HVAC RETROFIT MODELLING EXERCISE

EXPLORING SAVINGS FOR LOW-RISE MULTI-UNIT RESIDENTIAL BUILDINGS (MURBS)

The following modelling exercise describes a heating, ventilation and air conditioning (HVAC) retrofit for a low-rise multi-unit residential building in the Greater Toronto and Hamilton Area. The building owner wanted to explore the potential savings of installing mini-split heat pumps in each residential unit. Existing electric baseboard heaters would be kept for backup heating during occasional periods of extreme cold when outdoor temperatures drop below the heating capacity of cold-climate heat pumps.

APARTMENT BUILDING

Size	16,632 square feet
Location	Greater Toronto and Hamilton Area
Year built	1961
Floors	Three (including one half basement)
Units	20

EXISTING MECHANICAL SYSTEMS

System	Description
Heating	Electric baseboards.
Heating efficiency	Seasonal efficiency of 100%.
Cooling	No central air conditioner (AC). Assume that units have window-mounted ACs.
Cooling efficiency	Seasonal coefficient of performance (COP) of 2.5.
Controls	Heating is controlled by manual thermostats.
Domestic hot water	Electric water heater with 98% efficiency.

RETROFIT DETAILS

System	Description
Heating	Keep electric baseboards for backup heating and install mini-split air-source heat pump systems in each unit.
Heating efficiency	Heating Seasonal Performance Factor (HSPF) of 8.5. Standalone energy recovery ventilators with 70% efficiency. Existing electrical service capacity is suitable for the heat pump installation.
Cooling	Mini-split air-source heat pump systems.
Cooling efficiency	Seasonal heat pump cooling COP of 4.
Controls	Scheduling controls are available for the heat pump equipment via smart thermostats.
Domestic hot water	N/A (no retrofit proposed).

MODELLED ENERGY AND FUEL COST OUTPUT SUMMARY

The results below are from a preliminary analysis of the proposed HVAC retrofit using Natural Resource Canada's RETScreen Expert software. The model accounts only for energy associated with existing and proposed HVAC systems. The model was based on assumptions about the building enclosure following a review of available documentation and a facility walkthrough, and accounts only for energy associated with the existing and proposed HVAC systems. Other electricity loads, such as lighting and plug loads, are not included in the analysis. The model also assumes that the heat pump system will provide all of the annual heating demand, although legacy systems will remain as backup.

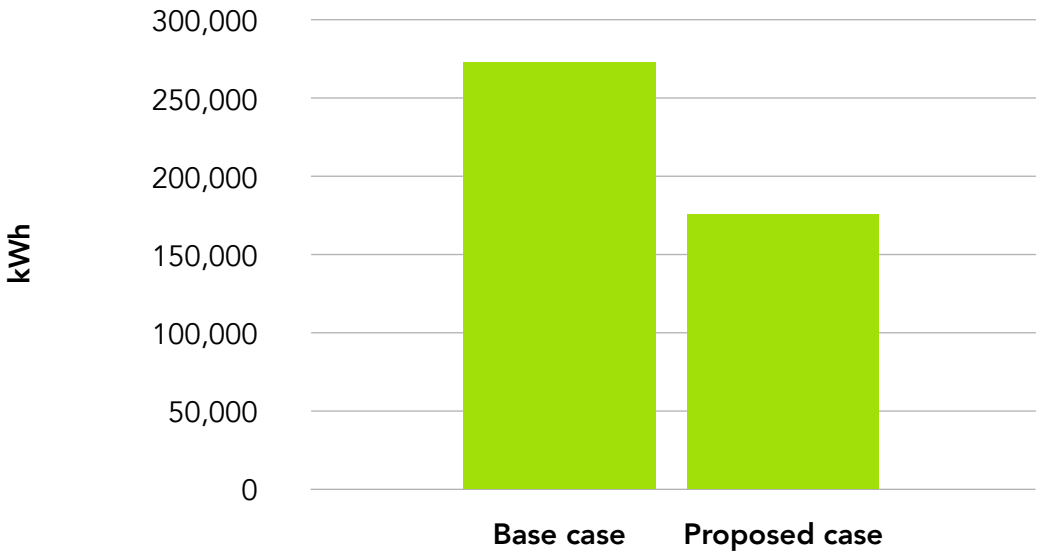
Fuel type		Base case		Proposed case		Projected annual savings	
Fuel type	**Rate[1]**	**Consumption**	**Cost**	**Consumption**	**Cost**	**Saved**	**Cost savings**
Electricity	$0.15	279,788 kWh	$41,968	175,433 kWh	$26,315	104,355 kWh	$15,653
Total			$41,968		$26,315		$15,653

