
# Pathway to Net Zero Emissions Feasibility Study

## Town of Antigonish

## Final Report

CBCL

237554.00 • February 2024

This project was carried out with assistance from the Green Municipal Fund, a Fund financed by the Government of Canada and administered by the Federation of Canadian Municipalities. Notwithstanding this support, the views expressed are the personal views of the authors, and the Federation of Canadian Municipalities and the Government of Canada accept no responsibility for them.

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Project No. 237554.00

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February 2, 2024

Lise Roy
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Dear Lise:

*RE: Town of Antigonish Pathway to Net Zero Emissions Feasibility Study*

CBCL Limited (CBCL) is pleased to present the final report for the Town of Antigonish Pathway to Net Zero Emissions Feasibility Study.

Please do not hesitate to contact the undersigned if you should have any questions. Thank you.

Yours very truly,

CBCL Limited

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# Executive Summary

CBCL Limited (CBCL) was engaged by the Town of Antigonish (TOA) to conduct a comprehensive greenhouse gas (GHG) emissions reduction and energy saving pathway study for a group of selected facilities comprised of office buildings, recreational facilities, fire stations, and water/wastewater treatment plants. The scope of this study is to present pathways for the TOA to reduce cumulative carbon emissions by 50% by 2033, Phase 1, and by 80% by 2043, Phase 2. Most of the facilities are over 20 years old and much of the original equipment is very close to, or past, the end of its functional lifespan.

There are eight (8) facilities included in this study. In no particular order, the facilities are listed with their current major functionalities in Table ES.1.1.

**Table ES.1.1: Names of Study Facilities and their Current Application**

| Facility Name | Current Use |
|---|---|
| Antigonish Arena | Recreational/Arena |
| Columbus Field Washrooms | Community Washrooms |
| Antigonish Fire Hall | Fire Safety |
| Antigonish Town and County Library | Community/Learning |
| Antigonish Public Works/Electric Utility | Electric Utility/Garage/Maintenance |
| Antigonish WWTP | Wastewater Treatment |
| Antigonish Town Hall | Community/Offices |
| Antigonish WTP | Drinking Water Treatment |

The emission intensity factor used for electricity for the 2022 baseline was 0.5572 $CO_2$e kg/kWh[1], for NSPI. The Antigonish Electric Utility 2022 emission intensity, 0.3387 $CO_2$e kg/kWh, was estimated to be comprised of 60% NSPI electricity and 40% electricity generated from the Ellershouse Wind Farm at an emission intensity of 0.011 kg $CO_2$e/kWh[2]. The emission intensity for heating oil and propane used were 2.71 $CO_2$e kg/L[3] and 1.52 $CO_2$e kg/L[3], respectively.

Due to the length of the study, 20 years, the reduction of carbon emissions as the grid become cleaner, needs to be considered. The 2030 and 2040 provincial proposed regulatory caps represent a 37% and 50% decrease respectively from the Provincial total

[1] Source: Air Emissions Reporting| Nova Scotia Power (nspower.ca). Retrieved: 2023-09-18
[2] Source: How Wind Can Help Us Breathe Easier | Department of Energy. Retrieved: 2023-09-18
[3] Source: Emission Factors for Greenhouse Gas Inventories (epa.gov). Retrieved: 2023-09-18

emissions generated from electricity production in 2022[4]. There will also be an increase in electricity generation in the next 20 years; current projections estimate an increase of 2.1% and 16.8% by 2030 and 2040[5].

The projected emission intensities for 2022, Phase 1: 2033 and Phase 2: 2043 for NSPI, Antigonish, heating oil and propane are summarized in Table ES.1.2.

**Table ES.1.2: Summary of Projected Emission Intensities**

| Electricity Source | Carbon Emission: kg $CO_2$e/kWh (kg $CO_2$e/GJ) | | |
|---|---|---|---|
| | Baseline: 2022 | Phase 1: 2033 | Phase 2: 2043 |
| Antigonish Electric | 0.3387 (94.1) | 0.1565 (43.5) | 0.03 (8.3) |
| NSPI | 0.5572 (154.8) | 0.3164 (87.9) | 0.1760 (48.9) |

The baseline energy usage for each of the buildings was obtained from the period of January/December 2022. This year was selected for the baseline as it was determined that this would more accurately depict the building's regular operations and energy usage after the COVID-19 pandemic. The baseline energy consumption for the facilities considered can is presented in Table ES.1.3.

**Table ES.1.3: Summary of Projected Emission Intensities**

| Facility | Electricity Consumption (kWh) | Heating Oil Consumption (L) | Propane Consumption (L) |
|---|---|---|---|
| Antigonish Arena | 532,800 | 36,775 | 4,310 |
| Columbus Field Washrooms | 7,111 | 0 | 0 |
| Antigonish Fire Hall | 14,685 | 12,925 | 0 |
| Antigonish Town and County Library | 202,490 | 0 | 0 |
| Antigonish Public Works/Electric Utility | 74,927 | 17,777 | 0 |
| Antigonish WWTP | 1,553,220 | 0 | 0 |
| Antigonish Town Hall | 55,040 | 17,411 | 0 |
| Antigonish WTP | 269,444 | 43,694 | 0 |

The cumulative annual carbon emissions for all eight buildings and the natural decarbonization of the facilities as both electric grid's emission intensities reduce over time are presented in Table ES.1.4, as well as the reduction in emissions in fossil fuels from the implementation of the Canadian Clean Fuel Regulations.

