FEASIBILITY STUDY

Prepared For:

The Town of Kentville: Town Hall & Recreational Center
Kentville NS

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Executive Summary

Equilibrium Engineering Inc. performed a Level 2 Energy Audit on October 18th, 2022 at the Kentville Town Hall and Recreational Center building with the goal of determining the building's baseline energy use and investigating potential energy savings opportunities.

Ten (10) Energy Conservation Measures (ECMs) were identified, ranging from simple, low-cost savings opportunities to larger capital expenditure (CAPEX) projects. Ultimately eight (8) of the measures were selected for the project proposal, based on expected financial and energy performance. If implemented, total annual energy savings of 144,055 ekWh are expected, representing an approximate 45% reduction in total consumption. This would bring the building's Energy Use Intensity (EUI) down from the baseline of 152.4 kWh/m^2 to approximately 83.5 kWh/m^2. Annual carbon emissions avoided from undertaking these measures would equal 68.4 metric tons, equivalent to approximately 12.5 cars and light trucks off the road.

Under current market conditions, the proposed $356,678 project yields a pre-tax modified rate of return (MIRR) of 5.7%, representing an equity payback of approximately 16 years and a net present value of $11,954. On July 1, 2023, the federal carbon pricing system will take effect in Nova Scotia. If Kentville is not shielded from the impacts of the carbon pricing system, project performance improves to a MIRR of 8.2%, representing an equity payback of 8.7 years and a net present value of $82,369.

Table 1: KENTVILLE TOWN HALL AND RECREATION CENTER ENERGY CONSERVATION MEASURES

ESO #	*Measure Description*	*Relative Implementation Cost*	*Est. Install Cost ($)*[1]	*Est. Annual Savings [kWh]*	*Est. Annual Savings [L Oil]*	*Est. Annual Savings [$]*
Envelope Upgrades						
3.1.1	Window and doors replacement	High	$116,056	39,900	2,374	$10,036
Mechanical Upgrades (Electrification)						
3.2.1	Rooftop Heat Pump Upgrade (Town Hall)	High	$49,692	11,334	-	$1,932
3.2.2	VRV System (Rec Center)	High	$20,300	21,222	1,965	$6,295
3.2.3	Heat Pump Water Heater Upgrade	Medium	$15,000	-	824	$1,123
Operational Control						
3.3.1	LED Lighting Upgrade	Medium	$4,371	5,322	-	$907
3.3.2	Thermostat Replacements and Setbacks	Low	$2,600	17,725	1,263	$4,742
3.3.3	Hot Water Pipe Insulation	Low	$6/ft $8/ft	38 kWh/ft 46kWh/ft		
3.3.4	Employee Education Program	Low	$1,250	-		
Renewable Generation						
3.4.1	Roof Mounted Solar Photovoltaics[2]	High	$62,161	26,840	-	$4,574
3.4.2	EV Charging Station	High	$1,500 - $3,000 per EV charger	-		

[1] Cost estimates can vary greatly after the release of the report due to market-related pricing changes.
[2] Does not include potential demand savings on the electrical bills due to solar production.

Glossary

ASHP - Air Source Heat Pump. A highly efficient electric heating/cooling mechanical system.
ASHRAE - The American Society of Heating, Refrigerating and Air-Conditioning Engineers. This international professional association researches and develops technical standards for the HVAC industry.
CAPEX Measures - Measures with anticipated costs sufficient to qualify as a Capital Expenditure and would require increased specification before proceeding to implementation.
COP - Coefficient of Performance. A ratio of useful heating or cooling provided to work required.
ekWh - Equivalent kilowatt-hours. A unit of energy where non-electrical energy sources for the building are converted to the same unit as electricity for purposes of useful comparison.
ECM - Energy Conservation Measures.
ESO - Energy Saving Opportunities. An effort made to reduce the consumption of energy by using fewer energy services.
EUI - Energy Use Intensity. A metric that divides the total energy used from all sources by the building area. This is used to evaluate the energy intensity of a building relative to buildings of a similar type and to track changes within the same building over time.
EV - Electric Vehicle. A vehicle that uses one or more electric motors for propulsion.
HVAC - Heating, Ventilation, and Air Conditioning. The technology of indoor environmental comfort.
GHG - Greenhouse Gas. A greenhouse gas is a gas that absorbs and emits radiant energy within the thermal infrared range, causing the greenhouse effect.
kW - Kilowatt. A unit of power represents 1,000 watts and is commonly used to express the output power of motors, heaters, and lighting devices, describing the work done per unit of time. This unit is used to measure the electrical demand of a device or facility.
kWh - Kilowatt-hour. A unit of energy representing the power consumption over time, equivalent to a 1kW electrical load operating for 1 hour. This unit is commonly seen on electricity bills as the total energy consumption for the billing period.
LED - Light-emitting diode. A semiconductor light source that emits light when current flows through it.
MIRR - Modified Rate of Return.
NPV - Net Present Value. The difference between the present value of cash inflows and the present value of cash outflows over a period of time.
PV - Photovoltaics. A photovoltaic system employs solar modules, each comprising several solar cells that generate electrical power.
TRM - Technical Reference Manual.
W - The watt (W) is the standard SI unit of power. It is used to quantify the rate of energy transfer.

1 Site Visit Overview

A site visit was carried out on October 18th, 2022, which involved collecting detailed information on the major mechanical and electrical systems. Specific focus was given to collecting information about the current heating system, building envelope construction, ventilation equipment, and any non-routine equipment or process loads.

During the on-site visit, the team also conducted an interview with a senior staff member to better understand the building's typical operating hours, equipment setpoints, and general comfort level. The original construction drawings were used to obtain construction details and dimensions. These variables were used in conjunction with the equipment specifications to generate an energy model with NRCan's RETSCreen Expert software.

1.1. Facility Description

Kentville Town Hall, located at 345 Main Street in Kentville, is composed of two formerly separate structures. The east-facing structure was purchased by the Town of Kentville in 1946 from the Salvation Army to serve as the town’s Town Hall and Fire Station. It now houses the Kentville Recreation Center for recreational programming and some administration offices. In 1989, the Town Hall was joined to the adjacent Maritime Tel & Tel building; this most recent addition to the building houses the planning department with offices on the main floor and some more offices and the Town’s council chamber on the second floor.

The building envelope consists of two above-grade floors with wood frame, brick facade and a full-height concrete basement. The roof of the town hall and recreation center are flat roofs. During the site visit, it was observed that the building operation schedule is kept close to eight and a half hours a day with weekends off.

Figure 1: Kentville Town Hall and Recreation Center Front Elevation

The Town Hall, which consists of the former Maritime Tel & Tel building and the administrative offices in the structure bought from the Salvation Army in 1946, is heated and cooled primarily by seven (7) rooftop heat pumps with electric baseboards and portable electric space heaters supplying backup heat. These rooftop units also ventilate the space and are all equipped with economizers. A ductless wall-mounted heat pump supplies heating and cooling to the server room. The recreation center however, is heated by a no.2 oil boiler via cast iron radiators and two (2) ductless wall-mounted heat pumps in the activity room on the main and the top floor.

Thermostats are set to use the electric and hydronic baseboards as primary heat source with the ductless heat pumps serving as backup. The heat pumps are primarily used for cooling during the summer. There is currently no ventilation in the recreation center. Domestic hot water is provided by a mix of standard electric storage tanks and an indirect oil-fired tank in the basement boiler room.

The dominant lighting technology is fluorescent, with compact fluorescent bulbs and fluorescent tubes accounting for the majority of the lighting throughout the building. LED lights were found in the newly renovated office spaces and stairwells, with a mix of high-pressure sodium and LED lights on the building exterior.

1.2. Building/Maintenance Concerns

The windows on-site were installed decades ago and are experiencing some drafts. Most windows and doors appeared to seal well with minimum weather stripping present, though exit doors leading into the parking lot all showed signs of degradation on the bottom edge, in some cases making daylight visible despite being closed (Figure 2). This allows the conditioned air to pass through the building and affects thermal comfort and increases energy consumption. Air infiltration could also be a contributing factor to why portable heaters are reportedly used in office spaces through the winter months.

Figure 2: The Degraded Exit Door and the Vent next to the Door

The boiler room was noted to have a weekly checklist with regular entries. The coil plate and gasket have detached from the side wall of the boiler leaving a gap several inches wide; this allows heat from inside the boiler to bypass the insulation lining the boiler walls and escape into the boiler room. Ultimately, this lowers the efficiency of the boiler and adds to the heat in the boiler room. If not already noted from an earlier inspection, this should be addressed during the next boiler servicing.

There are several penetrations through the envelope as a result of rooftop heat pumps, dryer vents, exhausts, incoming services, and exterior wall-mounted light fixtures. Each penetration provides the opportunity for cold air to be driven in from strong winds on the exposed side, with the corresponding leakage of warm air through the remaining gaps and cracks in the building envelope. The existing wall and roof could be upgraded when replacing the brick facade with a more effective exterior insulation package to improve the effective R-value and also increase air tightness.

2 Annual Energy Analysis

To understand how a building's energy use compares to similar archetypes (e.g. warehouse vs warehouse or office vs office), the assessment team uses historical energy consumption data to calculate the Energy Use Index (EUI). The EUI is determined by dividing the total energy consumption in equivalent kilowatt-hours by the total conditioned floor area (ekWh/m²). Calculating the EUI allows for a direct comparison of similar buildings of different sizes and shapes.

2.1. Energy Benchmarking

Energy benchmarking calculates the total annual energy use, in this case, electricity and oil #2, and divide it by the total building floor area to determine the Energy Use Index (EUI) in kWh/m². These indexes allow comparisons between similar buildings to gain an understanding of the building's performance relative to others. The Kentville Town Hall and Recreation Center EUI was calculated using Energy Star Portfolio Manager and can be compared against the national median benchmark for public service buildings.

