Analysis of Heat Pumps

for Cost-Effectiveness & Climate Alignment

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Background

- Enbridge proposal:
  - $12 million on gas heat pumps and hybrid systems over 2023 and 2024
  - Fastest growing program area
  - $0 on all-electric cold climate heat pumps

- Purpose of report
  1. Assess the cost-effectiveness of gas, hybrid and electric heat pumps for residential buildings
  2. Assess the role of gas, hybrid and electric heat pumps in a net zero transition

Heat pump types

Traditional Gas Furnace	Electric heat pumps	Hybrid system	Gas heat pump
Converts fuel energy to heat	Moves heat using a compressor	Electric heat pump with Smart controls that switch to gas backup	Gas powers a heat pump or drives the refrigeration cycle
Max 100% efficient	Currently up to 390% efficient	Currently up to 390% efficient (but not modelled here due to complexity)	Expected efficiency of 120-140% (but not yet commercially available)
Heating only	Heating and cooling	Heating and cooling	Heating only
Gas water heaters are 81% efficient	Heat pump water heaters are currently 350% efficient	Paired with gas water heater in models	Same unit can heat water at 120-140% efficiency

Cost effectiveness (avoided cost)

- **Gas heat pumps are not cost-effective vs any option**
- **Electric heat pumps are often the most cost-effective option**
  - Cost-effective vs. all other options where gas infrastructure can be avoided
    - New residential developments where gas connection >$4,100
    - Gas pipeline expansion communities
  - For existing homes, outcomes depend on electricity cost assumptions
    - Using Enbridge electricity avoided costs
      - Hybrid and conventional gas-only systems somewhat more cost-effective than all electric heat pumps
    - Using IESO electricity avoided costs
      - All electric heat pump is more cost-effective (hybrid system not modeled)

Cost effectiveness (customer costs)

All electric heat pumps are most cost effective vs. gas furnace systems or gas heat pumps

Customer costs of gas furnace, water heater and air conditioner, a gas heat pump and air conditioner, and a ccASHP with a HPWH.

	Gas furnace (95%), gas water heater (EF 0.81) and SEER 13 AC	**Gas heat pump** (120%) with SEER 13 AC	**All electric ccASHP** (HSPF 10) with HPWH (EF 3.75)
Upfront cost	$10,500	$18,250	**$15,357**
15-yr operational cost	$27,135	$21,342	**$16,309**
15-yr NG fixed costs	$5,505	$5,505	**NA**
15-yr operational/NG fixed cost savings	NA	$5,793	**$16,331**
Lifetime savings	NA	-$1,957	**$11,474**
NPV (compare to gas furnace scenario)	NA	-$3,993	**$1,869**

[1] Discount rate of 6.08% used

Heat pumps in net zero transition

- Net zero target for 2050 in Canada
  - Heating equipment promoted should be consistent with this target
- Leading institutions call for electrification of heating
  - e.g. International Energy Agency recommends phase out of fuel-based heating systems by 2025
- Low carbon gas-based options (RNG, hydrogen) are untenable
  - Limited availability or feedstock
  - Very expensive
  - Needed for other uses
- Hybrid and gas heat pumps are likely to be inconsistent with our net zero targets
- Electric heat pumps are the best option for net zero transition

Future cost-effectiveness of electric HP

- Heat pump efficiencies have been increasing
- Current efficiencies not close to the theoretical maximum
- Equipment costs expected to decline
- Carbon costs are increasing
- Would benefit from market transformation program to
  - Overcome low consumer and installer awareness of the technology
  - Overcome misconceptions about their performance and lifetime costs
  - Build installer capacity

Issues raised by Enbridge

- Appropriate to model seasonal heat pump efficiency at 293% (HSPF 10, zone V)
  - YES
  - Units with up to 390% efficiency are already available
  - Many units are available with 293% or higher
- Appropriate to model straight line carbon price increases though 2030?
  - YES
  - Continuation of current $15/t/yr increase
  - IESO proposes the same in Pathways Modelling draft assumptions (link)
  - Carbon reductions after 2030 will cost more than $170/t after lower-hanging fruit is picked
  - Assuming no increase after 2030 is a forecast itself, and is inconsistent with net zero targets
- All electric heat pumps are still cost-effective even at lower efficiencies and no carbon price increase after 2030 (IESO avoided costs)

Big picture assessment

- Regardless of specific modelling assumptions, no doubt that:
  - All electric heat pumps are near or over a cost-effectiveness tipping point relative to gas
  - All electric heat pumps are getting more cost-effective as carbon prices increase and technology improves
  - All electric heat pumps would benefit from programming to overcome low consumer and installer awareness of the technology, overcome misconceptions about their performance and lifetime costs, and build installer capacity
  - Gas heat pumps are expensive and inconsistent with a net zero transition