DILLON CONSULTING

ENERGY STRATEGY

Riverside and Hall Residential Development

Prepared March, 2022

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References

[1] - “Electricity Rates.” ENWIN Utilities, https://enwin.com/electric-rates-residential/.

[2] - “Natural Gas Rates.” Enbridge Gas., Natural Gas Rates | Ontario Energy Board, https://www.oeb.ca/consumer-information-and-protection/natural-gas-rates.

[3] - Feasibility - Residential - Apartment building/Multi-unit housing - Model National Energy Code for Buildings (MNECB) / Canada

Appendix A

RETScreen Output Report - Carbon Mitigation Plan

1.0 Riverside & Hall Energy Strategy Report

1.1 Executive Summary

Dillon Consulting Limited was engaged by St Clair Rhodes Development Corp to prepare an energy strategy to evaluate energy efficiency options for the new Riverside and Hall condominium building in Windsor, Ontario.

Natural Resources Canada (i.e. NRCan) RETScreen Expert was used to create a model for the new Building. The modeling software allows evaluating and assessing the potential energy efficiency and renewable energy options; and to estimate the energy performance of the proposed design.

This project includes a 5-floor 5,359m^2 (~57,683 ft^2) residential building construction with 23 apartment units serving a total of 92 residents. The building also includes a rooftop terrace, a fitness room, a meeting room / lounge, a multi-purpose room, and underground parking.

The intent of the energy strategy report is to identify and evaluate energy efficiency opportunities that are efficient, low carbon, and resilient. A number of energy efficiency options were considered to improve the efficiency of the HVAC systems as well as provide renewable energy systems on site to offset some of the consumption. Due to the long payback period as well as the impact to occupant wellbeing and space use in the rooftop common areas, renewable energy systems were not recommended.

1.2 Inputs and Assumptions

1.2.1 Climate Data

The site is located in Windsor – Ontario. The standard Typical Meteorological Year (TMY) weather file for Windsor, ON was used to model the climate for a typical year of operation as per Code modeling guidelines.

1.2.2 Basis of Inputs

Proposed Case

The inputs were based on the mechanical and architectural design documents of the new building.

1.2.3 Assumptions

1) Occupancy: (2 per sleeping room)
   a) Floor 1: 20 persons
   b) Floor 2: 72 persons

2) Utility Rates [2022]:
The electricity rate was retrieved from ENWIN Utilities for residential properties - under Mid-Peak (moderate demand). [1] The natural gas rate was retrieved from Enbridge Gas. [2] Estimated blended rates were defined as follows:

   a) Electricity: $0.16 / kWh
   b) Natural Gas: 45.00 ¢/m3

3) Total Modeled Area:
The total modeled area is 5,359m^2 (57,683 ft^2).

1.3 Energy Calculations

A print out of the RETScreen simulation results is included in Appendix A of this report.

1.3.1 Towards Zero Emissions Development

The team evaluated several design options to assess the feasibility and constructability of Energy Conservation Measures (i.e. ECM's) that puts the facility on a path towards Zero Emissions operation. Several priorities and objectives were balanced in the decision making process, including:

1. GHG emissions measured in CO2e
2. Occupant amenities and facilities
3. Outdoor views and space use contributing to the well being
4. Energy consumption & efficiency
5. Energy resilience suitable for residential use
6. Feasibility and constructability

1.3.1.1 Energy Conservation & Demand Reduction

The Building HVAC design utilizes several technologies that were carefully considered to suit the various applications of the building spaces depending on space use. This includes the following:

1. Rooftop units serving the Occupant amenities and common facilities

2. Hydronic fuel-fired boiler plant serving Parking Garage heating
3. In-suite terminal forced-air ventilation & conditioning units complete with dedicated Fresh Air systems
4. In-suite domestic water heating units

The design philosophy was to provide dedicated HVAC and service HW systems to each suite to minimize central systems that require distribution and associated distributed losses. This design intent was maintained throughout the development of the Energy Strategy and the focus was to optimize the efficiencies of these systems as well as the integration of renewable energy systems.