[4] Source: Quantitative analysis of equivalency determination: coal-fired generation of electricity - Canada.ca. Retrieved: 2023-09-18

[5] Source: IRP Evergreen - Assumptions and Analysis (nspower.ca). Retrieved: 2023-12-28

**Table ES.1.4: Total Emissions by Source for all Eight Buildings**

| Energy Source | 2022 Energy Usage (GJ) | 2022 Emissions (tonnes) | 2033 Projected Emissions (tonnes) | 2043 Projected Emissions |
|---|---|---|---|---|
| Antigonish Electric | 8770.7 | 825.3 | 381.3 | 73.1 |
| NSPI | 970 | 150.1 | 85.3 | 47.4 |
| PV System | 14.3 | 0.17 | 0.17 | 0.17 |
| Heating Oil | 4951.6 | 348.3 | 348.3 | 348.3 |
| Propane | 109.7 | 6.6 | 6.6 | 6.6 |
| **Total** | **14,816.3** | **1330.5** | **821.4** | **475.6** |

The emission targets for the end of Phases 1 and 2 are a 50% and 80% reduction from 2022 values. This will be an annual emission of 665.2 and 266.1 tonnes $CO_2e$ by 2033 and 2043, respectively. Considering the natural reduction that will occur over this time period the implementation of energy efficiency measures will need to reduce carbon emissions by 156.2 tonnes in Phase 1 and 209.5 tonnes in Phase 2 to meet emissions targets.

The following list includes all the assumptions and variables considered for the technical and financial analysis:

- Cost of Electricity:
  - Antigonish Arena: $0.1258/kWh
  - Columbus Field Washrooms: $0.2667/kWh
  - Antigonish Fire Hall: $0.1745/kWh
  - Antigonish Town and County Library: $0.1467/kWh
  - Antigonish Public Works/Electric Utility: $0.1476/kWh
  - Antigonish WWTP: $0.1268/kWh
  - Antigonish Town Hall: $0.1541/kWh
  - Antigonish WTP: $0.1775/kWh
  - NSPI Electricity PV: $0.10521/kWh
- Cost of Heating Oil: $1.79/L
- Cost of Propane:
  - Antigonish Arena (Heating): $0.8/L
  - Antigonish Arena (Ice Resurfacer): $0.97/L
  - Antigonish WTP: $0.64
- Antigonish Electric GHG Emission Intensity Factor 2022: 0.3387 $CO_2e$ kg/kWh[6]
- Antigonish Electric GHG Emission Intensity Factor 2033: 0.1565 $CO_2e$ kg/kWh
- Antigonish Electric GHG Emission Intensity Factor 2043: 0.0300 $CO_2e$ kg/kWh
- NSPI GHG Emission Intensity Factor 2022: 0.5572 $CO_2e$ kg/kWh[7]
- NSPI GHG Emission Intensity Factor 2033: 0.3164 $CO_2e$ kg/kWh

[6] Source: Air Emissions Reporting | Nova Scotia Power (nspower.ca). Retrieved: 2023-04-01
[7] Source: Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics (Fact Sheet), NREL (National Renewable Energy Laboratory). Retrieved 2023-11-20

- NSPI GHG Emission Intensity Factor 2043: 0.1760 $CO_2$e kg/kWh
- PV Electricity GHG Emission Intensity[8]: 0.046 $CO_2$e kg/kWh
- Heating Oil GHG Emission Intensity Factor: 2.71 $CO_2$e kg/L[9]
- Propane GHG Emission Intensity Factor: 1.52 $CO_2$e kg/L[9]

When considering the implementation of Phase 1 reduction measures, the total emissions for each building are presented in Table ES.1.5. A cumulative natural reduction of emissions 508.9 tonnes can be observed, and an additional 211.1 tonnes can be attributed to the addition energy conservation measures implemented in Phase 1. The total annual emissions for all eight buildings is 609.0 tonnes, an emissions reduction of 54.1% compared to the baseline.

**Table ES.1.5: Town of Antigonish Phase 1 Emission Reductions Summary**

| Building | 2022 Baseline Emissions (Tonnes) | Natural Emission Reductions (Tonnes) - No ECMs Implemented | Phase 1 ECM Emissions Reductions (Tonnes) | 2033 Building Emissions After ECMs | Emissions Saved % |
|---|---|---|---|---|---|
| Antigonish Arena | 286.7 | 97.1 | 61.8 | 127.8 | 55.4% |
| Columbus Field Washroom | 2.4 | 1.3 | 0.6 | 0.6 | 77.1% |
| Antigonish Fire Hall | 40.0 | 2.7 | 11.6 | 25.7 | 35.7% |
| Antigonish Library | 67.4 | 36.2 | 8.2 | 22.9 | 66.0% |
| Public Works/ Electric Utility | 73.6 | 13.7 | 27.4 | 32.5 | 55.7% |
| WW Treatment Plant | 526.1 | 283.0 | 3.1 | 240.0 | 54.4% |
| Antigonish Town Hall | 65.8 | 10.0 | 34.3 | 21.5 | 67.4% |
| Water Treatment Plant | 268.5 | 64.9 | 64.1 | 139.5 | 48.0% |
| **Totals** | **1330.5** | **508.9** | **211.1** | **610.5** | **54.1%** |

The total capital cost to implement Phase 1 measures, as well as cost savings are presented in Table ES.1.6. The total estimated capital cost to implement Phase 1 will be $1,539,022.

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[8] Source: Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics (Fact Sheet), NREL (National Renewable Energy Laboratory). Retrieved 2023-11-20

[9] Source: Emission Factors for Greenhouse Gas Inventories (epa.gov). Retrieved: 2023-04-01

This will have a cost savings of approximately $142,098 per year. Based on this, Phase 1 will have a simple payback period of 10.8 years.