The next page presents the fuel consumption and cost summaries in a bar chart format.

[1] The fuel rate (price per unit fuel) is an overall blended rate which includes all associated fees.

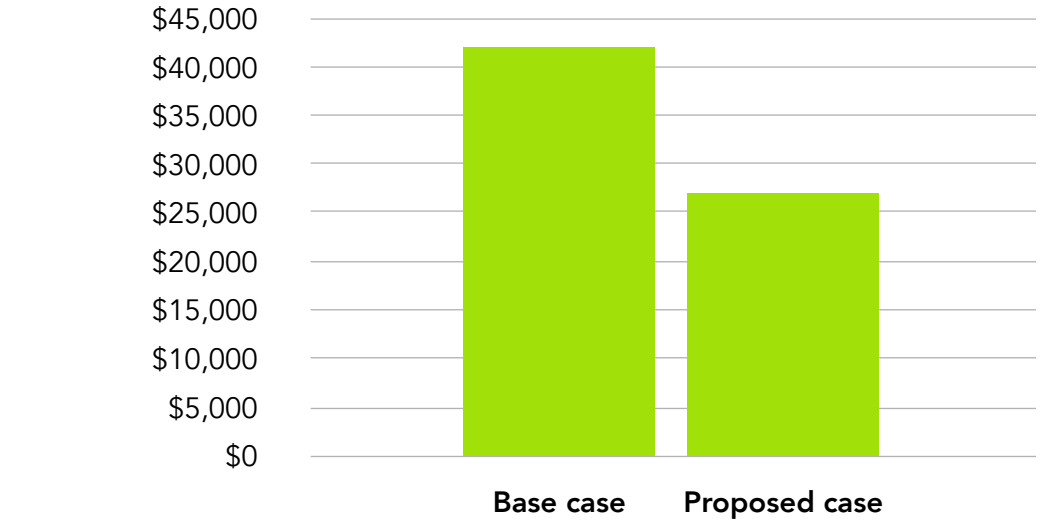
MODELLED ENERGY AND FUEL COST OUTPUT SUMMARY

FUEL CONSUMPTION SUMMARY[2]



Over **800,000 kWh** saved

COST SUMMARY



Over **$15,000** saved

[2] No natural gas used.

MODELLED SAVINGS SUMMARY IN TERMS OF ENERGY

	Heating	Cooling	Electricity	Total
Base case	202,836 kWh	22,038 kWh	54,914 kWh	279,788 kWh
Proposed case	106,608 kWh	13,911 kWh	54,914 kWh	175,433 kWh
Fuel saved	96,228 kWh	8,127 kWh	0 kWh	104,355 kWh
Percentage fuel saved	47.4%	36.9%	0%	37.3%

MODELLED BENCHMARKING SUMMARY

	Heating	Cooling	Electricity	Total
	kWh/ft²	**kWh/ft²**	**kWh/ft²**	**kWh/ft²**
NRCan benchmark[3]	–	–	–	23.5
Base case	12.2	1.3	3.3	16.8
Proposed case	6.4	0.84	3.3	10.5
Fuel saved	5.8	0.49	0	6.3

[3] Survey of Energy Consumption on Multi-Unit Residential Buildings, 2018 (Year of Construction 1960 to 1969) from Natural Resources Canada – Office of Energy Efficiency.