Energy Conservation Measures

A wide range of energy conservation measures were considered for the design with a decision matrix developed in order to narrow down feasible options based on project goals and objects as discussed under section 1.3.1 of this report. Further discussion of the ECMs that were eliminated from the Study is included in section 1.3.2 Energy Resilience below.

The focus of this study was consequently narrowed down to the following options:

1. Thermal efficiency of Fuel Fired/Furnace system serving the rooftop units
2. Boiler plant efficiency and system selection:
    a. Standard Efficiency Boilers
    b. Condensing Boilers
    c. Modulating Condensing Boilers
    d. Outdoor air reset strategy to reduce Hydronic Loop operating temperature off peak and allow the condensing boilers to operate in condensing range and approach peak thermal efficiency of 96% in actual operation.
3. Thermal efficiency of fuel-fired in-suite (i.e. CU-Suite #)
    a. Standard efficiency furnace
    b. High efficiency furnace
        i. Multi-stage vs Single-stage units
    c. Fresh air unit
        i. Addition of residential heat exchangers/heat recovery units
4. In-suite domestic hot water units (DHW)
    a. Electric DHW tanks vs heat pump DHW tanks

1.3.1.2 Low-Carbon Solutions

A solar water heating systems was considered for the Building with a target solar fraction of 35%. The intent of the design was to supplement service water heating tanks in the suites with renewable on-site generated energy.

The amount of domestic hot water used daily was estimated based on the Case Study Feasibility - Residential - Apartment building/Multi-unit housing - Model National Energy Code for Buildings (MNECB) / Canada and prorated for Building size and occupants

An array of 16 flat-plate glazed solar collectors mounted on the roof would be required. The specifications of the solar collectors were obtained from the RETScreen database based on the Viessmann VitoSol 100 5 m2 DI panel. Mounting specifications such as tracking mode, slope and azimuth angle, were estimated based on Building limitations.

Under "Balance of System & miscellaneous", the option of Storage was set to "Yes". System storage capacity was set to the total available thermal storage of the in-suite hot water tanks (i.e. 23 x 45 USgal for a typical HWT1).

1.3.2 Energy Resilience

A 100 kW emergency power generator (i.e. EG-1 located on the roof) was included in the design to provide emergency to critical Life Safety systems as well as improve the Energy Resilience of the Building, especially considering the use of the building/building type as a multi-unit residential building.

The Generator is sized and connected to the electrical panels in the building that are necessary to maintain the following:

1. Fire Protection system, including the Fire Pump
2. Emergency and outdoor lighting
3. Building heating system to avoid freeze over during extended outages

As discussed under section 1.3.1.1 of this report, some energy conservation systems and HVAC technologies were eliminated in order to provide a feasible option for an emergency power system that can meet Objective 3 for maintaining heating to the Building during a power outage, namely heat pump technologies.

Electrifying the HVAC systems was considered in order to minimize fuel-fired heating systems and associated consumption and GHG emissions. However, this would have the generator size by approximately 500% to a minimum of 500 kW (i.e. an additional 400 kW above current size) in order to maintain heating capacity. This is based on the following:

1. Twenty-three (23) in-suite furnace units with a total capacity of 2,024 MBH (i.e. 88 MBH each)
2. Four (4) rooftop units with a total capacity of 480 MBH (i.e. 120 MBH each)
3. Two (2) boilers with a total capacity of 1,000 MBH (i.e. 500 MBH total)
4. Estimated minimum COP of 2.5, requiring an input power of approximately 410.7 kW to maintain heating by heat pumps as opposed to only circulating pumps with fuel fired equipment.

