Adoption of Heat Pumps in Ontario

Transformation of emissions in residential space conditioning

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INTRODUCTION

Space heating with Ontario's residential sector contributes to 63.7% of energy usage and 75% of emissions. The project explores the energy-use and emission reductions made possible from heat pump alternatives. Heat pumps are highly efficient and have both heating and cooling capabilities. The economics of heat pumps are studied to determine the feasibility of the installation.

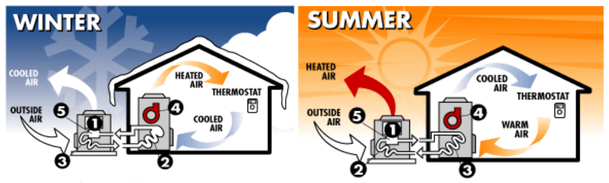
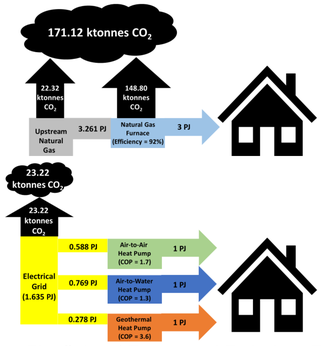


Fig. 1. Heat Pump Space Conditioning Processes [2]

METHODS



- No emissions produced by heat pumps at source
- Heat pumps require 1.626PJ less to provide 3PJ to a house
- Heat pump emissions are lower by 86%

Fig. 2. Input Energy and Emissions Flow Diagrams for a High Efficiency Natural Gas furnace and the three Heat Pumps in 2017

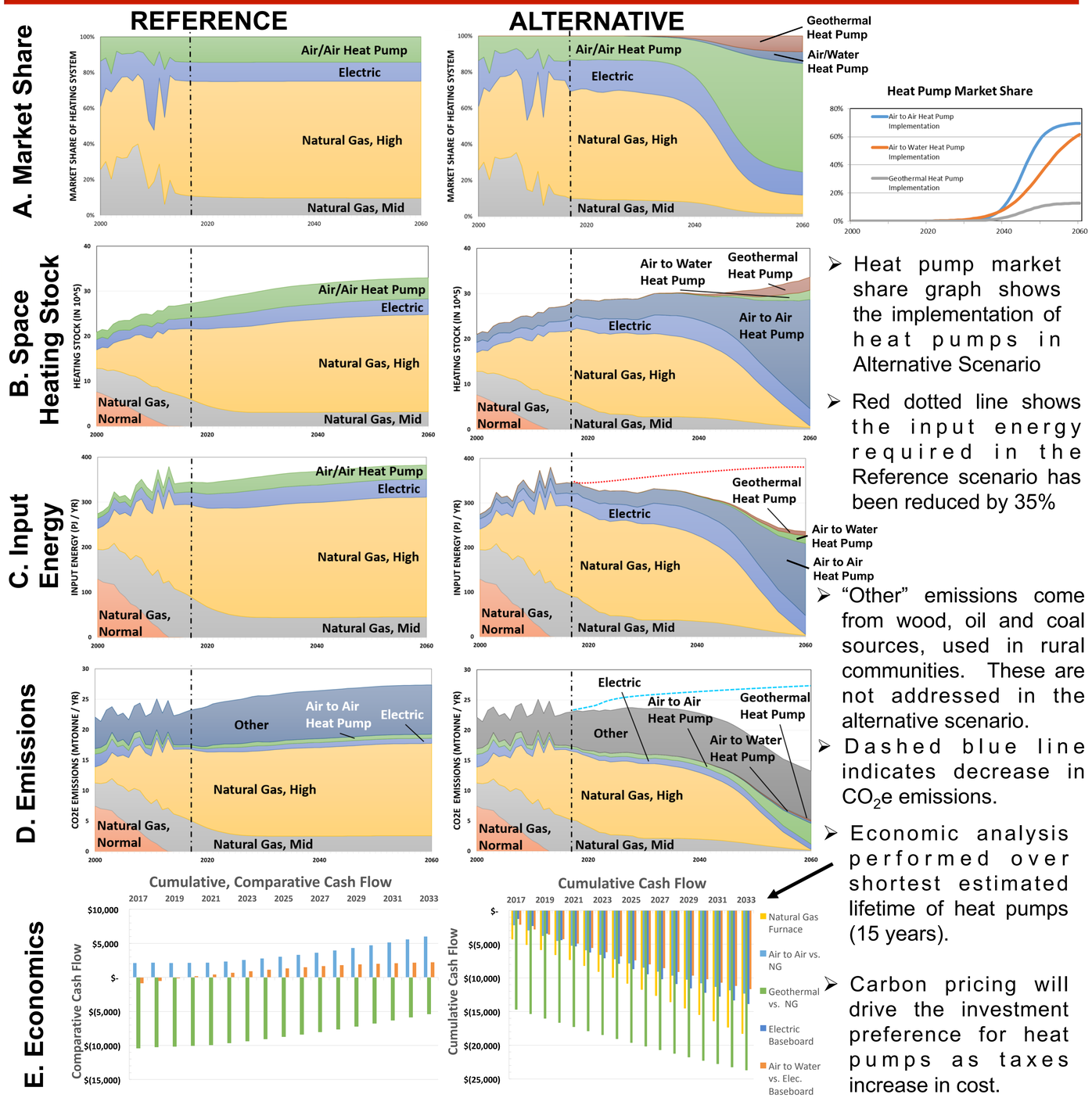
The following assumptions were made in developing the reference (future heat pump adoption) and alternative scenario.

