Addendum: Update with IESO Avoided Cost Values

Dr. Heather McDiarmid

Filed March 21, 2022

This addendum relates to my report, *"Analysis of Enbridge Gas' proposed low carbon transition program for cost effectiveness and climate alignment"* (exhibit L.ED.1) and considers avoided electricity cost issues discussed at the technical conference and in undertaking responses. The analysis in my report used Enbridge-supplied values wherever possible to facilitate comparisons between our analysis and Enbridge's analysis. The avoided cost values for electricity in Enbridge's analysis are significantly different from those published by IESO in its 2020 Annual Planning Outlook. As this analysis shows, the use of IESO avoided cost values increase the cost-effectiveness of the all-electric heat pump systems compared to all gas-based alternatives.

Specifically,

- The electric option is more cost-effective (gross lifetime and NPV) in the following scenarios:
    - Electric heat pump vs. traditional gas furnace (see Table 1)
    - Electric heat pump vs gas heat pump (Table 4)
    - Electric ccASHP and HWHP vs. gas furnace, AC and gas water heater (see Tables 2, 3, & 5);
- With more conservative conditions discussed in 10J-EGI-5-ED.1 (a 2023 installation date, no rising carbon tax after 2030, and a reduced ccASHP efficiency value to HSPF 9):
    - The all-electric scenario is still more cost-effective (gross lifetime and NPV) than a gas heat pump, by over $4,000 (Table 6); and
    - The all-electric scenario is more cost-effective than a gas furnace, AC and gas water heater on a gross lifetime basis and cost-comparable on a net present value basis, being slightly less cost-effective based on Enbridge's discount rate of 6.08% (Table 6) and slightly more cost-effective based on the rate of 2.5% (Table 7) proposed by the Energy Futures Group.

Table 1: Cost-effectiveness of a ccASHP compared to a gas furnace and air conditioner.

	Gas furnace (95%) with SEER[1] 13 AC	ccASHP (HSPF[2] 10)
Upfront cost	$8,000	$11,100
15-yr operational cost	$22,744	$13,989
15-yr operational cost savings	NA	$8,755
Lifetime savings	NA	$5,655
NPV (compared to gas/AC)	NA	$2,113

Table 2: Cost-effectiveness of a ccASHP and HPWH compared to a gas furnace, air conditioner and gas water heater in gas expansion area homes.

	Gas furnace (95%) with SEER 13 AC and EF 0.81 gas water heater	ccASHP (HSPF 10) and HPWH (EF 3.75)
Upfront cost, including NG infrastructure investments	$37,200	$15,357
15-yr operational cost	$26,093	$15,104
15-yr operational cost savings	NA	$10,989
Lifetime savings	NA	$32,832
NPV (compared to gas/AC)	NA	$28,439

[1] SEER is the Seasonal Energy Efficiency Ratio. It measures the average efficiency of moving heat out of a home over the entire cooling season.

[2] HSPF is the Heating Seasonal Performance Factor. It is the average efficiency of moving heat into a home over the entire heating season. The HSPF changes based on the climate region. All figures in this report are for HSPF region V, which applies to most of Ontario. An HSPF of 10 region V equates to heating season average co-efficient of performance ("sCOP") of 2.93.

Table 3: Cost-effectiveness of a ccASHP compared to a gas furnace, air conditioner, and gas water heater in new housing developments.

	Gas furnace (95%) with SEER 13 AC and EF 0.81 gas water heater	ccASHP (HSPF 10) and HPWH (EF 3.75)
Upfront cost, including NG connection	$13,800	$15,357
15-yr operational cost	$26,093	$15,104
15-yr operational cost savings	NA	$10,989
Lifetime savings	NA	$9,432
NPV (compared to gas/AC or gas/AC/DHW)	NA	$5,039

Table 4: Cost effectiveness of a ccASHP paired with a HPWH compared to a gas heat pump with an air conditioning system.

	Gas heat pump (120%) with SEER 13 AC	ccASHP (HSPF 10) with HPWH (EF 3.75)
Upfront cost	$18,250	$15,357
15-yr operational cost	$21,201	$15,104
15-yr operational cost savings	NA	$6,097
Lifetime savings	NA	$8,990
NPV (compared to gas/AC)	NA	$6,369

Table 5: Cost-effectiveness of a ccASHP and HPWH compared to a gas furnace, air conditioner and gas water heater.

	Gas furnace (95%) with SEER 13 AC and EF 0.81 gas water heater	ccASHP (HSPF 10) and HPWH (EF 3.75)
Upfront cost, including NG infrastructure investments	$10,500	$15,357
15-yr operational cost	$26,093	$15,104
15-yr operational cost savings	NA	$11,510
Lifetime savings	NA	$6,132
NPV (compared to gas/AC)	NA	$1,739

Table 6: Cost effectiveness of a ccASHP paired with a HPWH compared two gas systems with a 2023 start date, a flat carbon tax after 2030 and a lower heat pump efficiency value (HSPF 9).

	Gas furnace (95%) with SEER 13 AC and EF 0.81 gas water heater	Gas heat pump (120%) with SEER 13 AC	ccASHP (HSPF 9) with HPWH (EF 3.75)
Upfront cost	$10,500	$18,250	$15,357
15-yr operational cost	$21,459	$17,574	$14,594
15-yr operational cost savings (compared to gas furnace)	NA	$3,885	$6,866
Lifetime savings (compared to gas furnace)	NA	-$3,865	$2,009
NPV (compared to gas furnace)	NA	NA	-$582
NPV (compared to GHP)	NA	NA	$4,658

Table 7: Net present value analysis with different discount rates for a ccASHP paired with a HPWH compared two gas systems with a 2023 start date, a flat carbon tax after 2030 and a lower heat pump efficiency value (HSPF 9).

NPV discount rate	Gas furnace (95%) with SEER 13 AC and EF 0.81 gas water heater	ccASHP (HSPF 9) with HPWH (EF 3.75)
6.08%	NA	-$582
2.50%	NA	$735

Data sources and assumptions

Annual avoided costs $/kWh costs from IESO Annual Planning Outlook ("APO") 2020 were used as these values were applied to both heating and cooling applications.

Winter and summer avoided peak costs ($/kW-month) from IESO APO 2020 were used. Peak electrical load values for summer and winter and for the all-electric, and gas systems were taken from Table 1 of Exhibit JT1.22. Gas furnace values were used for the gas heat pump scenario.

In undertaking responses Enbridge suggests using the IESO's avoided cost figures from its Cost Effectiveness Tool. These figures are lower and would make heat pumps even more cost effective in comparison to the IESO APO figures that were used in the above analysis.

The avoided cost of electricity for all appliances were calculated using the new avoided $/kWh values and the formulas used previously. The additional $/kW charge was calculated using the following calculation for year X:

$$\begin{aligned} annual\ avoided\ peak\ cost \\ &= (peak\ winter\ load) \\ &* \big((4\ months) * (winter\ avoided\ cost\ per\ kW for\ year\ X) + (2\ months) \\ &* (winter\ avoided\ cost\ perkW\ for\ year\ X+1)\big) + (peak\ summer\ load) \\ &* (6\ months) * summer\ avoided\ cost\ per\ kW\ for\ year\ X) \end{aligned}$$