This resulted in the elimination of the following systems from the assessment that were considered for reducing energy consumptions and emissions:

1. Variable Refrigerant Flow/Volume (i.e. VRF/VRV) systems
2. Ground-source (i.e. geothermal) distributed heat pump systems
3. Rooftop heat pump units

1.3.3 Analysis, Preferred Scenario and Recommendations

A print out of the RETScreen simulation results showing detailed results for building energy use, energy/fuel consumption, and carbon emissions is included in Appendix A of this report.

1.4 Conclusions

The total reduction in energy consumption of the Building due to the simulated Energy Conservation Measures is approximately 621.8 MWhe (i.e. equivalent MWh's) and 217.9 tCO2e (i.e. tonnes of equivalent CO2 emissions). This represents 23.1% reduction in energy consumption and 31.7% in GHG emissions. However, two of the considered options were not recommended due to project challenges and impact on residents and building users. The excluded options were the Domestic Hot Water (DHW) options, namely Solar Hot Water and Heat Pump DHW tanks.

The Solar Hot Water system, which results in a net energy saving of 18,095 kWh/yr (i.e. total renewable energy provided to the building, less pumping consumption for distribution) and a net GHG emission reduction of 8.9 tCO2e presented a significant challenge in maintaining target usable roof-top spaces for the following objectives:

1. Occupant amenities and facilities
2. Outdoor views and space use contributing to the well being

The DHW tanks were eliminated due to potential challenges with serviceability and downtime. Given that each tank includes a refrigerant circuit c/w associated compressor and controls as well as supplemental electric heating element, there are more potential failure points and in a residential application where in-suite tanks are used instead of one or two central units, that multiplies the additional failure points by the number of units (i.e. 23 tanks). This presents a highly increased likelihood of failure which results in down time without hot water for residents. This additional downtime would be exacerbated by the need for refrigerant technician to service the tank on site or wait for a whole new tank replacement.

1.4.1 Recommended Measures

The following HVAC and plumbing Energy Conservation Measures are recommended, which maintain over 80% of the possible energy savings of the overall reductions of all options considered.

1. Increased Thermal efficiency of Fuel Fired/Furnace system serving the rooftop units to 80%, with an average seasonal efficiency of 75%
    a. Savings: 16,943.4 kWhe/yr
2. Modulating Condensing Boilers complete with Outdoor air reset strategy to reduce Hydronic Loop operating temperature off peak and allow the condensing boilers to operate in condensing range and approach peak thermal efficiency of 96% in actual operation.
    a. Savings: 163,159 kWhe/yr
3. Improved thermal efficiency of fuel-fired in-suite (i.e. CU-Suite #) including multi-stage control to improve part load efficiency
    a. Savings: 77,904 kWhe/yr
4. Addition of residential heat exchangers/heat recovery units
    a. Savings: 226,013 kWhe/yr

Overall estimated energy savings are 484 MWhe (i.e. 18%) and 153 tCO2e (i.e. 22%), equivalent to taking approximately 28 cars & light trucks off the road. Furthermore, the two options eliminated, namely Solar HW Heating and Heat Pump DHW tanks, offset only electrical energy consumption (i.e. no on-site fuel fired equipment or appliances serve these loads). Given that the remaining load is 100% electrified, GHG emissions associated with this remaining load would be reduced as the overall percentage of renewable power supplied by the grid increases.

The total annual Carbon cost reduced by 2030 is $26,010, based on the City of Windsor ENERGY STRATEGY TERMS OF REFERENCE rate of a $170/tonne of CO2e and current grid-side emissions.

References

[1] - “Electricity Rates.” ENWIN Utilities, https://enwin.com/electric-rates-residential/.

[2] - “Natural Gas Rates.” Enbridge Gas., Natural Gas Rates | Ontario Energy Board, https://www.oeb.ca/consumer-information-and-protection/natural-gas-rates.