**Table ES.1.6: Town of Antigonish Phase 1 Capital Cost and Simple Payback Summary**

| Building | CAPEX | CAPEX/Phase 1 ECM GHG Reduction ($tonne) | Energy Savings (GJ) | Cost Savings | Simple Payback Period |
|---|---|---|---|---|---|
| Antigonish Arena | $350,125 | $5,665 | 594.6 | $36,929 | 9.5 |
| Columbus Field Washroom | $2,060 | $3,668 | 12.9 | $973 | 2.1 |
| Antigonish Fire Hall | $195,060 | $16,820 | 132.4 | $6,147 | 31.7 |
| Antigonish Library | $8,000 | $991 | 185.7 | $5,867 | 1.4 |
| Public Works/Electric Utility | $227,822 | $8,329 | 218.0 | $12,363 | 18.4 |
| WW Treatment Plant | $213,780 | $69,445 | 70.8 | $2,530 | 84.5 |
| Antigonish Town Hall | $331,610 | $9,655 | 357.0 | $18,159 | 18.3 |
| Water Treatment Plant | $210,565 | $3,283 | 436.6 | $59,129 | 3.6 |
| **Totals** | **$1,539,022** | **$7,292** | **2008.0** | **$142,098** | **10.8** |

When considering the implementation of Phase 2 reduction measures The total emissions savings for each building are presented in Table ES.1.7. A cumulative natural reduction of emissions 854.9 tonnes can be observed, and an additional 280.5 tonnes can be attributed to the addition energy conservation measures implemented in Phase 1. Phase 2 efficiency measures result in an additional savings of 4.0 tonnes. The total annual emissions for all eight buildings is 191.1 tonnes, an emissions reduction of 85.3% compared to the baseline.

**Table ES.1.7: Town of Antigonish Phase 2 Emission Reductions Summary**

| Building | 2022 Baseline Emissions (Tonnes) | Natural Emission Reductions (Tonnes) – No ECMs Implemented | Phase 1 ECM Emissions Reductions (Tonnes) | Phase 2 ECM Emissions Reductions (Tonnes) | 2043 Building Emissions After ECMs | Emissions Saved % |
|---|---|---|---|---|---|---|
| Antigonish Arena | 286.7 | 164.5 | 87.3 | 3.8 | 31.1 | 89.2% |
| Columbus Field Washrooms | 2.4 | 2.2 | 0.1 | 0.01 | 0.1 | 96.1% |
| Antigonish Fire Hall | 40.0 | 4.5 | 14.6 | 0.0 | 20.8 | 47.9% |
| Antigonish Library | 67.4 | 61.4 | 1.5 | 0.0 | 4.4 | 93.4% |

| Building | 2022 Baseline Emissions (Tonnes) | Natural Emission Reductions (Tonnes) – No ECMs Implemented | Phase 1 ECM Emissions Reductions (Tonnes) | Phase 2 ECM Emissions Reductions (Tonnes) | 2043 Building Emissions After ECMs | Emissions Saved % |
|---|---|---|---|---|---|---|
| Public Works/ Electric Utility | 73.6 | 23.1 | 43.1 | 0.2 | 7.2 | 90.2% |
| WW Treatment Plant | 526.1 | 479.5 | 0.6 | 0.0 | 46.0 | 91.3% |
| Antigonish Town Hall | 65.8 | 17.0 | 46.4 | 0.0 | 2.4 | 96.3% |
| Water Treatment Plant | 268.5 | 102.7 | 86.9 | 0.0 | 79.0 | 70.6% |
| **Totals** | **1330.5** | **854.9** | **280.5** | **4.0** | **191.1** | **85.6%** |

The total capital cost and cost savings for each building can be seen in Table ES.1.8. The total estimated capital cost to implement Phase 2 will be $243,500. This will have a cost savings of approximately $2,245 per year. Based on this, Phase 2 will have a simple payback period of 108.5 years.

**Table ES.1.8: Town of Antigonish Phase 2 Capital Cost and Simple Payback Summary**

| Building | CAPEX | CAPEX/Phase 2 ECM GHG Reduction ($/tonne) | Energy Savings (GJ) | Cost Savings | Simple Payback Period |
|---|---|---|---|---|---|
| Antigonish Arena | $190,000 | $49,906 | 29.8 | $1,254 | 152 |
| Columbus Field Washroom | $6,000 | $547,945 | 1.3 | $97 | 62 |
| Antigonish Fire Hall | $34,500 | $936,980 | 2.1 | 102.4 | 336.8 |
| Antigonish Library | $0 | $0 | 0.0 | 0.0 | 0.0 |
| Public Works/ Electric Utility | $13,000 | $80,846 | 19.3 | 791.1 | 16.4 |
| WW Treatment Plant | $0 | $0 | 0.0 | 0.0 | 0.0 |
| Antigonish Town Hall | $0 | $0 | 0.0 | 0.0 | 0.0 |
| Water Treatment Plant | $0 | $0 | 0.0 | 0.0 | 0.0 |
| **Totals** | **$243,500** | **$60,636.11** | **52.5** | **2244.9** | **108.5** |

A life cycle cost analysis (LCCA) was completed for this study and includes annual O&M costs and replacement costs for major building components and equipment over a 30-year assessment horizon. The analysis parameters considered in the LCCA development are presented below:

- LCCA Term (Years): 30 Years
- Debt (%): 100%
- Equity (%): 0%
- Loan Term (Years): 30 Years
- Loan Amortization Every Month: 1
- Interest Rate: 4.5%
- Discount Rate: 3.75%
- Inflation Rate (Operation and Maintenance Cost): 2.0%
- Construction Cost Inflation: 3.5%
- Antigonish Electric Utility Inflation 4.1%
- NSPI Electric Utility Inflation 4.1%
- Heating Oil Inflation 10.9%
- Propane Inflation 10.9%
- Carbon Tax**:** $50/ton in 2022, increased by $15/ton/yr until 2030. Then, assuming $300/ton in 2050. Lineal increased is assumed.

