HVAC RETROFIT MODELLING EXERCISE

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

The following modelling exercise describes a heating, ventilation and air conditioning (HVAC) retrofit for a high-rise MURB in the Greater Toronto and Hamilton Area. The building owner wanted to explore potential savings for retrofitting the existing HVAC equipment, which was at the end of its useful life. A hybrid HVAC solution was modelled for the retrofit.

APARTMENT BUILDING

Size	175,766 square feet
Location	Greater Toronto and Hamilton Area
Year built	Mid-1970s
Floors	15 (including one basement with parking garage)
Units	165

ieso Connecting Today. Powering Tomorrow. | SAVE ON ENERGY POWER WHAT'S NEXT

EXISTING MECHANICAL SYSTEMS

System	Description
Heating	Hydronic natural gas-fired boiler system (distributed to most areas by terminal units).
Heating efficiency	Seasonal efficiency of 70%.
Cooling	No central air conditioner (AC). Assume that units have window-mounted ACs.
Cooling efficiency	Seasonal coefficient of performance (COP) of 2.5.
Make-up air units (MUAs)	Four MUAs provide 100% fresh air to common corridors. No pre-heat function.
Parking garage heating	Boiler system supplies unit heaters.
Domestic hot water (DHW)	Dedicated natural gas boilers.
Building automation system (BAS)	BAS controls the central heating and ventilation systems.

RETROFIT DETAILS[1]

System	Description (building)	Description (in suite)
Heating	High-efficiency natural gas boilers, sized appropriately for the building's peak heating load.	Cold-climate mini-split air-source heat pump systems for the baseload in each unit, with packaged heat recovery ventilator (HRV) units.
Heating efficiency	Seasonal efficiency of 85%.	Heating Seasonal Performance Factor (HSPF) of 8.5. Heat recovery efficiency of 70%.
Cooling	N/A	Cold-climate mini-split air-source heat pump systems.
Cooling efficiency	N/A	Seasonal COP of 4.

[1] A hybrid solution is typically recommended for high-rise MURBs when the building envelope upgrade is not included in the retrofit project.

RETROFIT DETAILS CONT'D

System	Description
Make-up air units	High-efficiency electric heat pump, which includes a pre-heat function and air flow control through variable speed motors.
Parking garage heating	Supplied by the new high-efficiency gas boilers. Airborne contaminant monitoring system installed to save on exhaust fan energy.
Domestic hot water	Dedicated natural gas boilers.
Building automation system (BAS)	BAS controls the central heating and ventilation systems. Smart thermostats installed in each suite to control the mini-split heat pumps.

MODELLED FUEL CONSUMPTION AND 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 is 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.

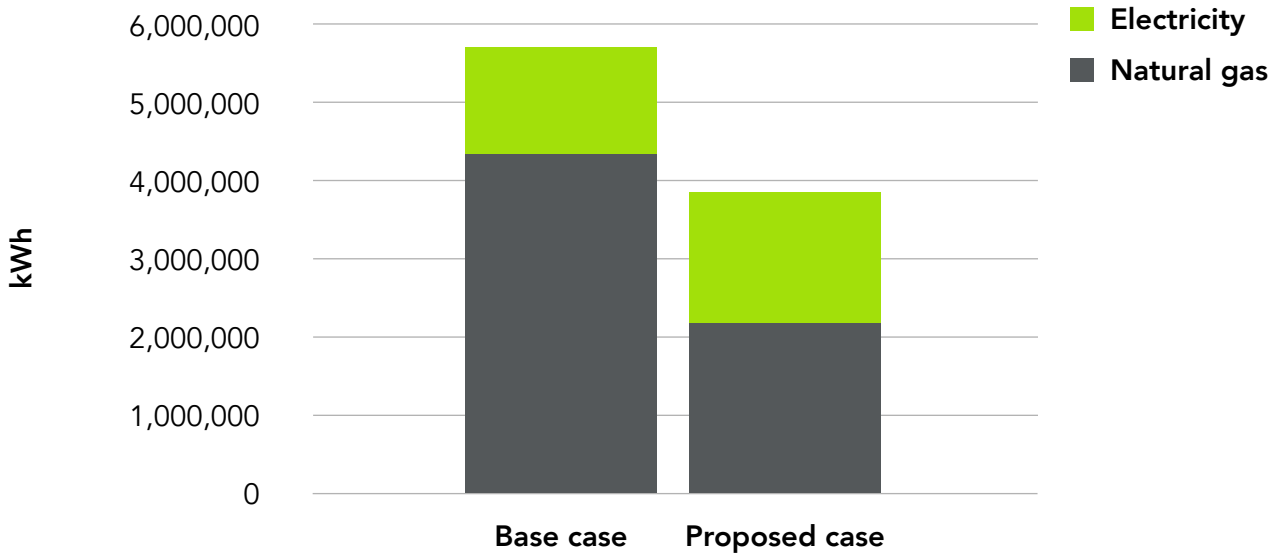
Fuel type		Base case		Proposed case		Projected annual savings	
Fuel type	**Rate[2]**	**Consumption**	**Cost**	**Consumption**	**Cost**	**Saved**	**Cost savings**
Natural gas	$0.40	409,576 m^3	$163,830	196,074 m^3	$78,430	213,501 m^3	$85,401
Electricity	$0.15	1,451,932 kWh	$217,790	1,784,850 kWh	$267,727	(332,918) kWh	$(49,938)
Total			$41,968		$26,315		$15,653