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Appendix A

Carbon mitigation strategy

Riverside and Hall Condominum Building

5 Story Condominum Building

Residential - Apartment building/Multi-unit housing

Prepared by:

Dillon Consulting Limited

Executive summary

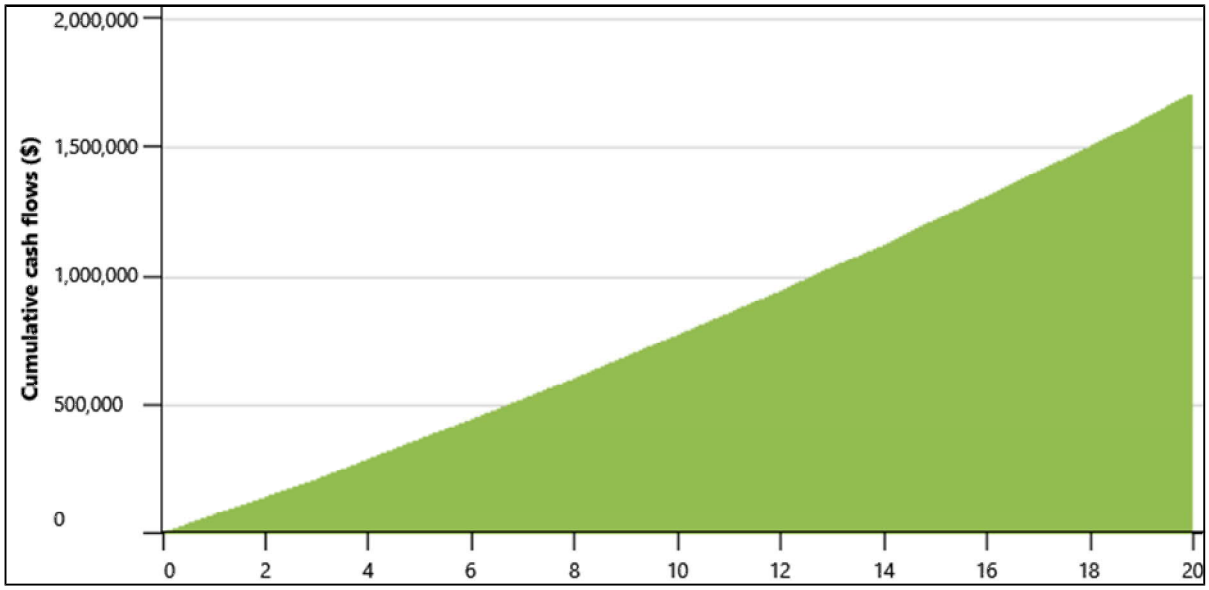
This report was prepared using the RETScreen Clean Energy Management Software. The key findings and recommendations of this analysis are presented below:

Target

	Fuel consumption MWh	Fuel cost $	GHG emission tCO_2
Base case	2,695	195,613	687
Proposed case	2,073	126,646	469
Savings	622	68,967	218
%	23.1%	35.3%	31.7%

The main results are as follows:

Cash flow - Cumulative



Location | Climate data

Location

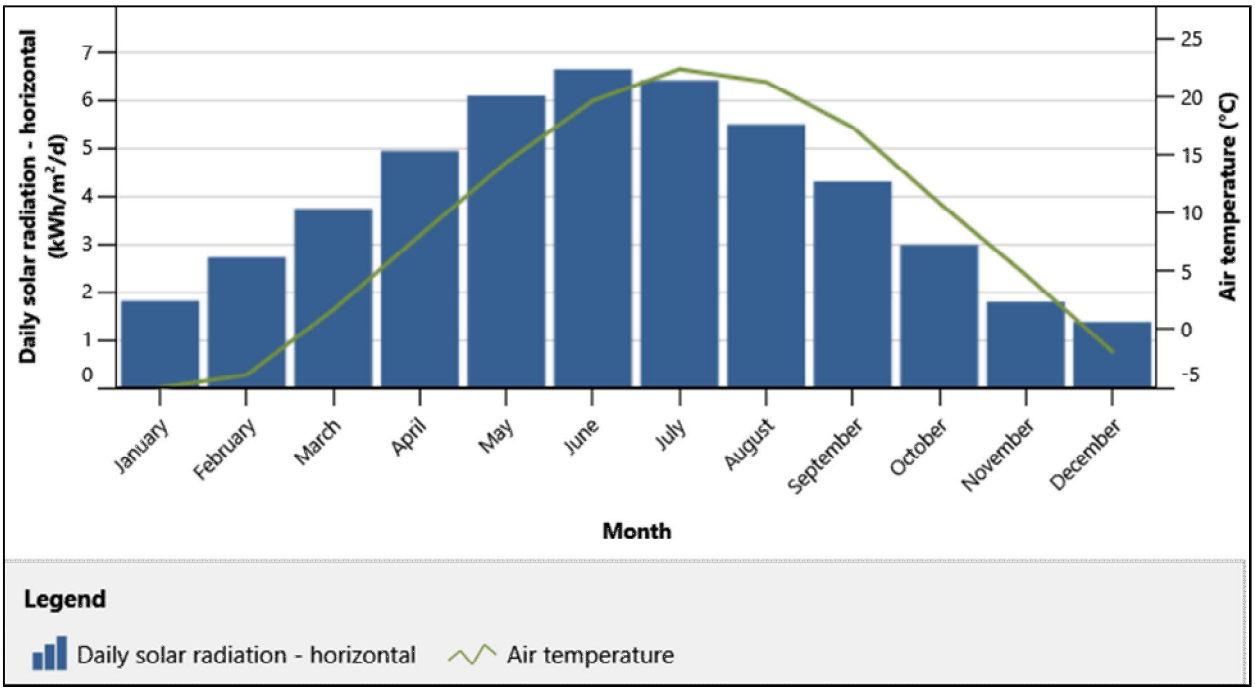
Legend

Facility location

Climate data location

	Unit	Climate data location	Facility location
Name		Canada - Ontario - Windsor Airport	Canada - ON - Windsor
Latitude	˚N	42.3	42.3
Longitude	˚E	-83.0	-83.0
Climate zone		5A - Cool - Humid	5A - Cool - Humid
Elevation	m	190	174