Table 2: Kentville Town Hall & Recreation Center Energy Use Index & Comparison

	2020	2021	Benchmark Facility*	% Difference
EUI	152.4 kWh/m²	120.6 kWh/m²	225 kWh/m²	**-32%**

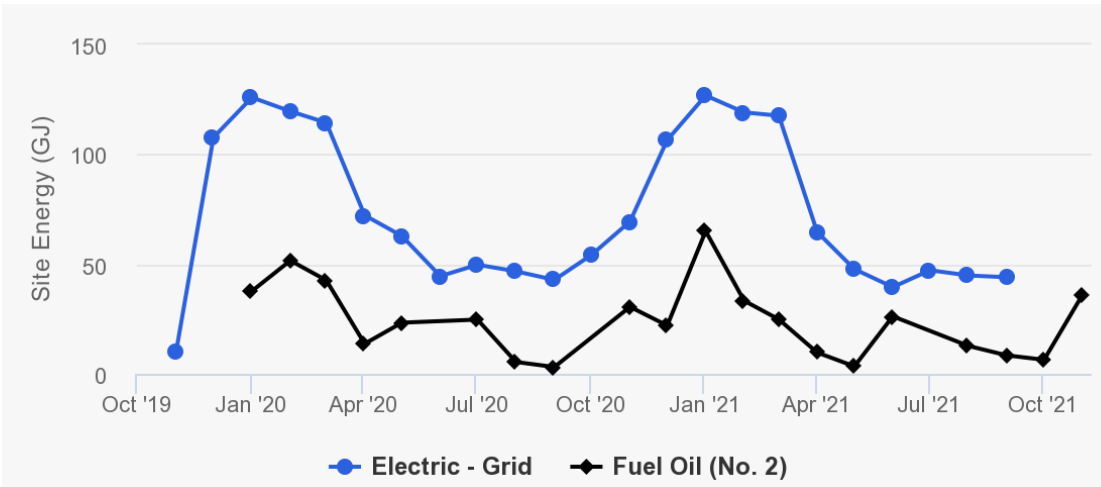
**Median EUI for Public Service buildings taken from Energy Star Portfolio Manager report.*

The 2020 EUI was accepted as the standard value due to insufficient data for the previous years. A difference in the EUI is observed in comparison to the Level 1 energy audit study due to the change in the total area of the building obtained from the drawings to the measurements obtained from online sources such as google maps and viewpoint. The 2020 EUI was found to be 32% better than the benchmark value. The years 2020 and 2021 saw usage patterns change in many buildings due to the COVID-19 Pandemic. The 2020 EUI was found to be 32% better than the benchmark value, this is likely due to the public use spaces in the basement and Recreation Center having lower occupancy, and therefore lower energy use. To normalize the occupancy effects, it is recommended to use the 2020 EUI as a baseline for future comparisons.

2.2. Energy End-Use Breakdown

Historical energy data was used to break down the monthly energy consumption and as discussed in the Energy Benchmarking section. The usage pattern for both electricity and fuel consumption is shown in Figure 3.

Figure 3: Energy Use by Calendar Month for Kentville Town Hall & Recreation Center [3]



The annual energy use breakdown is shown in Figure 4. Electricity is responsible for approximately three-fourths of the energy consumption at 252,360 kWh annually. Furnace oil accounts for the remainder totaling 70,860 ekWh (or 6,560 L) per year.

The typical energy use breakdown for other services building in Atlantic Canada[4] is shown in Figure 5. The major drivers are space heating, lighting, and auxiliary equipment representing approximately 80% of all building energy consumption.

[3] Energy Use by Calendar Month Data generated by Energy Star Portfolio Manager.
[4] National Energy Use Database Commercial/Institutional Sector – Atlantic Canadian Offices Secondary Energy Use, 2018

Figure 4: Kentville Town Hall & Recreation Center Annual Energy Breakdown

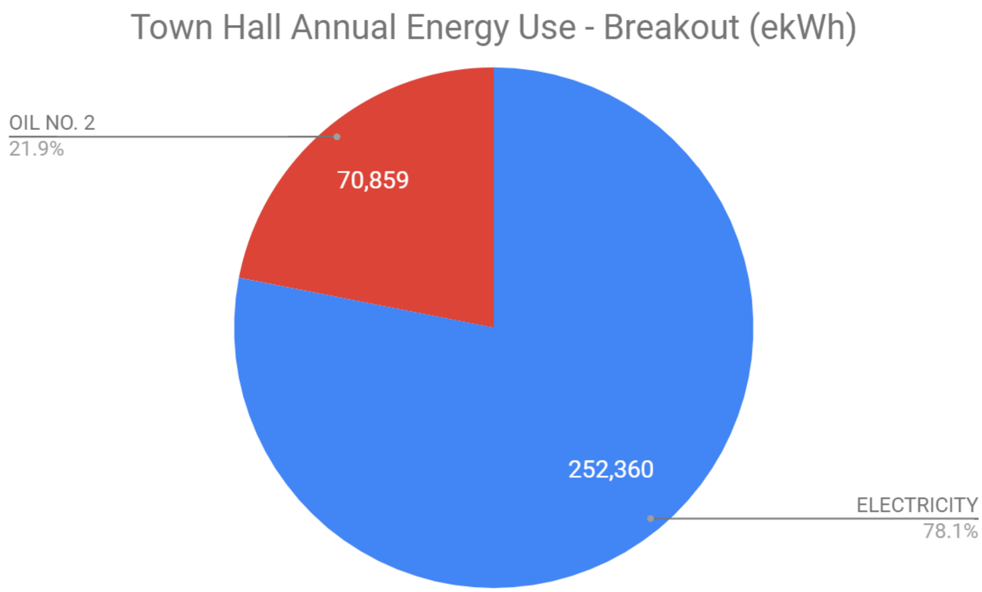
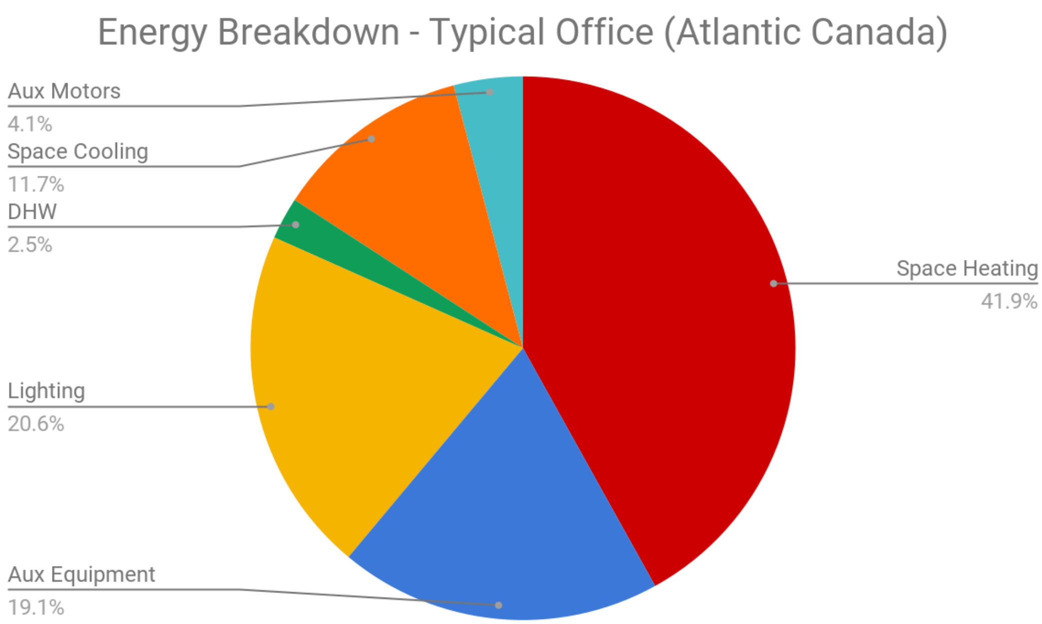


Figure 5: Secondary Energy Uses, Other Services



2.3. Greenhouse Gas Emissions

Energy cost often dominates the conversation when making investments in building retrofits. However, greenhouse gas (GHG) emissions have become a more common part of the discussion and are now considered part of the total cost of ownership. On July 1, 2023 the federal carbon pricing system will take effect in Nova Scotia which will accelerate focus on carbon emissions from all sources, including buildings. **The annual base case emissions of the building is 171 tonnes CO_2.**

For this assessment, standard emission factors ($kgCO_2/kWh$) were taken from the Canada Green Building Council's Zero Carbon Building (ZCB) standard and Nova Scotia Power.

Table 3: Fuel Carbon Intensities Utilized

Nova Scotia Electric Carbon Intensity ($kgCO_2/kWh$)[5]	Fuel Oil Carbon Intensity ($kgCO_2/kWh$)[6]
0.603	0.256

[5] https://www.nspower.ca/cleanandgreen/air-emissions-reporting
[6] https://portal.cagbc.org/cagbcdocs/zerocarbon/v2/ZCB-Design_v2_Workbook.xlsx

3 Energy Savings Opportunities

The generally accepted approach to energy conservation is to emphasize

- Efficient building envelopes,
- Efficient electric mechanical systems,
- Intelligent operational practices / controls,
- Renewable energy generation.

The following sections describe the recommended Energy Conservation Measures (ECMs), the annual energy savings estimates, and the relative implementation costs. Note that the total savings from implementing multiple measures cannot be strictly additive and should be evaluated as a whole as presented in Section 4. The energy performance of the measures was evaluated using a calibrated energy model using the RETScreen Expert Clean Energy Management Software.

3.1. Building Envelope Upgrades

Air leakage occurs when outdoor air enters, or conditioned indoor air exits, the building in an uncontrolled manner. The uncontrolled flow of air can increase heating and cooling loads and decrease operational efficiencies. Increasing building envelope efficiency is often regarded as the most important area of an energy retrofit. Envelope efficiency can be increased by upgrading wall and roof insulation, window and door fixtures, and air-sealing.

3.1.1. Window and Door Fixtures

The current windows and doors were installed decades ago and are in poor condition. In addition, the existing fixtures do not have comparable thermal performance to modern ones. Full window and frame replacement of the existing single pane windows found at Kentville town hall and recreational center would offer more energy savings than air-sealing and caulking old windows.

The most common door upgrade is steel-skinned with a polyurethane foam insulation core. These typically have magnetic strips that act as weatherstripping. The most common window upgrade is double-glazed windows with argon between the glazing layers to slow the conductive heat transfer between the outside air and indoor air.

This measure was evaluated in RETScreen by improving the air leakage setting for window and door components by two levels, i.e. from “Leaky” to “Tight”. Further analysis is recommended for this measure as the pandemic has affected the pricing and availability of common building materials and to ensure the assumed activities can be coordinated with current CAPEX plans.

The **non-electrical benefits** are: increased thermal comfort for staff.