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

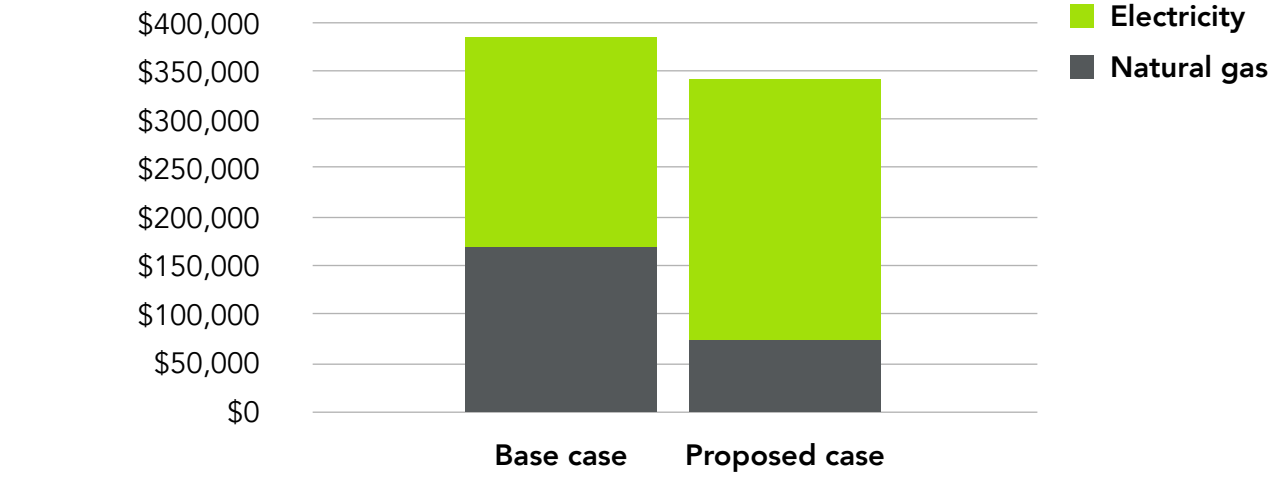
[2] The fuel rate (price per unit fuel) is an overall blended rate which includes all associated fees.

MODELLED FUEL CONSUMPTION AND COST OUTPUT SUMMARY

FUEL CONSUMPTION SUMMARY[3]



COST SUMMARY



[3] A conversion factor of 10.628 kWh per m^3 of natural gas is used.

MODELLED ENERGY SAVINGS SUMMARY

	Heating	Cooling	Electricity	Total
Base case	4,352,879 kWh	522,349 kWh	929,582 kWh	5,804,811 kWh
Proposed case	2,676,575 kWh	271,126 kWh	920,983 kWh	3,868,684 kWh
Fuel saved	1,676,305 kWh	251,223 kWh	8,599 kWh	1,936,127 kWh
Percentage fuel saved	38.5%	48.1%	0.93%	33.4%

MODELLED BENCHMARKING SUMMARY

	Heating	Cooling	Electricity	Total
	kWh/ft²	**kWh/ft²**	**kWh/ft²**	**kWh/ft²**
NRCan benchmark[4]	–	–	–	22.5
Base case	24.8	3	5.3	33
Proposed case	15.2	1.5	5.2	22
Fuel saved	9.5	1.4	0.05	11

[4] Survey of Energy Consumption on Multi-Unit Residential Buildings, 2018 (Year of Construction 1970 to 1979) from Natural Resources Canada – Office of Energy Efficiency.