Climate data

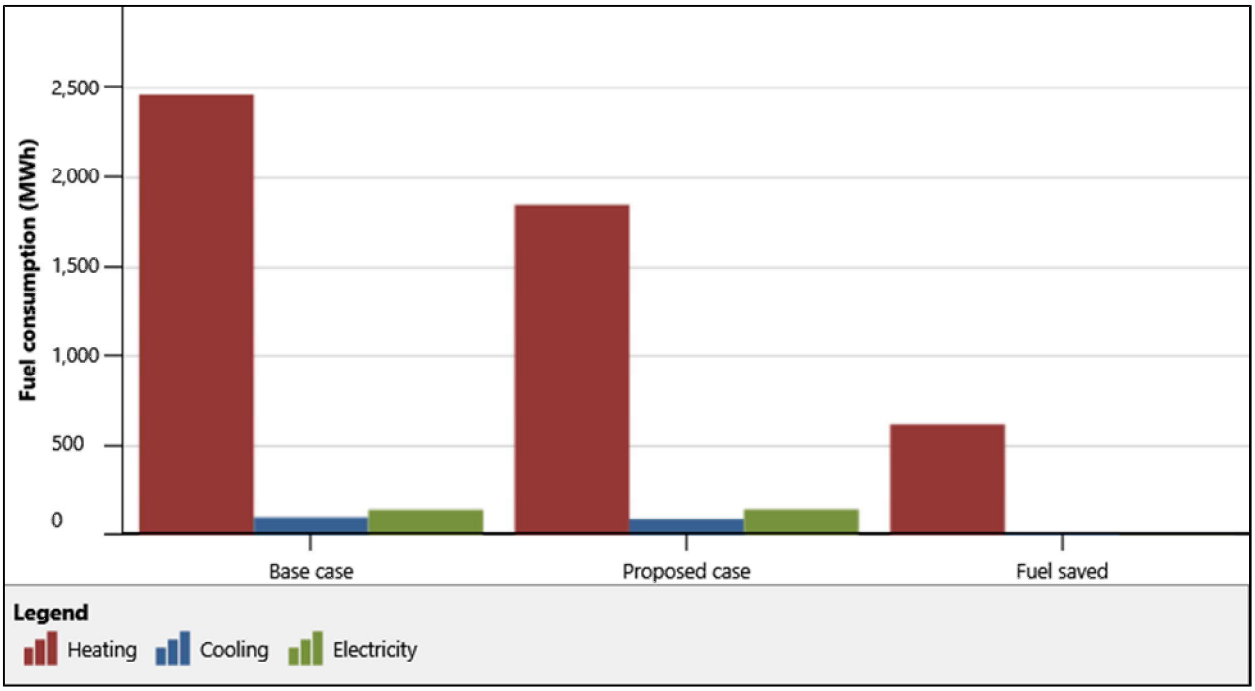


Heating design temperature	-13.7
Cooling design temperature	30.3
Earth temperature amplitude	21.4

Month	Air temperature	Relative humidity	Precipitation	Daily solar radiation - horizontal	Atmospheric pressure	Wind speed	Earth temperature	Heating degree-days	Cooling degree-days
	°C	%	mm	kWh/m²/d	kPa	m/s	°C	°C-d	°C-d
January	-5.0	74.5%	46.81	1.81	99.4	5.6	-3.6	713	0
February	-3.9	71.5%	44.52	2.72	99.4	5.3	-2.9	613	0
March	1.7	68.2%	54.25	3.73	99.3	5.6	1.2	505	0
April	8.1	64.7%	71.70	4.94	99.2	5.3	6.9	297	0
May	14.4	65.0%	80.29	6.09	99.2	4.7	12.8	112	136
June	19.7	66.2%	80.70	6.64	99.2	4.2	18.3	0	291
July	22.4	67.9%	81.84	6.41	99.3	3.6	21.5	0	384
August	21.3	72.3%	79.67	5.49	99.4	3.3	21.0	0	350
September	17.4	72.1%	78.30	4.30	99.5	3.6	17.3	18	222
October	10.9	70.7%	65.10	2.98	99.5	4.5	11.0	220	28
November	4.7	73.4%	64.50	1.79	99.3	4.7	5.0	399	0
December	-1.9	75.7%	56.11	1.37	99.4	5.0	-0.6	617	0
Annual	**9.2**	**70.2%**	**803.79**	**4.03**	**99.3**	**4.6**	**9.1**	**3,494**	**1,412**