Table 4: Window Replacements Savings

Capital Costs [$]	Electrical Savings [kWh]	Oil #2 Savings [L]	Payback [Yrs]	GHG Reduction [tCO2 equivalent]
$116,056	39,899	2,374	11.6	39.5

3.2. Mechanical Systems Upgrade & Electrification

After building envelopes, upgrades to mechanical systems typically represent the biggest opportunity for a building to reduce its energy consumption and operational costs. This is especially the case in situations where the current system relies upon fossil fuels which leave the building vulnerable to increasingly stringent building efficiency standards and carbon pricing policies. Electrification is essential to obtain a Net-Zero energy and carbon result without relying on the purchase of future carbon offsets.

3.2.1. End of Life Replacement - Rooftop Heat Pumps

Building space heating and cooling are primarily provided by rooftop heat pumps. Of the existing seven heat pumps, two are under six years old. The remaining five heat pumps are approximately 30 years old. The expected useful life of a heat pump is 15 years, thus the 30 year old rooftop heat pumps are due for replacement. Modern high-efficiency models should be targeted for replacements above standard efficiency models as they offer both higher performance and are often eligible for rebates through Efficiency Nova Scotia.

To evaluate this measure it was assumed that the replacement rooftop heat pump units would be from the *Daikin DRH* Commercial line of high-efficiency heat pumps (model #'s: DRH0363D, DRH0483D, DRH0723D).

The **non-electrical benefits** are: increased thermal comfort for staff.

Table 5: Heating System Upgrade Savings

Capital Costs [$]	Electrical Savings [kWh]	Oil #2 Savings [L]	Payback [Yrs]	GHG Reduction [tCO2 equivalent]
$49,692	11,334	-	25.7	6.8

3.2.2. Recreation Center Heating Electrification - Variable Refrigerant Volume System

The recreational center is heated predominantly by a fuel oil boiler via cast iron radiators. It is recommended to install a centralized Variable Refrigerant Volume System (VRV) heat pump system to provide efficient space heating and cooling to this area of the building. The efficient VRV system will displace the building's fuel oil usage providing significant GHG reductions and energy savings.

To evaluate this measure it was assumed that the recreation center is equipped with a *DAIKIN VRV IV S-Series* outdoor unit paired with four *FXSQ* concealed, ducted, indoor units (18 SEER, 3.75 COP). Some of the annual savings would be reduced due to the addition of air conditioning and ventilation, however, the net effect is a significant reduction in heating costs.

The **non-electrical benefits** are: increased thermal comfort, reduced maintenance issues

Table 6: Heating Electrification Savings

Capital Costs [$]	Electrical Savings [kWh]	Oil #2 Savings [L]	Payback [Yrs]	GHG Reduction [tCO2 equivalent]
$20,300	21,222	1,965	3.2	25.6

3.2.3. Recreation Center Ventilation upgrade - Heat Recovery Ventilator

The recreation center portion of the building has insufficient ventilation. It is recommended to install a Heat Recovery Ventilator to provide the necessary ventilation capacity. Adding ventilation capacity will increase the energy consumption, however, it is necessary to provide a comfortable and safe working environment for the occupants. The HRV evaluated for upgrade is the *Fantech SHR 450* Heat Recovery Ventilator with a sensible efficiency of 56%.

Note that this measure does not decrease energy capacity but is recommended for code compliance and safety. As such the measure is excluded from the analysis in Section 4.

Table 7: Heat Recovery Ventilator Impact

Capital Costs [$]	Electrical Savings [kWh]	Oil #2 Savings [L]	Payback [Yrs]	GHG Reduction [tCO2 equivalent]
$15,888	NA	NA	*NA*	*NA*

3.2.4. Domestic Hot Water Electrification - Heat Pump Water Heater

The domestic hot water is provided by an indirect oil-fired tank in the basement boiler room and a couple of electric water heaters throughout the rest of the building. A more effective alternative would be to add a heat pump water heater (HPWH) to take over the boiler's water heating load and keep the indirect tank for top up if ever necessary. HPWH have significantly higher efficiencies than oil fired tanks providing fuel and cost savings. The replacement of the smaller electric water heaters with similar HPWHs was not deemed cost efficient due to their limited use.

Savings for this measure were calculated considering HPWTs with a COP of 3.3 (minimum COP to be eligible for a commercial heat pump water heater by Energy Star), providing a 6°C to 65°C lift to the water temperature.

The **non-electrical benefits** are: reduced demand during peak demand.

Table 8: Heat Pump Water Heater Savings

Capital Costs [$]	Electrical Savings [kWh]	Oil #2 Savings [L]	Payback [Yrs]	GHG Reduction [tCO2 equivalent]
$15,000	-	824	13.4	5.4

3.3. Efficient Operational Practices & Control

Operating parameters of a building (such as temperature setpoints, lighting level, operational practices, etc.) often shift over time impacting overall building performance. Staff members can influence the energy use of a building through their daily actions. Whenever possible, controls should be implemented which ensure efficient building operation, shifting the burden of awareness away from employees and minimizing human error. Common examples of operational controls which reduce energy usage are lighting occupancy sensors and programmable thermostats.

3.3.1. Lighting Upgrades

The building is primarily lit by a variety of fluorescent lighting technologies, and LED lights in the newly renovated office spaces and stairwells, with a mix of high-pressure sodium and LED lights on the building exterior. The fluorescent and high-pressure sodium technologies have been superseded by modern LED lighting options that offer energy savings, increased control options, fewer lamp replacements, and longer lifetimes.

Savings estimates were calculated by determining the total consumption per fixture in both the existing base case and the proposed retrofit case, adding this data to the RETScreen model to simulate their use according to the various space schedules. The model results are presented in the following table.

Table 9: LED Replacement Wattage and Corresponding Energy Savings

Fixture Type	Quantity	Existing Wattage [W]	LED Wattage [W]	Annual Energy Savings [kWh]	Annual Cost Savings [$]
4-Lamp 4’ Fluorescent	21	94	50	3,357	$570
2-Lamp 4’ Fluorescent	21	50	32	554	$95
Compact fluorescent	46	13	9	434	$74
High Pressure Sodium	2	70 and 200	44 and 128	758	$129
Other	34	Varies	Varies	230	$39
Total	124	-	-	5,322	$907

The total annual savings from avoided electricity costs due to the replacement of these older lighting technologies with compatible LED replacements would amount to just over $900. This translates to a reduction in energy consumption of about 5,300 kWh annually. With an estimated implementation cost of $4,370, this measure would yield a payback of 4.8 years.

Table 10: Lighting Upgrade Savings

Capital Costs [$]	Electrical Savings [kWh]	Oil #2 Savings [L]	Payback [Yrs]	GHG Reduction [tCO2 equivalent]
$4,371	5,322	-	4.8	3.2

3.3.2. Programmable Thermostats

The rooftop heat pumps and the hydro baseboard heaters are controlled by thermostats, primarily older style models using mercury switches or bi-metallic strips. The building currently has no programmable thermostats. These control methods are old and prone to inaccuracy over time. The setpoints were left at approximately 21°C year round, with baseboards set back to 18°C to serve as backup heating sources.

Digital thermostats offer more accurate control of the temperature and can better anticipate the space reaching the setpoint, reducing temperature overshoot. Additionally, these often allow programming schedules for the temperature setpoint, allowing setbacks for unoccupied periods. Reducing the heating setpoint by 1°C for 8 hours a day resulted in about a 1% reduction in the annual fuel consumption. The New York Technical Reference Manual (TRM) estimates a programmable thermostat with setbacks saves an average of 6.8% on fuel consumption.

Preliminary cost estimates for digital thermostats are $200 per unit and it is advised to coordinate any thermostat replacements with HVAC contractors to ensure compatibility with existing or future HVAC equipment. About half of the heating is already on digital thermostats (without schedules), thus the savings from replacing the remaining thermostats and setting schedules for heating/cooling is estimated at 17,725 kWh and per year.

Table 11: Programmable Thermostats & Temperature Setbacks

Capital Costs [$]	Electrical Savings [kWh]	Oil Savings [L]	Payback [Yrs]	GHG Reduction [tCO2 equivalent]
$2,600	17,725	1,263	0.5	18.9

Note that in section 4, this measure is evaluated in conjunction with the other measures by adjusting temperature setpoints and schedules in the RETScreen model as per the schedule attached in the Appendix.

3.3.3. Hot Water Pipe Insulation

Domestic hot water is provided by a standard electric water heater with a capacity of 181.7 L and 175 L and a direct tank heated by the oil-fired boiler with a storage tank capacity of 285 L. The pipes from the tank should be insulated to reduce heat loss. The water heater used for domestic water heating has no noticeable insulation on the pipes, as seen in Figure 6. It is recommended to install pipe insulation on copper pipes extending from the water heater (to a maximum of 10 feet). Studies have shown that DHW pipe insulation has savings of 38 kWh/ft and 46 kWh/ft per year depending on the pipe dimension.

Figure 6: Uninsulated Hot Water Pipes

Although the exact hot water consumption at Kentville Town Hall and Recreation Center is unknown, energy savings would still be realized by installing pipe insulation at a very low cost. The table below shows the estimated cost of material and labor per linear foot of 1’’ insulation for 1” and ¾’’ diameter pipes.

Table 12: Hot Water Pipe Insulation Unitary Savings

Type	Capital Costs [$]	Savings [ekWh]
1” Insulation of ¾” Pipes 1” Insulation of 1” Pipes	$6 per foot $8 per foot	38 ekWh/ft per year 46 ekWh/ft per year

3.3.4. Employee Energy Education

Staff members can influence the energy use of a building through their daily actions. Behavioral programs that set goals, establish an energy champion, and review team results have been shown to save on a building's annual energy consumption, with 10% savings being proven in real-world applications[7]. For the Town Hall and Recreation Center, this could result in savings of 25,360 kWh in electricity per year. A recommended energy education program is *Thinkwell Shift's GET 2 ZERO*[8] Program which is tailored to help everyday businesses identify, measure, and manage their energy use and emissions with 10 hours of hands-on training. The cost requirement would be approximately $1,250.

Note that potential energy savings resulting from this measure will be highly variable depending on building circumstances and staff buy-in. For this reason, this measure has been excluded from the overall analysis presented in Section 4.

3.4. Renewable Generation and Electrification

The carbon footprint of electrical appliances and HVAC equipment depends on the generation mix of the electric supply (renewables, fossil fuels etc.). A major benefit of electrifying buildings is the ability to offset loads with a carbon neutral source via clean renewable electricity. Renewable energy can be obtained via on-site generation or through community renewable programs.