The 30-year LCCA for each of the facilities, as well as the total all eight buildings included in this study are presented in Table ES.1.9.

**Table ES.1.9: 30-Year LCCA for Each of the Eight Facilities**

| Building | Baseline (W/O Energy Efficiency Measures) | With Energy Efficiency Measures |
|---|---|---|
| Antigonish Arena | $9,670,125 | $4,221,784 |
| Columbus Field Washrooms | $69,765 | $37,918 |
| Antigonish Fire Hall | $2,471,512 | $1,903,751 |
| Antigonish Town and County Library | $984,459 | $778,060 |
| Antigonish Public Works/Electric Utility | $5,348,272 | $3,103,804 |
| Antigonish Wastewater Treatment Plant | $6,644,684 | $6,688,173 |
| Antigonish Town Hall | $3,778,343 | $1,352,517 |
| Antigonish Water Treatment Plant | $9,408,296 | $5,306,300 |
| **Totals for the Eight Facilities** | **$38,375,455** | **$23,392,306** |

With the exception of the WWTP, the remainder of the facilities show a lower LCC over a 30-year-period, compared to the same building without the implementation of EEMs. Also, for the group of eight buildings with EEMs, the LCC is lower than the baseline LCC. This indicates that the implementation of the recommended EEM/phases will result in a lower operational cost over a 30-year-period.

Differences in the life cycle cost assessments between the baseline and proposed facilities are higher in buildings where switching from to a lower carbon emitting energy source was recommended. This is due to a combination of the inflation rate for fossil fuels being higher than that of electricity, as well as the increase in the carbon tax on building emissions over time.

# Contents

# Appendices

# 1 Introduction

## 1.1 Background and Study Scope

CBCL Limited (CBCL) was contracted by the Town of Antigonish (TOA) to conduct a comprehensive greenhouse gas (GHG) emissions reduction and energy saving pathway study for a group of selected facilities comprised of office buildings, recreational facilities, fire stations, and water/wastewater treatment plants. The scope of this study is to present a pathway for the TOA to reduce cumulative carbon emissions by 50% by 2033, Phase 1, and by 80% by 2043, Phase 2. Most of the facilities are over 20 years old and much of the original equipment is very close to, or past, the end of its functional lifespan.

With the increasing pace in the development of new technologies and materials, decisions about the right course of action for equipment replacement or facility renewal can become complex. However, waiting too long to make these kinds of decisions could also lead to missed opportunities in implementing energy and cost saving upgrades. The timing for and the scale to which to undertake significant facility renewal actions without losing out on the new improvements is a delicate balance.

Several of the buildings in this study primarily serve to provide a comfortable place for people to conduct business in an office environment, or fans and spectators in the arena, or even community members in the library. The greater the degree of comfort provided to the occupants of a building, the more efficient and productive the occupants can be in their activities. People working in comfortable work environments are generally more productive and miss less work hours due to illness. Major influences on building environmental comfort are temperature, humidity, air quality, noise, space layout, and adequate water supply. Energy is required for the maintenance of most of these comfort indicators and has an influence on all of them. Similarly, given the energy source types, GHG emissions are directly proportional to the amount of energy consumed in maintaining these space comforts. Thus, reduction in energy and water consumption in the buildings can directly reduce GHG emissions.

There are eight (8) facilities included in this study. In no particular order, the facilities are listed with their current major functionalities in Table 1.1.

**Table 1.1: Names of Study Facilities and their Current Application**

| Facility Name | Current Use |
|---|---|
| Antigonish Arena | Recreational/Arena |
| Columbus Field Washrooms | Community Washrooms |
| Antigonish Fire Hall | Fire Safety |
| Antigonish Town and County Library | Community/Learning |
| Antigonish Public Works/Electric Utility | Electric Utility/Garage/Maintenance |
| Antigonish WWTP | Wastewater Treatment |
| Antigonish Town Hall | Community/Offices |
| Antigonish WTP | Drinking Water Treatment |

## 1.2 Carbon Emission Intensity Projections

The emission intensity factor used for electricity for the 2022 baseline was 0.5572 CO2e kg/kWh[10], for NSPI. The Antigonish Electric Utility 2022 emission intensity, 0.3387 CO2e kg/kWh, was estimated to be comprised of 60% NSPI electricity and 40% electricity generated from the Ellershouse Wind Farm at an emission intensity of 0.011 kg CO2e/kWh[11]. The emission intensity for heating oil and propane used were 2.71 CO2e kg/L[12] and 1.52 CO2e kg/L[12] respectively.