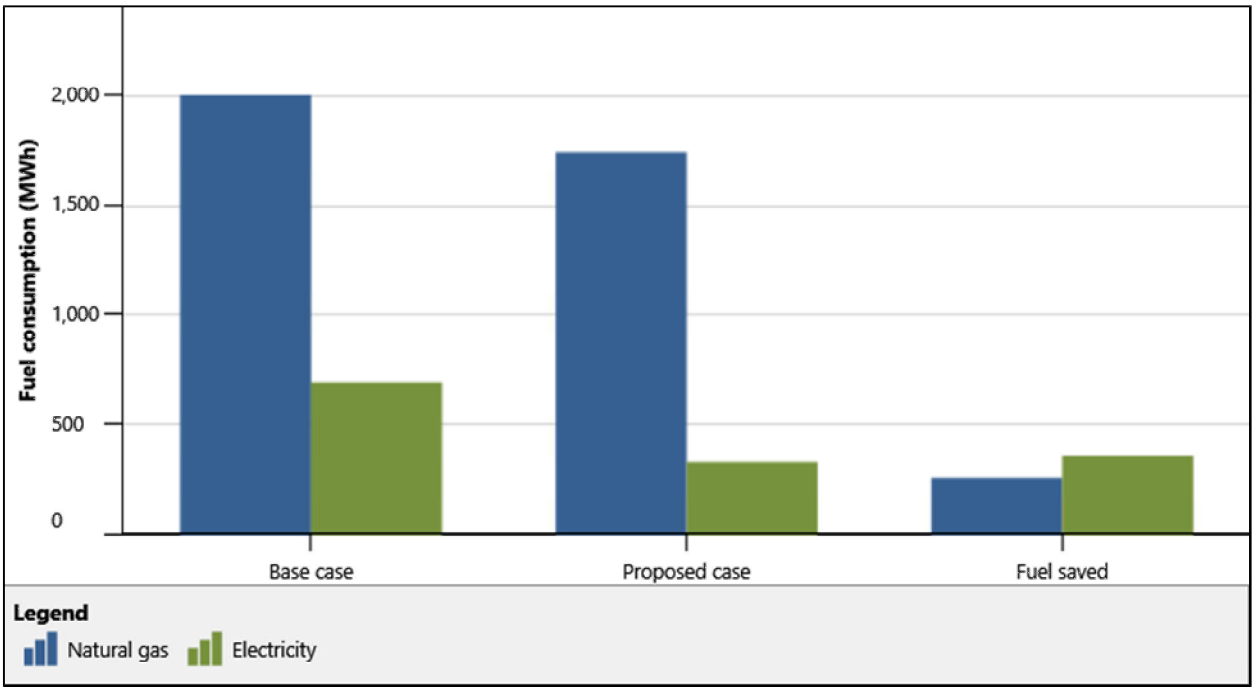
Energy savings | Fuel summary

Energy savings



Fuel consumption	Heating kWh	Cooling kWh	Electricity kWh	Total kWh
Base case	2,465,746	93,312	135,782	2,694,839
Proposed case	1,850,443	84,956	137,688	2,073,087
Fuel saved	615,303	8,355	-1,906	621,752
Fuel saved - percent	25%	9%	-1.4%	23.1%

Fuel summary

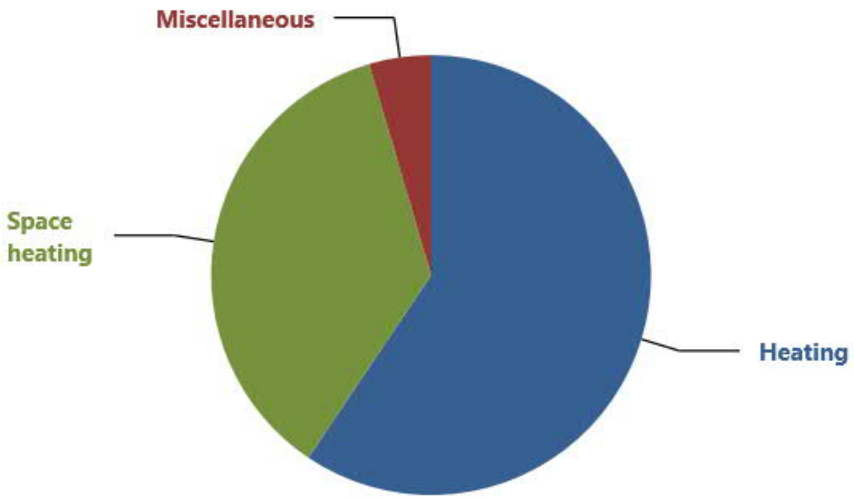


Fuel type	Fuel Unit	Base case Fuel consumption	Proposed case Fuel consumption	Savings Fuel saved
Natural gas	m³	188,382	163,980	24,402
Electricity	kWh	692,761	330,346	362,415