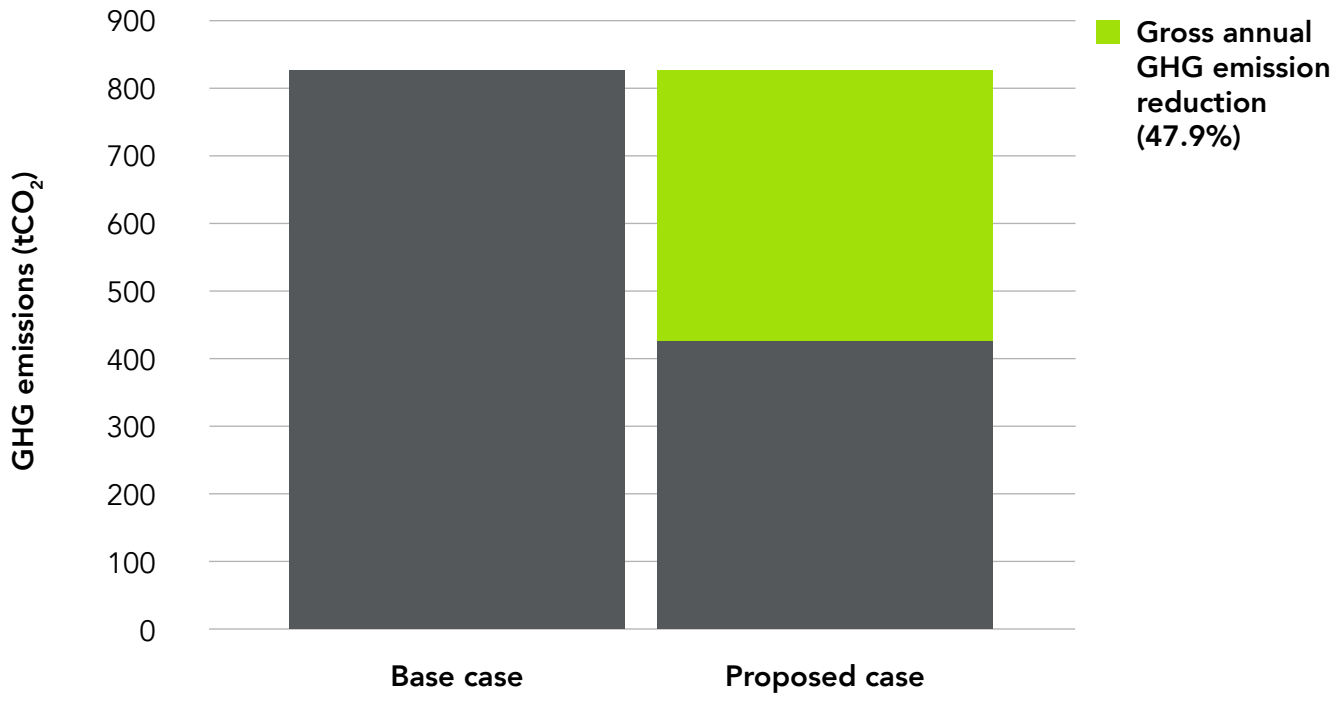
MODELLED GREENHOUSE GAS (GHG) EMISSION REDUCTION ANALYSIS

EMISSION ANALYSIS

Base case electricity system

Country – region	Fuel type	GHG emission factor[5] (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	828	
Proposed case	431	
Gross annual GHG emission reduction	**Tonnes of carbon dioxide equivalent (tCO_2)**	**Percentage in savings**
	396	47.9



[5] Emission Factors and Reference Values Version 2.0, Environment and Climate Change Canada, May 2024: https://publications.gc.ca/collections/collection_2024/eccc/En84-294-2024-eng.pdf.