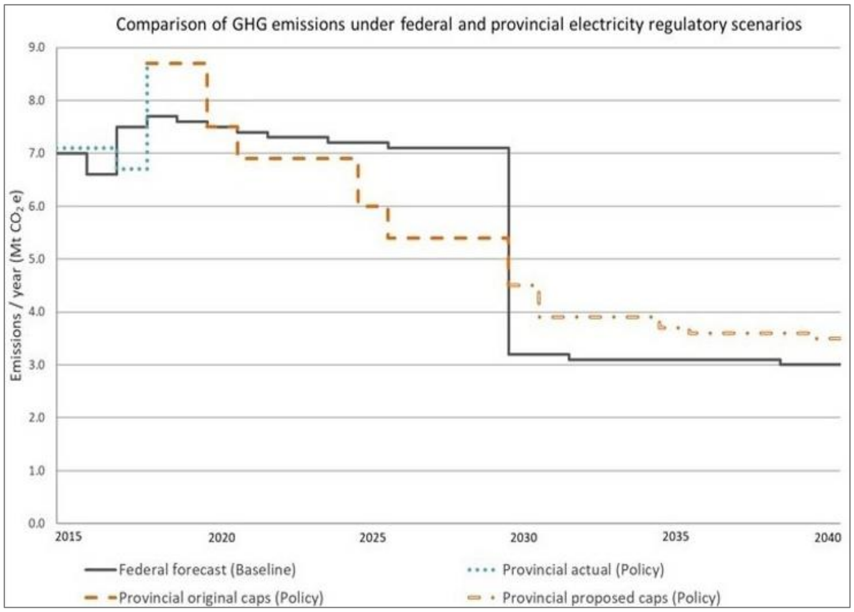


**Figure 1.1: Annual Electricity Generation Emissions Based Under Federal and Provincial Regulatory Scenarios**

Due to the length of the study, 20 years, the reduction of carbon emissions as the grid becomes cleaner needs to be considered. This will help provide a clearer estimate of the emission reductions necessary to reach the Phase 1 and Phase 2 emissions targets, as well as provide a more accurate estimate of the emissions reductions generated by each efficiency measure.

[10] Source: Air Emissions Reporting| Nova Scotia Power (nspower.ca). Retrieved: 2023-09-18
[11] Source: How Wind Can Help Us Breathe Easier | Department of Energy. Retrieved: 2023-09-18
[12] Source: Emission Factors for Greenhouse Gas Inventories (epa.gov). Retrieved: 2023-09-18

Two factors were considered when projecting the emissions intensity of NSPI and Antigonish Electric grid. The first, shown in Figure 1.1[13], is the annual total emissions from electricity generation in Nova Scotia under Federal and Provincial regulatory scenarios. The 2030 and 2040 provincial proposed regulatory caps represent a 37% and 50% decrease respectively from the Provincial total in 2022. A linear regression in total emissions was assumed between these points.

The second factor considered is the increase in electricity production during this time due to population increase and increased electrification. Current projections estimate an increase of 2.1% and 16.8% by 2030 and 2040, respectively, as seen in Figure 1.2[14], labeled as the 2022 IRP Evergreen Baseline DSM. This results in an increased amount of electricity produced, with lower allowable annual emissions.

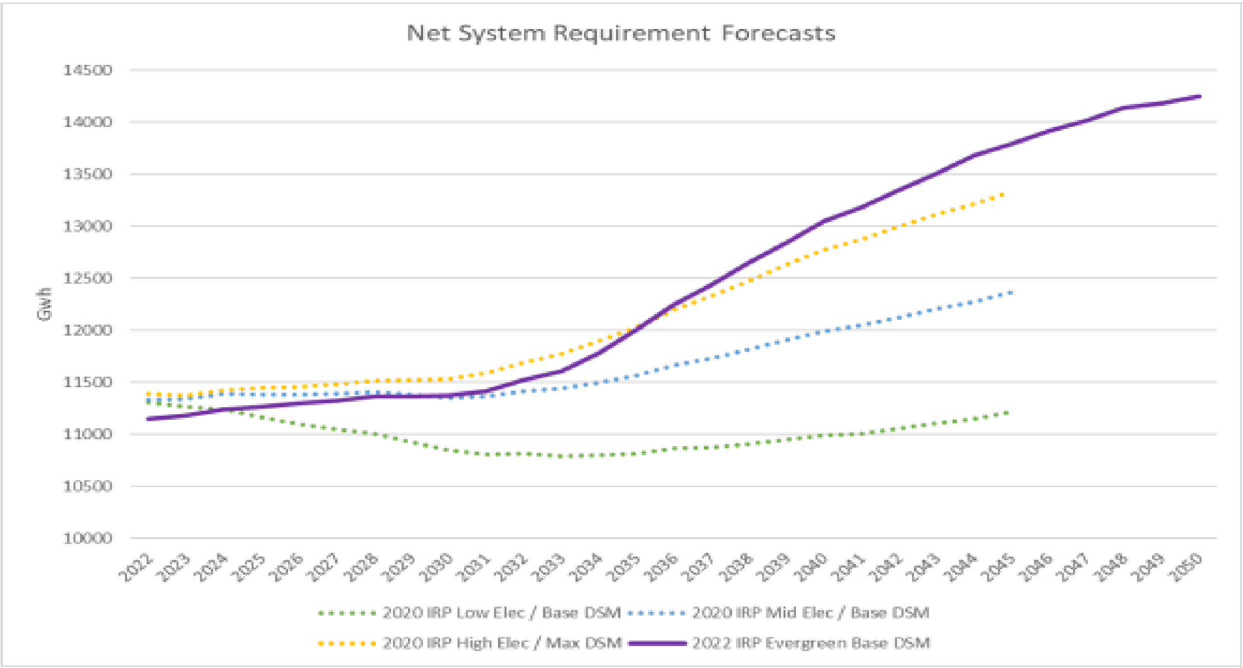


**Figure 1.2: Projected NSPI Load Requirements 2022-2050**

Both estimates for total emissions decrease, as well as increase in electricity production were applied to the current carbon emission intensity for NSPI to estimate values from 2022 to 2040. NSPI's parent company Emera has a goal of net-zero by 2050[15], net zero in this report is defined as 0.03 $CO_2e$ kg/kWh, which is the intensity at which carbon emissions can sufficiently be removed from the atmosphere at the same rate that they are being emitted[16]. A linear regression was assumed from 2040 to 2050.