3.4.1. On-site Generation

Solar electricity generation has become more cost-effective in recent years making it a real opportunity to add value to buildings by generating renewable power on-site. Equilibrium Engineering used Helioscope[9] software to perform a PV screening simulation and estimate energy production. The preliminary model consisted of a roof-mounted array using standard spacing criteria from all mechanical equipment and roof edges, resulting in an array capacity of 20.8 kW and an

[7] https://www.nrcan.gc.ca/sites/nrcan/files/oee/files/pdf/publications/commercial/Awareness_Program_e.pdf
[8] https://www.thinkwellshift.ca/get2zero
[9] https://www.helioscope.com/

estimated annual production of 26,840 kWh. This array would offset approximately 10.6% of the Town Hall's current annual electricity consumption. Figure 7 illustrates the proposed PV array layout used in the simulation.

Figure 7: Layout of Rooftop Solar Arrays (blue rectangles) and Obstructions such as Rooftop Heat-pumps and Fans (orange).

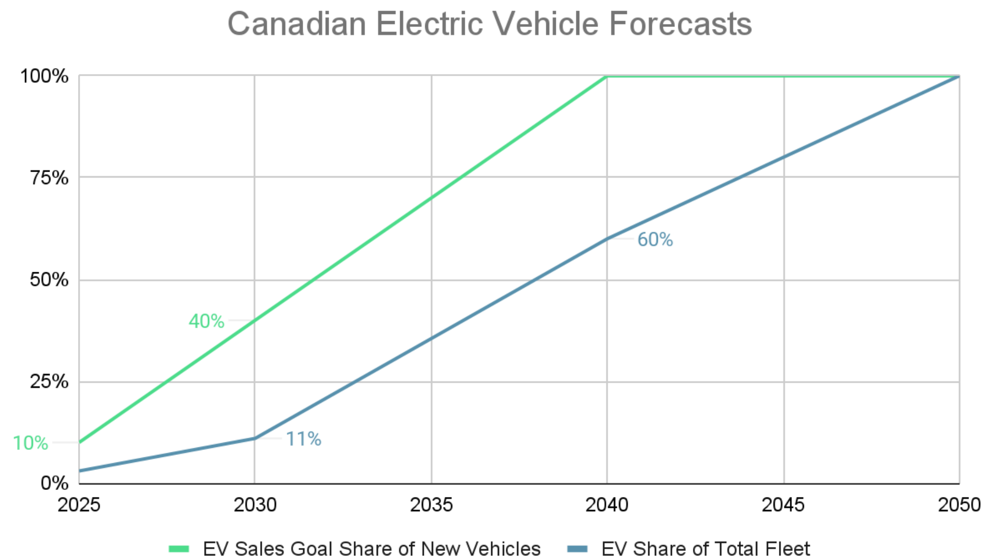
Table 13: Photovoltaic Savings

Capital Costs [$]	Electrical Savings [kWh]	Oil #2 Savings [L]	Payback [Yrs]	GHG Reduction [tCO2 equivalent]
$62,160	26,840	-	13.6	16.8

3.4.2. EV Charging Station

The Canadian government has identified electric vehicles (EVs) as a key technology to meet federal carbon emission reduction targets. Sales targets have been set for EVs to influence the pace of adoption, with the sales targets and share of EVs among all registered vehicles in the Canadian fleet illustrated in the chart below. While an estimated 80% of charging will occur at home, Level 2 charging stations at workplaces and public buildings are expected to be part of the solution in developing an adequate charging network.

Figure 8: Electric Vehicle Forecasts - Canada



Level 2 charging stations use a 240 Volt outlet (similar to a kitchen stove) and add about 30 km of range per hour charged. Commercial chargers offer options including employee/fleet access control, scheduled charging times, monetization, and overall load control limits to allow for a variety of EV charging scenarios. Budget costs for purchase and installation are $1,500 - $3,000 per EV charger and would require a review of the existing service capacity and distribution as part of the system design. **Note that the savings resulting from this measure would vary depending on the use case, thus EV chargers are excluded from the analysis in Section 4.**

4 Project Performance

Ten energy conservation measures were identified for the Kentville Town Hall. The performance of the measures was analyzed individually and the following eight measures were selected for the project proposal:

- Window and Doors Upgrade
- Rooftop Heat Pump Upgrade (Town Hall)
- VRV System (Rec Center)
- Heat Pump Water Heater Upgrade
- LED Lighting Upgrade
- Thermostat Replacements and Setbacks
- Roof Mounted Solar Photovoltaics

This section of the report provides a financial and energy performance analysis of the proposed project comprising the above measures. Justification for the omission of various measures is provided in Section 3. The calibrated RETScreen model was used to evaluate the combined impact of the energy measures and facilitate detailed financial and energy analyses. Note that the financial analysis does *not* include any available rebates or tax credits. The results of the calculations are summarized and presented below with a full RETScreen Expert report included in the Appendix.

Table 14: Energy Savings Summary

	Fuel consumption MWh	Fuel cost $	GHG emission tCO_2
Base case	324	52,140	171
Proposed case	180	29,872	103
Savings	144	22,268	68.4
%	44.5%	42.7%	40%

4.1 Financial Results

To realize the energy savings identified in this energy assessment, the Kentville Town Hall and Recreation Center would require an investment of approximately $356,678, which represents a Class C budget. The financial returns support the investment and generate a positive net present value over the current operating model.

As with all financial analyses, assumptions had to be made regarding the variables used in calculating Net-Present Value (NPV). Further refinement of these values can easily be implemented with input from the Municipality. The following tables summarize the costs, savings, projected cash flow, and financial viability of the proposed energy upgrades. A full copy of the RETScreen Expert report is available in the Appendix.

Figure 9: Kentville Town Hall and Recreation Center - Financial Variables

General		
Fuel cost escalation rate	%	3.5%
Inflation rate	%	3%
Discount rate	%	6%
Reinvestment rate	%	0%
Project life	yr	20
Finance		
Incentives and grants	$	
Debt ratio	%	80%
Debt	$	285,342
Equity	$	71,336
Debt interest rate	%	5%
Debt term	yr	15
Debt payments	$/yr	27,491

Figure 10: Costs, Savings & Revenue (Without Carbon Pricing)

Initial costs			
Engineering	7%	$	25,000
Incremental initial costs	79.9%	$	285,155
Balance of system & miscellaneous	13%	$	46,523
Total initial costs	**100%**	$	**356,678**
Yearly cash flows - Year 1			
Annual costs and debt payments			
O&M		$	0
Fuel cost - proposed case		$	29,872
Debt payments - 15 yrs		$	27,491
Total annual costs		**$**	**57,362**
Annual savings and revenue			
Fuel cost - base case		$	52,140
GHG reduction revenue		$	0
Other revenue (cost)		$	0
CE production revenue		$	0
Total annual savings and revenue		**$**	**52,140**
Net yearly cash flow - Year 1		**$**	**-5,223**

Figure 11: Kentville Town Hall and Recreation Center - Projected Cash Flow

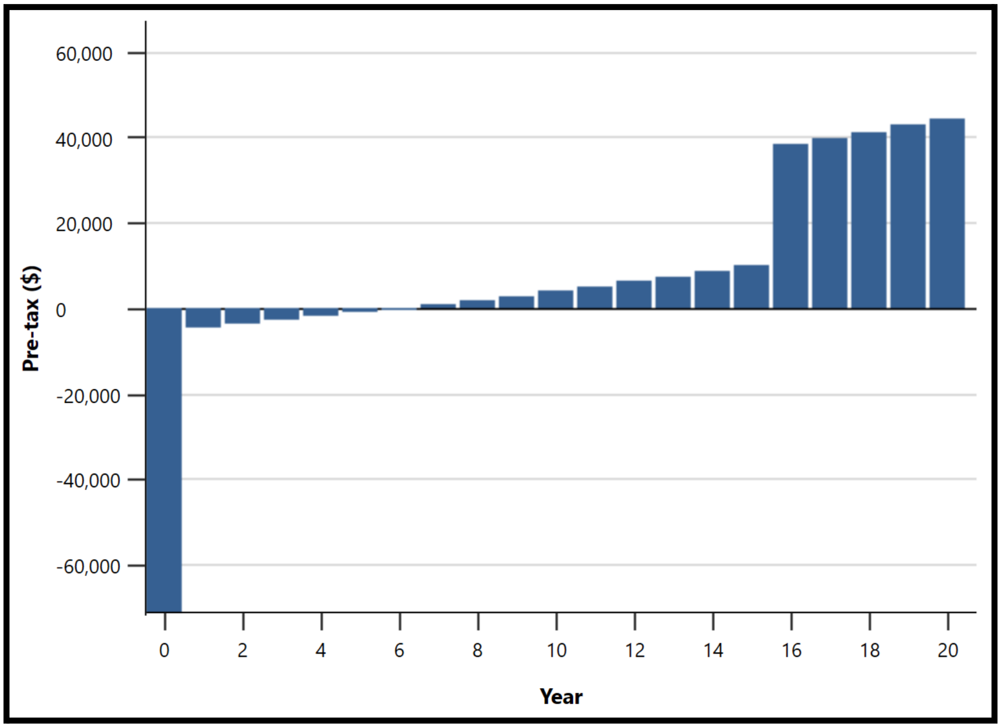


Figure 12: Kentville Town Hall and Recreation Center - Financial Viability

Pre-tax IRR - equity	%	6.9%
Pre-tax MIRR - equity	%	5.7%
Pre-tax IRR - assets	%	-2.2%
Pre-tax MIRR - assets	%	-1.9%
Simple payback	yr	16
Equity payback	yr	16
Net Present Value (NPV)	$	11,594
Annual life cycle savings	$/yr	1,011
Benefit-Cost (B-C) ratio		1.2
Debt service coverage		0.84
GHG reduction cost	$/tCO$_2$	8.61

4.2 Federal Carbon Pricing

On July 1, 2023, the federal carbon pricing system will take effect in Nova Scotia. The price of carbon will start at \$65/tCO_2 and raise by \$15/tCO_2 each year until 2030. If Berwick is not shielded from the impacts of the carbon pricing system it will be vulnerable to increased energy costs. The carbon pricing system improves the performance of the proposed project, resulting in the performance shown in Figure 9. For evaluation, it was assumed that the carbon pricing does not extend past 2030 as the government has not provided prices beyond this time frame. If the carbon pricing system does continue after 2030, project performance will be further improved.