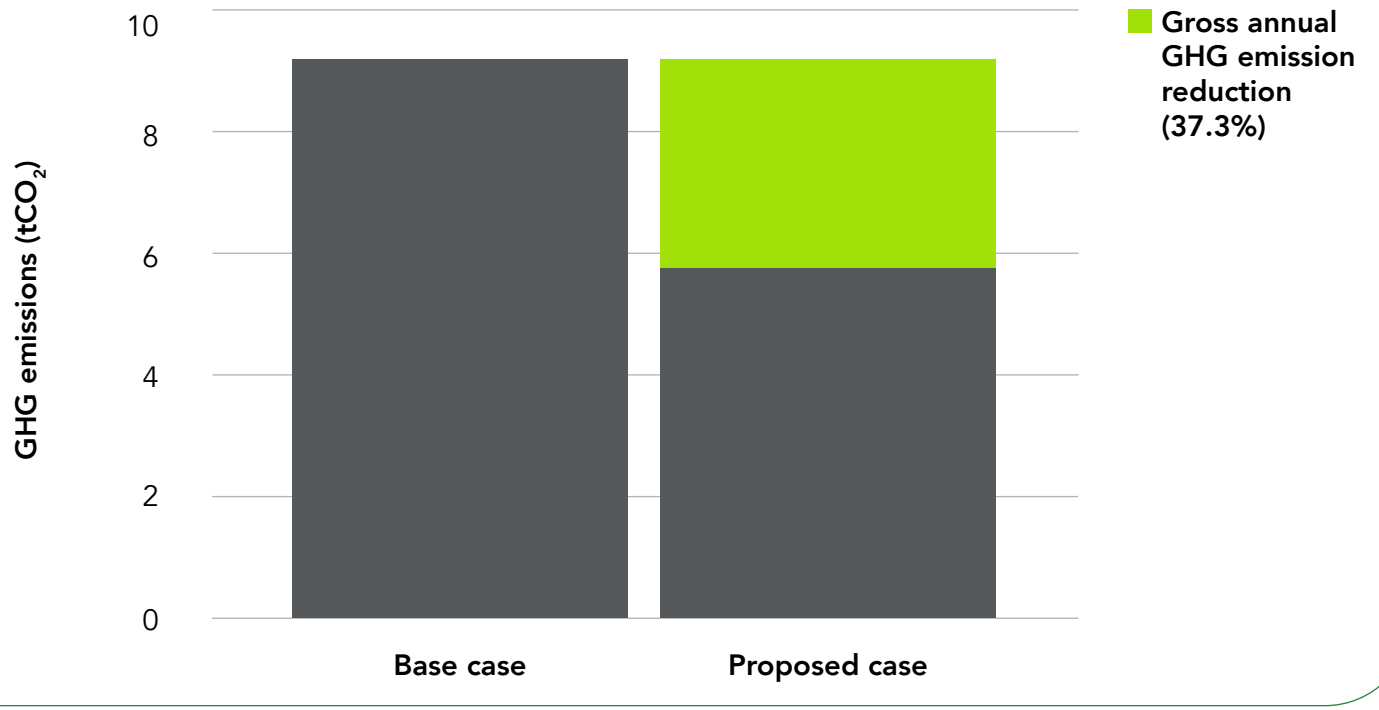
MODELLED GREENHOUSE GAS (GHG) EMISSION REDUCTION ANALYSIS

EMISSION ANALYSIS

Base case electricity system

Country – region	Fuel type	GHG emission factor[4] (excl. T&D) tCO_2/MWh	T&D losses %	GHG emission factor tCO_2/MWh
Canada – Ontario	Electricity	0.030	7.0	0.032

Annual GHG emissions	Tonnes of carbon dioxide equivalent (tCO_2)	
Base case	9.0	
Proposed case	5.7	
Gross annual GHG emission reduction	**Tonnes of carbon dioxide equivalent (tCO_2)**	**Percentage in savings**
	3.4	37.3



[4] Emission Factors and Reference Values Version 2.0, Environment and Climate Change Canada, May 2024