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[13] Source: Quantitative analysis of equivalency determination: coal-fired generation of electricity - Canada.ca. Retrieved: 2023-09-18

[14] Source: IRP Evergreen - Assumptions and Analysis (nspower.ca) Retrieved: 2023-12-28

[15] Source: Our Climate Commitment | Emera. Retrieved: 2023-09-18

[16] Source: Canada Gazette, Part 1, Volume 1, Number 1: Clean Electricity Regulations. Retrieved: 2023-11-20

To determine emission intensities for the Antigonish Electric Utility from 2022 to 2030 the same electricity source ratios, 60% NSPI and 40% wind energy, were used. The utility also has a goal of achieving net-zero by 2040, so a linear regression between 2030 and 2040 was used. These values can be seen in Figure 1.3 below.

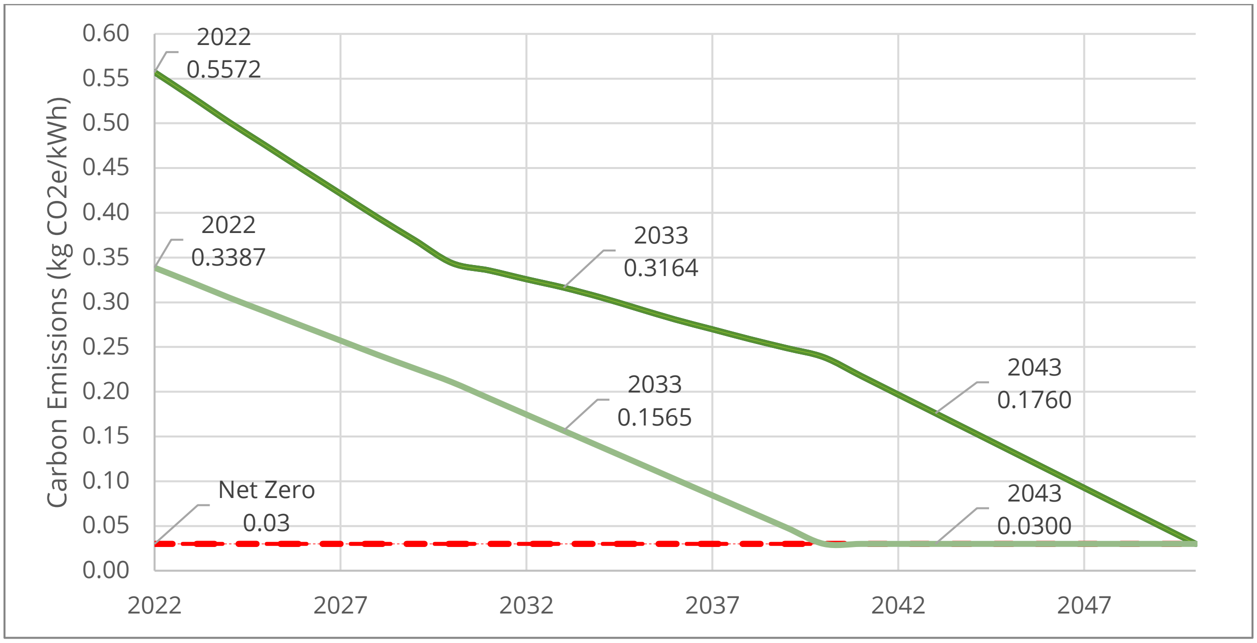


**Figure 1.3: Electricity Carbon Emission Projections**

The projected emission intensities for 2022, Phase 1: 2033 and Phase 2: 2043 for NSPI, and Antigonish Electric are summarized in Table 1.2.

**Table 1.2: Summary of Projected Emission Intensities**

| Electricity Source | Carbon Emission: kg $CO_2$e/kWh (kg $CO_2$e/GJ) | | |
|---|---|---|---|
| | Baseline: 2022 | Phase 1: 2033 | Phase 2: 2043 |
| Antigonish Electric | 0.3387 (94.1) | 0.1565 (43.5) | 0.03 (8.3) |
| NSPI | 0.5572 (154.8) | 0.3164 (87.9) | 0.1760 (48.9) |

## 1.3 Energy Modelling Approach

To determine energy and carbon emissions savings based on the implementation of the prescribed efficiency measures, energy models were created in Carrier HAP V6.1, an 8760-hour simulation tool, for the following four buildings:

- Antigonish Arena
- Antigonish Fire Hall
- Antigonish Public Works/Electric Utility
- Antigonish Town Hall

The baseline energy usage for each of the buildings was obtained for the period of January/December 2022. This year was selected for the baseline as it was determined that this would most accurately depict the building's regular operations and energy usage after the COVID-19 pandemic.

The baseline model's electricity consumption was calibrated by comparing the modeling outputs with the monthly electricity consumption obtained from the billing data provided by the Town of Antigonish . Each building's electricity usage was calibrated to ASHRAE 14 guidelines which states that the difference between the monthly output from the energy model and the historic energy data should be within the following:

- Coefficient of Variation of the Root Mean (CVRMSE): ± 15%.
- Normalized Mean Bias Error (MBE): ± 5%.

Fossil fuel usage for the buildings was calibrated on an annual basis as information available was based on delivered quantities each month and does not necessarily reflect quantities consumed each month. Fossil fuel consumption was calibrated within ±5% of annual consumption for all sites.

This calibration procedure is an estimation based on information collected during the site visit and from the drawings. This information can only be confirmed with dedicated submetering of the different electrical subpanels and fuel-fired equipment and appliances in the facility.

### 1.3.1 Antigonish Arena Energy Model

The monthly electricity usage of the calibrated model compared to the historic data provided is presented in Figure 1.4.