Figure 13: Financial Viability (With Carbon Pricing)

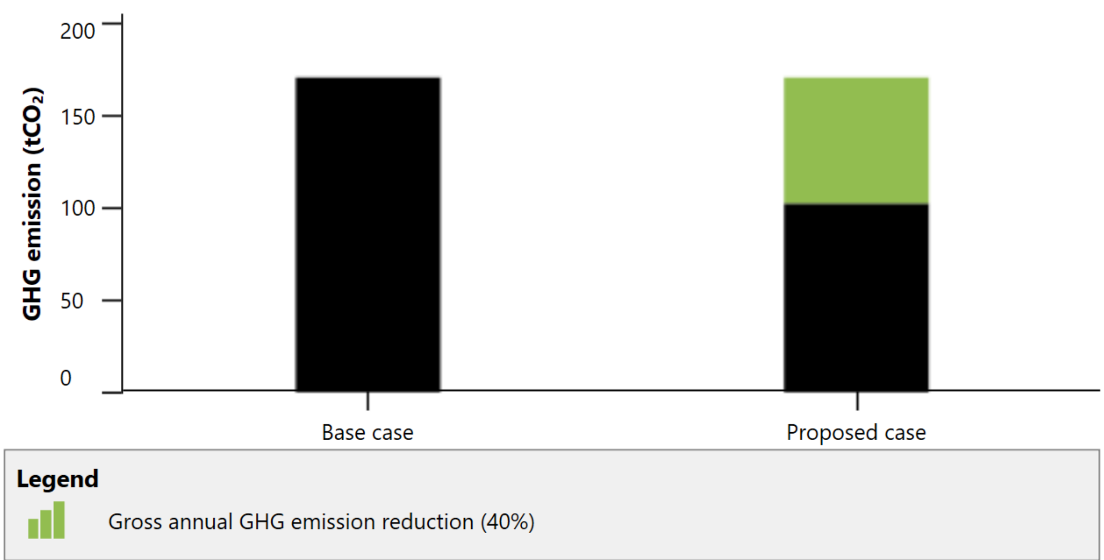
Pre-tax IRR - equity	%	13%
Pre-tax MIRR - equity	%	8.2%
Pre-tax IRR - assets	%	-0.29%
Pre-tax MIRR - assets	%	-0.21%
Simple payback	yr	13.4
Equity payback	yr	8.7
Net Present Value (NPV)	$	82,369
Annual life cycle savings	$/yr	7,181
Benefit-Cost (B-C) ratio		2.2
Debt service coverage		1
GHG reduction cost	\$/tCO_2	8.61

4.3 Road to Net-Zero

The proposed project would lead to annual GHG reductions of 68.4 tCO_2, equivalent to roughly 15.5 acres of forest absorbing carbon.

Figure 14: Greenhouse Gas Emission Reductions

GHG emission			
Base case	tCO_2	171	
Proposed case	tCO_2	103	
Gross annual GHG emission reduction	tCO_2	68.4	40%



5 Future Action Items

To realize the energy savings identified in this assessment, Equilibrium Engineering can offer the following services to the Municipality:

1. Submit applications for rebates on the applicable opportunities.
2. Prepare and submit a fixed fee cost proposal for the energy efficiency and building modernization upgrade.
3. Assist in the preparation of funding applications.
4. Create an implementation plan to coordinate the energy upgrades.
5. Supervise the contractors during the implementation to ensure the work is being completed as required.
6. Provide commissioning documents and an energy/cost analysis for implemented ESOs.
7. Prepare and submit the handover package with appropriate operator training for the new equipment.
8. Create and offer a contract for ongoing annual inspections and building maintenance.

Appendix

Basecase and Proposed Programmable Thermostat Schedule

Schedules

Description		24/7	Proposed setback
Occupied			
Temperature - space heating	°C	21	21
Temperature - space cooling	°C	23	23
Unoccupied			
Temperature - space heating	°C		18
Temperature - space cooling	°C		25
Occupancy rate - daily			
Monday	h/d	24	8.5
Tuesday	h/d	24	8.5
Wednesday	h/d	24	8.5
Thursday	h/d	24	8.5
Friday	h/d	24	8.5
Saturday	h/d	24	2
Sunday	h/d	24	0
Occupancy rate - annual	h/yr	8,760	2,320
	%	100%	26.5%
Heating/cooling changeover temperature	°C	17	
Length of heating season	d	271	
Length of cooling season	d	93.9	

Energy management report

Kentville Town Hall

Commercial/Institutional - Office building

Prepared for:

Kentville Town Hall
354
Kentville, NS, B4N 1K6
Canada

Prepared by:

Julien Aucoin, Efficiency Engineer
Equilibrium Engineering
12 Cornwallis Street
Kentville, NS, B4N 2E1
Canada
Phone: (902) 224-5769
E-mail: julien.aucoin@equilibrium-engineering.ca

Executive summary

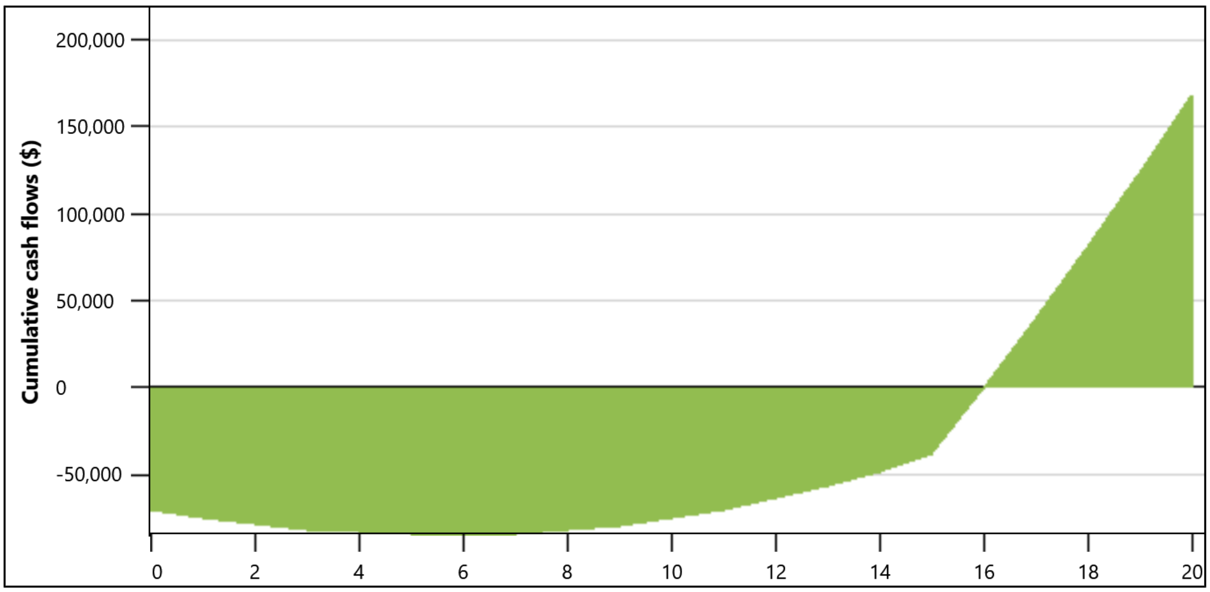
This report was prepared using the RETScreen Clean Energy Management Software. The key findings and recommendations of this analysis are presented below:

Target

	Fuel consumption MWh	Fuel cost $	GHG emission tCO_2
Base case	324	52,140	171
Proposed case	180	29,872	103
Savings	144	22,268	68.4
%	44.5%	42.7%	40%

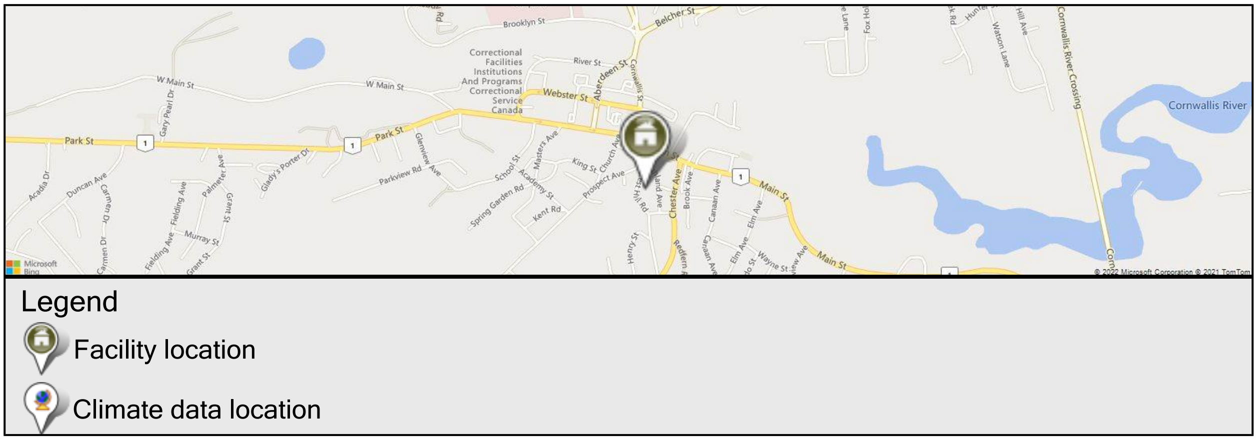
The main results are as follows:

Cash flow - Cumulative



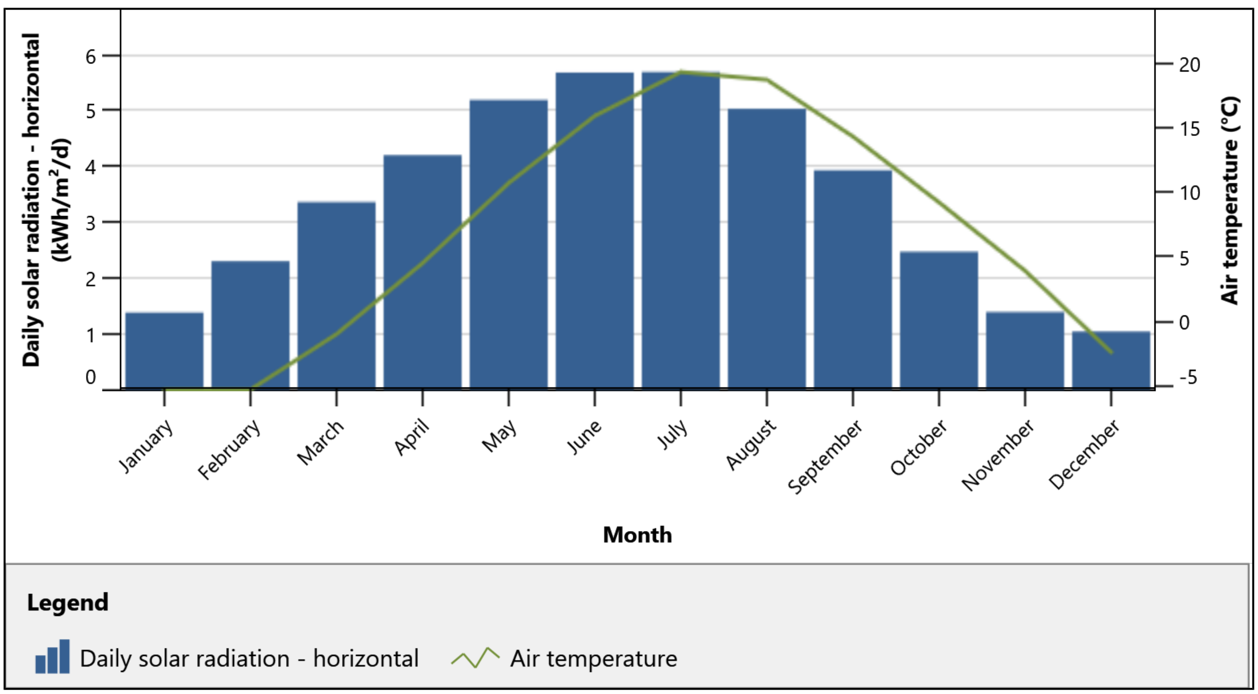
Location | Climate data

Location



	Unit	Climate data location	Facility location
Name		Canada - Nova Scotia - Kentville	Canada - NS - Kentville
Latitude	˚N	45.1	45.1
Longitude	˚E	-64.5	-64.5
Climate zone		6A - Cold - Humid	6A - Cold - Humid
Elevation	m	49	15

Climate data

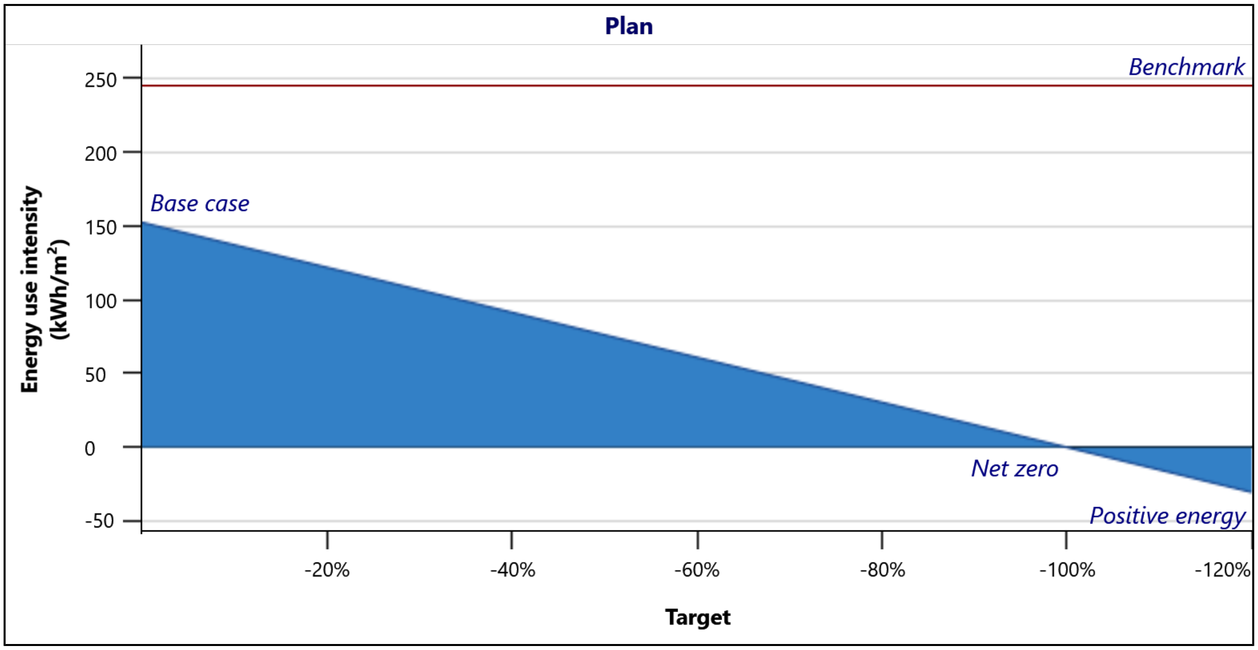


Heating design temperature	-16.0	
Cooling design temperature	27.1	
Earth temperature amplitude	23.1	

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	-5.3	87.2%	79.98	1.38	100.1	3.4	-5.7	722	0
February	-5.3	86.1%	70.84	2.30	100.1	3.4	-5.1	652	0
March	-1.0	82.3%	79.67	3.36	100.2	3.4	-1.4	589	0
April	4.5	81.4%	77.70	4.20	100.2	3.0	3.3	405	0
May	10.7	81.1%	84.63	5.19	100.3	2.6	8.4	226	22
June	15.9	81.7%	87.30	5.68	100.1	2.4	13.6	63	177
July	19.3	82.4%	79.36	5.69	100.2	2.2	17.4	0	288
August	18.7	81.8%	79.36	5.03	100.3	2.2	17.5	0	270
September	14.3	82.3%	94.50	3.93	100.5	2.5	14.2	111	129
October	9.2	83.8%	104.78	2.47	100.4	3.0	9.1	273	0
November	3.9	86.5%	103.50	1.39	100.4	3.1	3.6	423	0
December	-2.4	86.9%	97.03	1.04	100.1	3.4	-2.3	632	0
Annual	6.9	83.6%	1,038.65	3.48	100.2	2.9	6.1	4,097	886

Benchmark

Fuel consumption

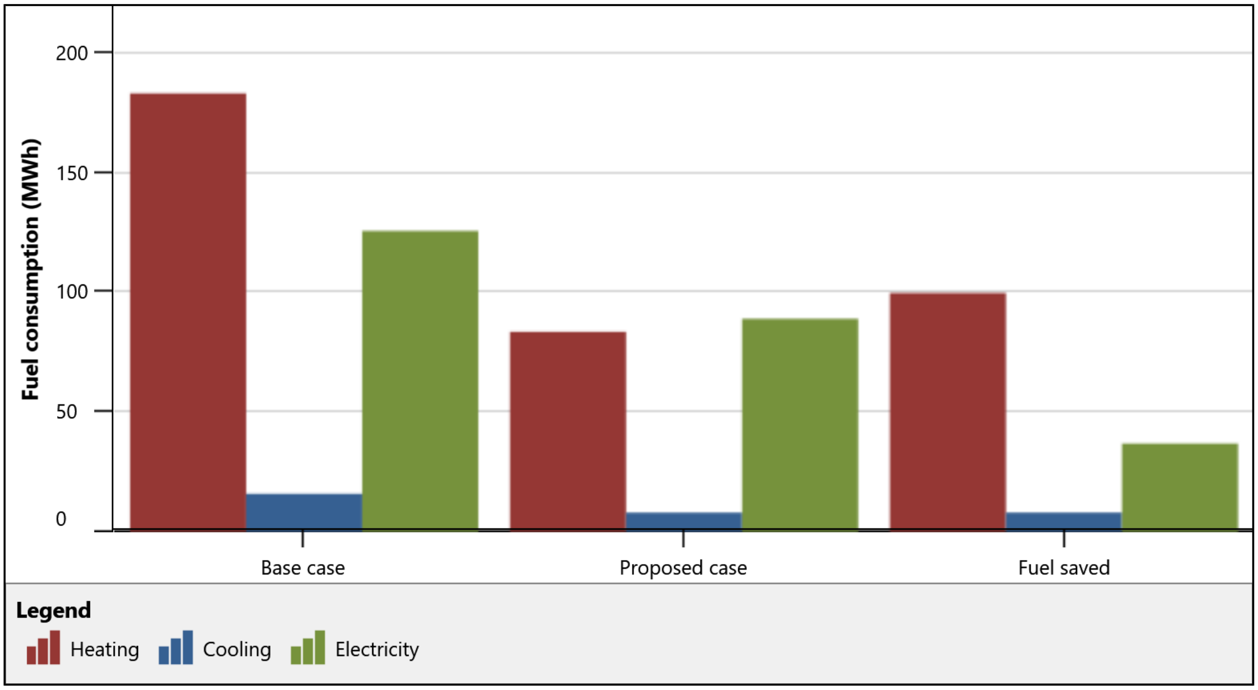


Facility size	2,120	m²
Benchmark	245	kWh/m²
Minimum - average	185	kWh/m²
Maximum - average	513	kWh/m²
Base case	152	kWh/m²
Reference year	2020	
Set target	Target	
Year		
Target	44.5%	
Proposed case	220	kWh/m²
Facility - Plan		

Fuel consumption	Annual	
Base case	323,219	kWh
Proposed case	466,939	kWh
Fuel saved	-143,720	kWh

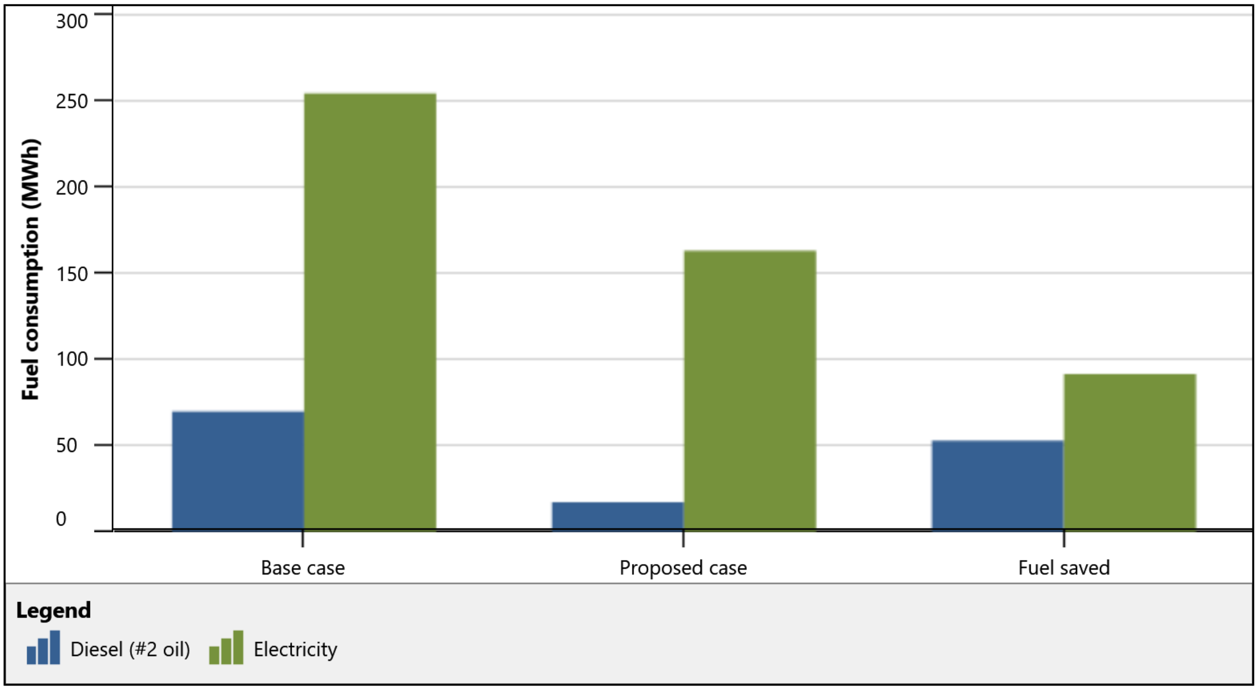
Energy savings | Fuel summary

Energy savings



Fuel consumption	Heating kWh	Cooling kWh	Electricity kWh	Total kWh
Base case	182,850	15,688	125,435	323,974
Proposed case	83,327	7,835	88,756	179,918
Fuel saved	99,523	7,853	36,680	144,055
Fuel saved - percent	54.4%	50.1%	29.2%	44.5%