Fuel type	Fuel Fuel rate	Base case Fuel cost	Proposed case Fuel cost	Savings Savings
Natural gas	0.45 $/m³	$ 84,772	$ 73,791	$ 10,981
Electricity	0.16 $/kWh	$ 110,842	$ 52,855	$ 57,986
Total		$ 195,613	$ 126,646	$ 68,967

End-use

Fuel saved



Section	Fuel saved kWh	%
Heating	370,591	59.4%
Space heating	224,711	36%
Miscellaneous	28,356	4.5%
Solar water heater	20,001	3.2%
Space cooling	8,355	1.3%
Mechanical equipment	-1,906	-

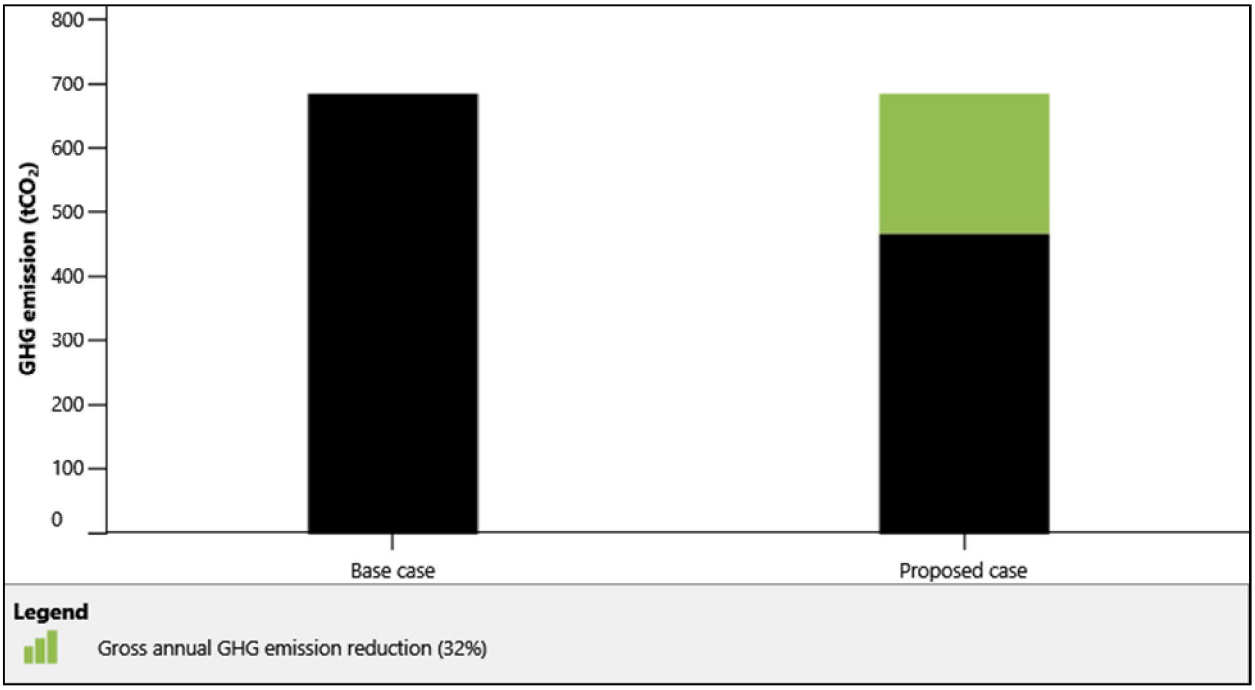
Target

Summary

	Fuel consumption MWh	Fuel cost $	GHG emission tCO_2
Base case	2,695	195,613	687
Proposed case	2,073	126,646	469
Savings	622	68,967	218
%	23.1%	35.3%	31.7%

GHG emission

GHG emission



GHG equivalence

217.9 tCO_2 is equivalent to 39.9

Cars & light trucks not used

GHG emission		
Base case	686.8	tCO_2
Proposed case	468.9	tCO_2
Gross annual GHG emission reduction	**217.9**	**tCO_2**