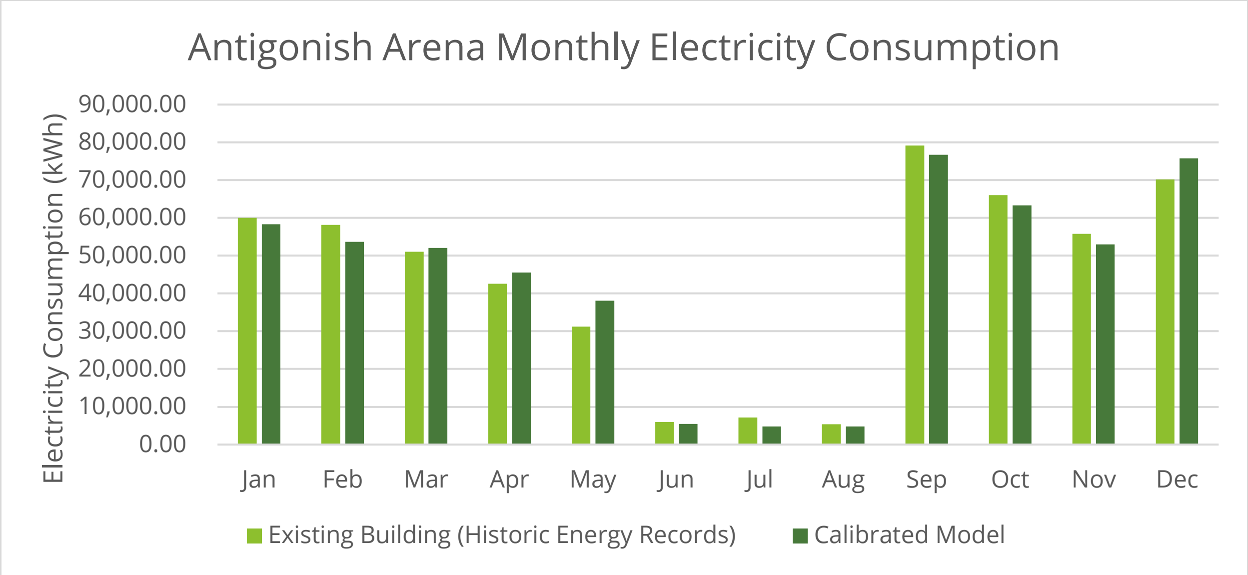


**Figure 1.4: Monthly Electricity Consumption: Calibrated Model versus Historical Energy Records**

Both the CVRMSE and NMBE for the calibrated model are within the range to meet the ASHRAE 14 standard as presented in Table 1.3.

**Table 1.3: Calibration of Antigonish Arena to ASHRAE 14 Guidelines**

| CVRMSE (%) [ASHRAE 14: +/-15%] | NMBE (%) [ ASHRAE: +/-5%] |
|---|---|
| 8.01 | 0.25 |

Two sources of fossil fuels are consumed on site: heating oil and propane. These values were both calibrated within 5% on an annual basis as presented in Table 1.4.

**Table 1.4: Calibration of Fossil Fuels on Site within 5%**

| Energy Source | Historic Energy Consumption (L) | Calibrated Model (L) | % Difference |
|---|---|---|---|
| Heating Oil | 36,775 | 36,595 | -0.5% |
| Propane (Heating Only) | 1,594.30 | 1,668 | 4.6% |

### 1.3.2 Antigonish Fire Hall Energy Model

The monthly electricity usage of the calibrated model compared to the historic data provided are presented in Figure 1.5.

