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

A DISRUPTIVE APPROACH TO ACHIEVE SUBSTANTIAL GHG EMISSION REDUCTIONS IN CANADA'S EXISTING BUILDING STOCK

M.F. Lightstone
Mechanical Engineering, McMaster University, Hamilton Canada
lightsm@mcmaster.ca

ABSTRACT

Extreme weather events during 2021 have highlighted the impact of the climate crisis and the urgent need to transition to non-carbon energy sources. With Canada's cold climate and increasingly hot summers, building energy use for heating and cooling contributes substantially to our greenhouse gas (GHG) emissions. While new builds can be subjected to more rigorous energy efficiency building codes, retrofit of existing buildings to reduce GHG emissions is expensive and often results in incremental reductions in GHG emissions.

Electric based heating through heat pumps offers an opportunity for significant emissions reductions if the electrical generation supply mix is predominantly non-carbon based. While air-source heat pumps are of far less capital cost than ground source heat pumps, their performance is coupled with the outdoor air temperature making them less suitable for climates with cold winters and hot summers. In contrast, ground source heat pumps (GSHPs) have a coefficient of performance which is based on a relatively constant ground temperature and is thus essentially de-coupled from weather. The capital cost of installation of a ground source heat pump can be prohibitively expensive for many consumers due to the high cost of drilling and installation of the borehole heat exchanger. To achieve a net reduction in GHG emissions, however, the electrification of heating needs to consider the interaction with the electrical grid, thus treating the entities as a coupled integrated system.

To achieve Canada's GHG reduction goals, disruptive and expensive solutions are needed. This presentation discusses a possible path forward through the broadscale implementation of GSHPs in the existing building stock through cluster installations in neighbourhoods of older buildings. Electrical demand management can be achieved by creating hybrid heating systems that integrate the GSHP into the existing natural gas heating system for the building. Based on the state of the electrical grid, a "smart controller" can be used to optimize the building heating source. This also reduces the need for new peaking power plants. As the electrical grid evolves to include more renewables, the use of the gas furnace can be ramped down to zero or it can be used to provide auxiliary heating during severe cold weather if the GSHP heat flux is insufficient. De-risking is achieved by using mature technologies. The goal of this presentation is to spark discussion amongst the CSME community on a disruptive path forward for achieving our GHG reduction targets within the existing building stock.

Word count: 398