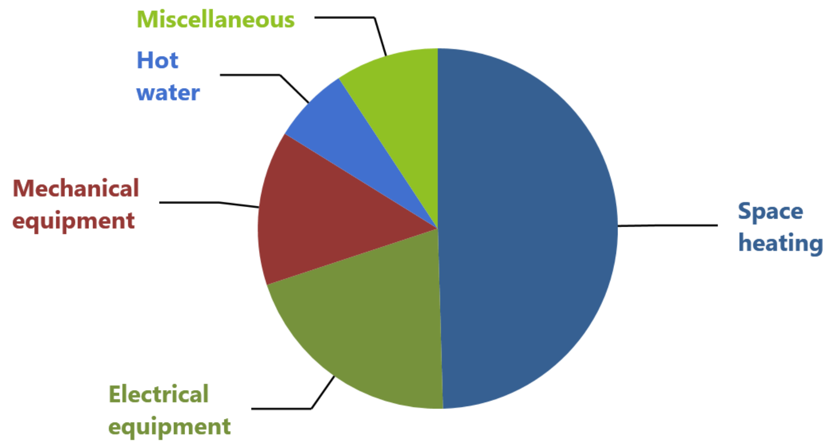
Fuel summary



Fuel type	Fuel Unit	Base case Fuel consumption	Proposed case Fuel consumption	Savings Fuel saved
Diesel (#2 oil)	L	6,545	1,592	4,952
Electricity	kWh	254,347	162,977	91,370
Fuel type	**Fuel** **Fuel rate**	**Base case** **Fuel cost**	**Proposed case** **Fuel cost**	**Savings** **Savings**
Diesel (#2 oil)	1.36 $/L	$ 8,901	$ 2,166	$ 6,735
Electricity	0.17 $/kWh	$ 43,239	$ 27,706	$ 15,533
Total		$ 52,140	$ 29,872	$ 22,268

End-use

Fuel consumption - base case



	Fuel consumption - base case	
Section	kWh	%
Space heating	160,516	49.5%
Electrical equipment	66,054	20.4%
Mechanical equipment	45,007	13.9%
Hot water	22,335	6.9%
Miscellaneous	30,063	9.3%
Space cooling	15,688	4.8%
Lights	14,375	4.4%

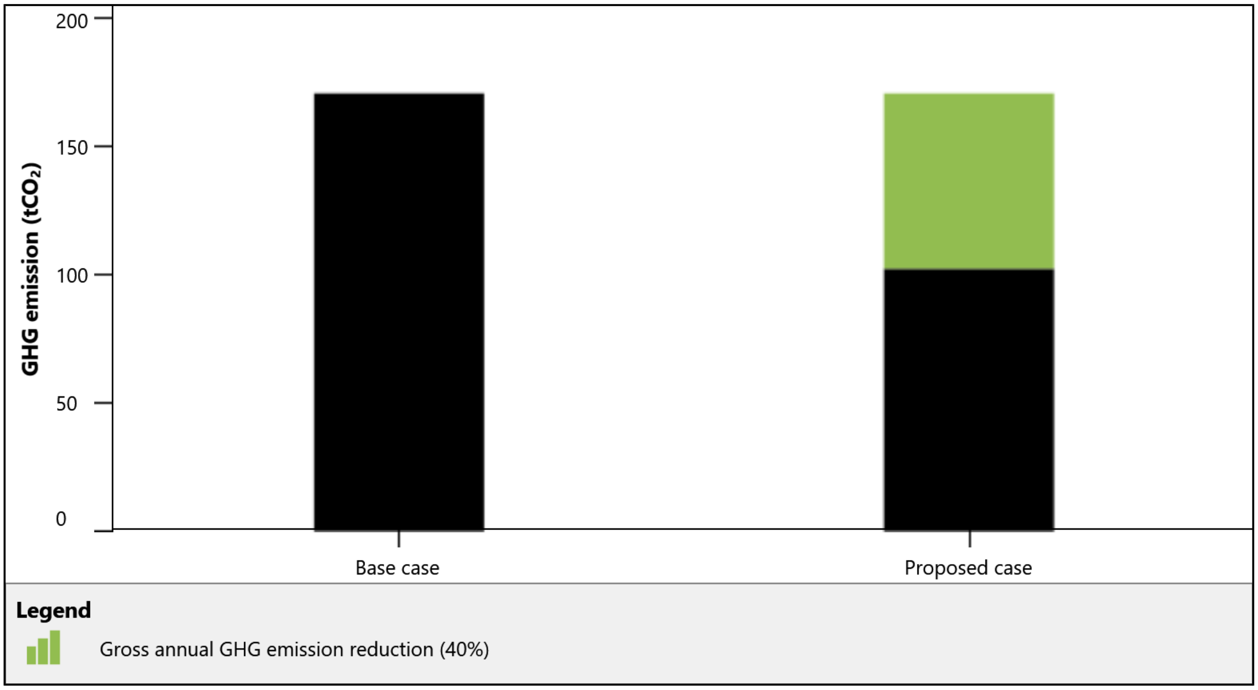
Target

Summary

	Fuel consumption MWh	Fuel cost $	GHG emission tCO_2
Base case	324	52,140	171
Proposed case	180	29,872	103
Savings	144	22,268	68.4
%	44.5%	42.7%	40%

GHG emission

GHG emission



GHG equivalence

68.4 tCO_2 is equivalent to 12.5

Cars & light trucks not used

GHG emission		
Base case	171	tCO_2
Proposed case	102.6	tCO_2
Gross annual GHG emission reduction	68.4	tCO_2

Financial viability

Financial parameters

General		
Fuel cost escalation rate	%	3.5%
Inflation rate	%	3%
Discount rate	%	6%
Reinvestment rate	%	0%
Project life	yr	20
Finance		
Debt ratio	%	80%
Debt	$	285,342
Equity	$	71,336
Debt interest rate	%	5%
Debt term	yr	15
Debt payments	$/yr	27,491

Costs | Savings | Revenue

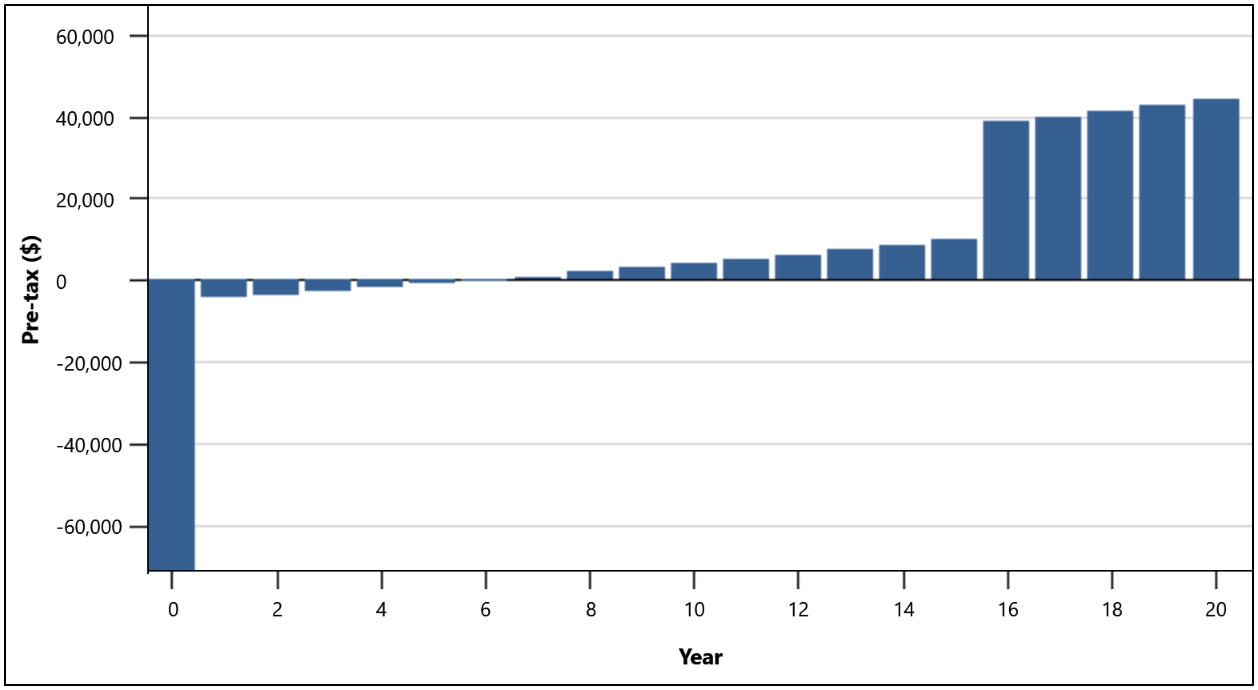
Initial costs			
Engineering	7%	$	25,000
Incremental initial costs	79.9%	$	285,155
Balance of system & miscellaneous	13%	$	46,523
Total initial costs	100%	$	356,678
Yearly cash flows - Year 1			
Annual costs and debt payments			
O&M		$	0
Fuel cost - proposed case		$	29,872
Debt payments - 15 yrs		$	27,491
Total annual costs		$	57,362
Annual savings and revenue			
Fuel cost - base case		$	52,140
GHG reduction revenue		$	0
Other revenue (cost)		$	0
CE production revenue		$	0
Total annual savings and revenue		$	52,140
Net yearly cash flow - Year 1		$	-5,223

