs, and greenhouse gas emission reduction potential for decarbonization of transportation and residential heating in BC. The dispatch behavior of a 100% renewable electricity system is investigated using SILVER. SILVER is a spatially resolved production cost model. While large reservoir hydroelectric facilities, as found in BC, are known for their flexibility, their ability to balance renewable variability can be limited by seasonal water-management considerations. Existing generation assets in BC are represented in SILVER and seasonal water flows are explicitly captured in operating constraints. Additional generating capacity to serve increased demands arising due to electrification or electrolytic hydrogen production is met with wind, solar and storage technologies. Generation and storage capacities are based on a previous study examining optimal capacity expansion and dispatch for decarbonizing building heat and transportation in Metro Vancouver. For direct electrification scenarios, hourly demand profiles for building heating and transportation are added to the residual provincial electricity load. In renewable gas scenarios, hourly demand for electrolytic hydrogen production is added to the provincial load to serve a fraction of residential heating demands. Three scenarios representing variations in demand, technology cost, and resource availability are simulated. Results show emission reduction potentials of 80% for both pathways and indicate peak demand as the main cost driver of end-use electrification as electricity storage is required to meet peak demand. Storage capacity and dispatch profiles from the Metro Vancouver study do not enable a 100% electrified grid such that all scenarios require natural gas generation to meet demand. Insufficient storage capacities are resulting from the model's more accurate representation of hydro dispatch constraints and highlight the challenges of insufficient operational detail in capacity expansion models.

Word count: 400