- Reference model was run based on CanESS provided data [3]
- Geothermal heat pumps are installed in newly constructed homes over 2500ft^2
- Electric heating systems are retrofitted with an air/water heat pump based on similar infrastructure

The following assumptions were made in developing the economic analysis.

- Air to air and geothermal installations are compared against natural gas furnaces.
- Air to water installations are compared against water baseboard heaters.
- All installations use electric appliances
- Capital cost includes rebate incentives.

RESULTS



- Heat pump market share graph shows the implementation of heat pumps in Alternative Scenario
- Red dotted line shows the input energy required in the Reference scenario has been reduced by 35%
- "Other" emissions come from wood, oil and coal sources, used in rural communities. These are not addressed in the alternative scenario.
- Dashed blue line indicates decrease in CO_2e emissions.
- Economic analysis performed over shortest estimated lifetime of heat pumps (15 years).
- Carbon pricing will drive the investment preference for heat pumps as taxes increase in cost.

DISCUSSION

The deep decarbonization scenario of space conditioning comprises of new installations and retrofits of traditional space heating sources to heat pumps. From our analysis, heat pumps have the potential to replace 350PJ worth of input energy into space conditioning in 2060. This result suggests emission reductions of over 17 Mtonnes of CO_2e in 2060 is possible with heat pump adoptions.

The economic analysis of heat pumps aligns with the emissions analysis. The scenario is estimated to be economically viable compared to traditional space conditioning due to carbon costs, rebates and efficiency.

CONCLUSIONS

Deep decarbonization of Ontario's residential space conditioning sector will be achieved through heat pump installations running on clean electricity. Our alternative scenario installs 220 PJ worth of heat pump capacity, in 2060. On the projected grid intensity for Ontario, this results in 13 Mtonne CO_2e emissions in 2060. From this study, policies will play a significant role in influencing the market uptake of heat pumps, including residential building standards and cleaner electricity grids.

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REFERENCES

[1] Government of Canada, Natural Resources Canada, *Residential Sector Canada Table 2: Secondary Energy Use and GHG Emissions by End-Use*, 2017 [Online]. Available: http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP§or=res&juris=ca&rn=2&page=4&CFID=46055594&CFTOKEN=b8fa1d72a7577a9f-A5E926B6-F8A0-8BB9-CEAFA750C08F2471. [Accessed: September 28, 2017]

[2] Altitude Comfort, *Heat Pumps,* 2017. [Online]. Available: http://www.altitudecomfort.com/heat-pumps.php [Accessed: November 6, 2017]

[3] whatIf? Technologies Inc., University of Calgary. *The CanESS Model*, 2017. [Accessed: September 25, 2017]

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