Financial viability

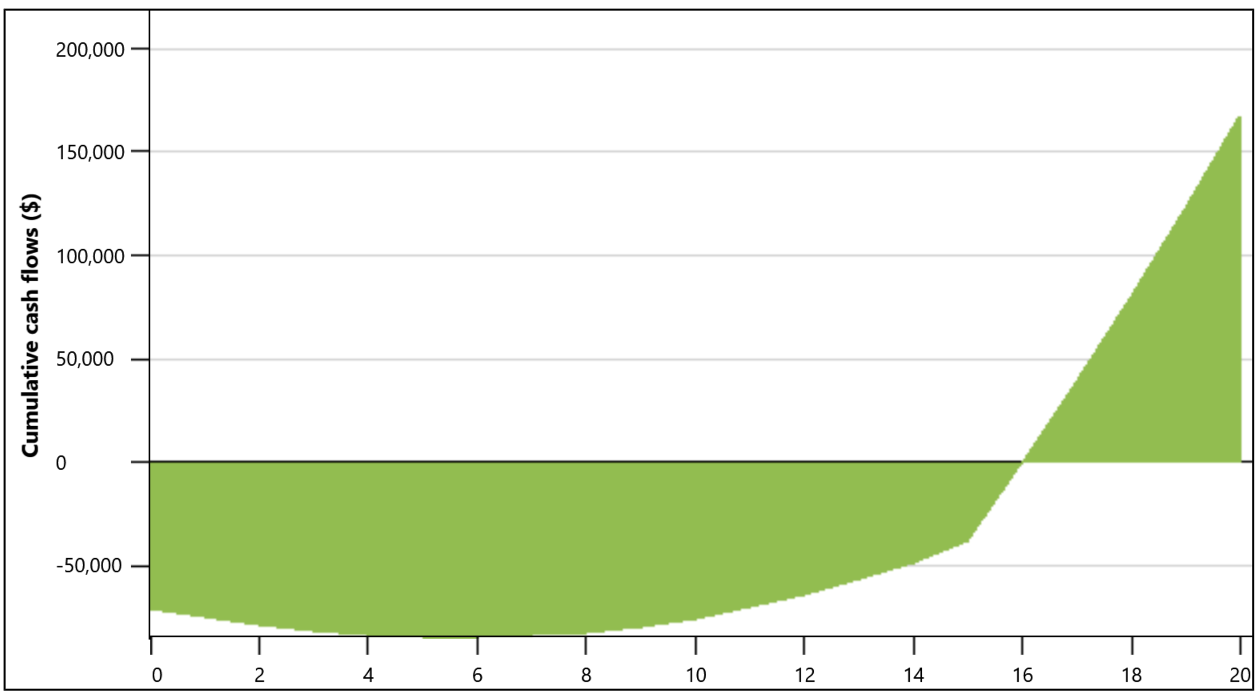
Pre-tax IRR - equity	%	6.9%
Pre-tax MIRR - equity	%	5.7%
Pre-tax IRR - assets	%	-2.2%
Pre-tax MIRR - assets	%	-1.9%
Simple payback	yr	16
Equity payback	yr	16
Net Present Value (NPV)	$	11,594
Annual life cycle savings	$/yr	1,011
Benefit-Cost (B-C) ratio		1.2
Debt service coverage		0.84
GHG reduction cost	$/tCO$_2$	8.6

Cash flow

Annual



Cumulative

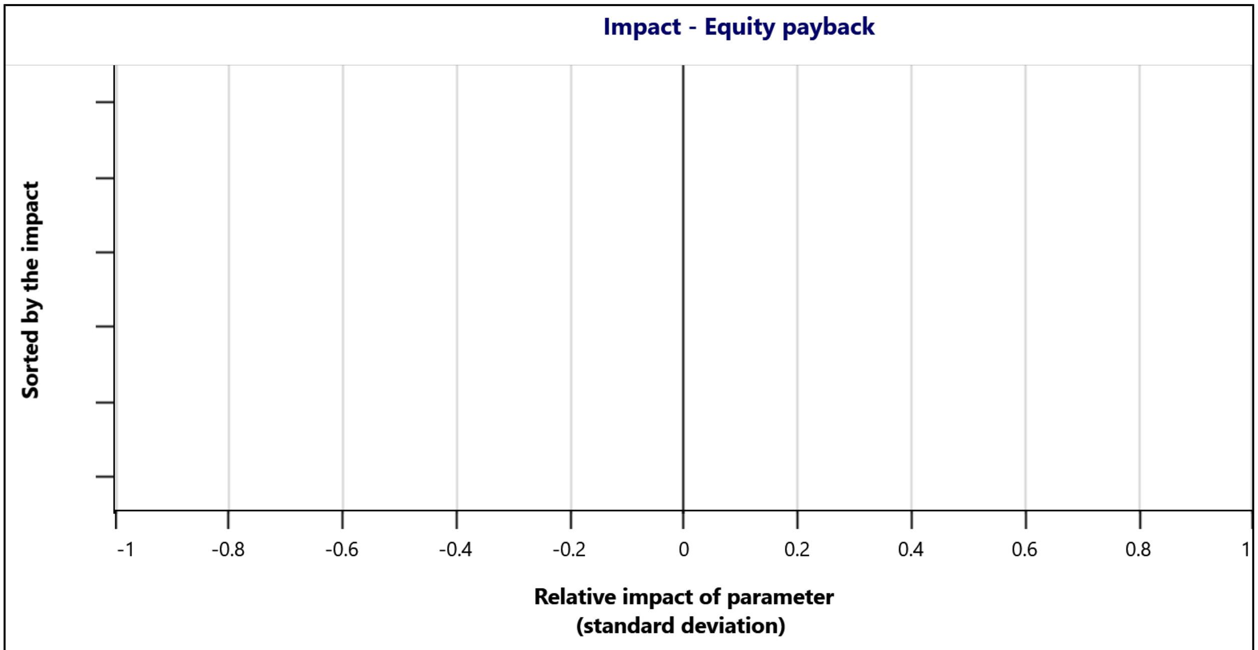


Yearly cash flows

Year #	Pre-tax $	Cumulative $
0	-71,336	-71,336
1	-4,443	-75,779
2	-3,637	-79,416
3	-2,802	-82,217
4	-1,938	-84,155
5	-1,043	-85,199
6	-118	-85,316
7	840	-84,476
8	1,832	-82,644
9	2,858	-79,786
10	3,920	-75,865
11	5,020	-70,846
12	6,158	-64,688
13	7,335	-57,353
14	8,554	-48,798
15	9,816	-38,983
16	38,612	-370
17	39,963	39,593
18	41,362	80,955
19	42,810	123,765
20	44,308	168,073

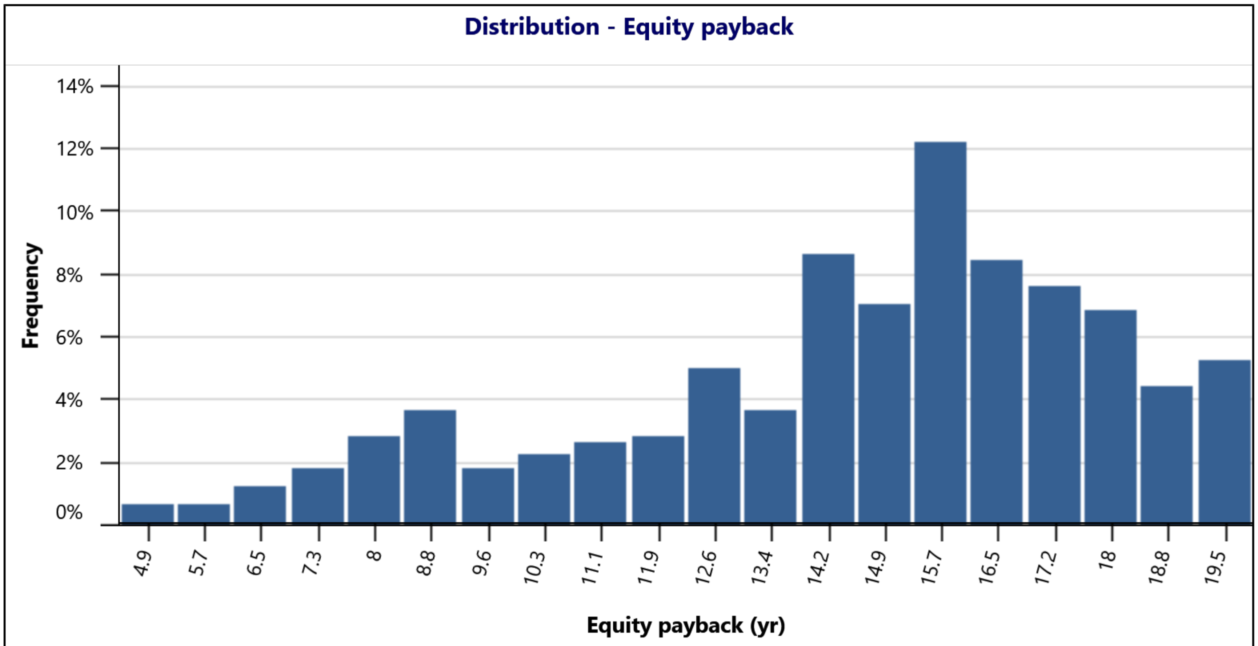
Risk

Impact



11.2% of cases have an equity payback either immediate or greater than the project life.

Distribution



11.2% of cases have an equity payback either immediate or greater than the project life.

Perform analysis on		Equity payback			
Number of combinations		500			
Random seed		No			

Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Initial costs	$	356,678	25%	267,509	445,848
Fuel cost - proposed case	$	29,872	25%	22,404	37,340
Fuel cost - base case	$	52,140	25%	39,105	65,174
Debt ratio	%	80.0%	25%	60.0%	100.0%
Debt interest rate	%	5.00%	25%	3.75%	6.25%
Debt term	yr	15	25%	11	19

Median	yr	15.4
Level of risk	%	10%
Minimum within level of confidence	yr	7.8
Maximum within level of confidence	yr	19.4

Analysis type

Project life