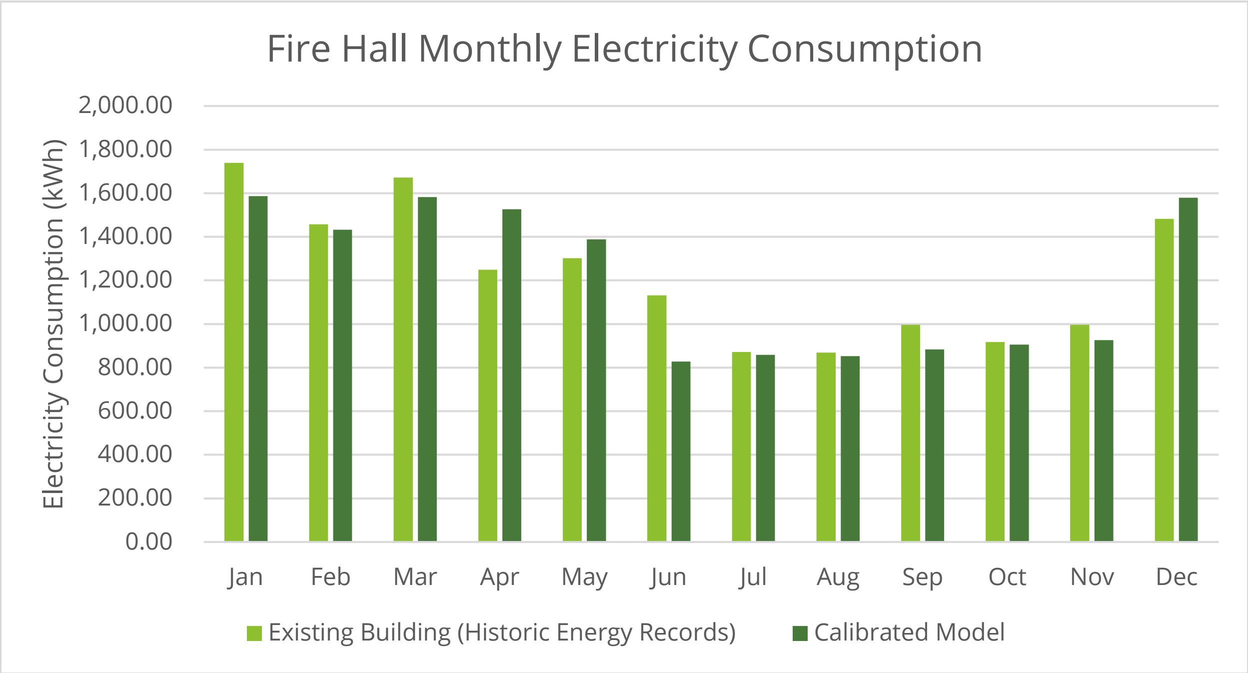


**Figure 1.5: Monthly Electricity Consumption: Calibrated Model versus Historical Energy Records**

Both the CVRMSE and NMBE for the calibrated model are within the range to meet the ASHRAE 14 standard as presented in Table 1.5.

**Table 1.5: Calibration of Antigonish Fire Hall to ASHRAE 14 Guidelines**

| CVRMSE (%) [ASHRAE 14: +/-15%] | NMBE (%) [ ASHRAE: +/-5%] |
|---|---|
| 12.00 | 2.5 |

One source of fossil fuel is consumed on site: heating oil. This value was calibrated within 5% on an annual basis presented in Table 1.6**.**

**Table 1.6: Calibration of Fossil Fuels on Site within 5%**

| Energy Source | Historic Energy Consumption (L) | Calibrated Model (L) | % Difference |
|---|---|---|---|
| Heating Oil | 12,925.3 | 12,401 | -4.1% |

### 1.3.3 Antigonish Public Works/Electric Utility Energy Model

The monthly electricity usage of the calibrated model compared to the historic data provided is presented in Figure 1.6.

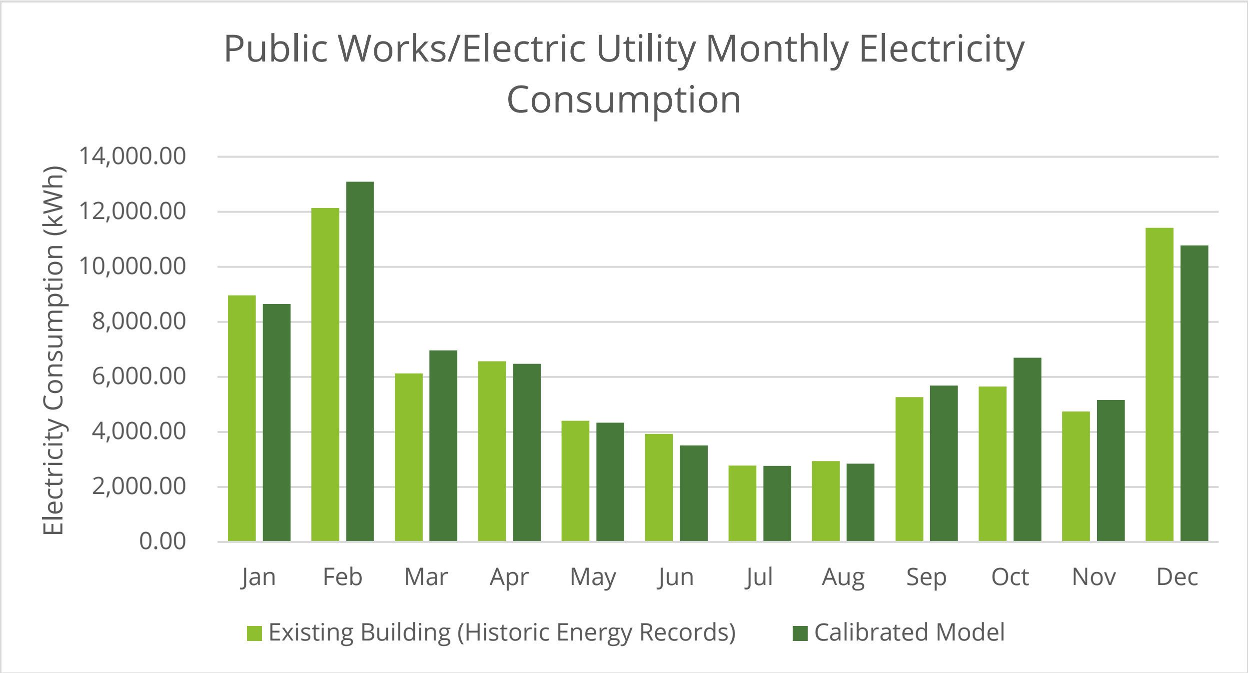


**Figure 1.6: Monthly Electricity Consumption: Calibrated Model vs Historical Energy Records**

Both the CVRMSE and NMBE for the calibrated model are within the range to meet the ASHRAE 14 standard as presented in Table 1.7.

**Table 1.7: Calibration of Public Works/Electric Utility to ASHRAE 14 Guidelines**

| CVRMSE (%) [ASHRAE 14: +/-15%] | NMBE (%) [ ASHRAE: +/-5%] |
|---|---|
| 10.63 | -2.83 |

One source of fossil fuel is consumed on site: heating oil. This value was calibrated within 5% on an annual basis presented in Table 1.8.

**Table 1.8: Calibration of Fossil Fuels on Site within 5%**

| Energy Source | Historic Energy Consumption (L) | Calibrated Model (L) | % Difference |
|---|---|---|---|
| Heating Oil | 17,777.0 | 18,194 | 2% |

### 1.3.4 Antigonish Town Hall Energy Model

The monthly electricity usage of the calibrated model compared to the historic data provided is presented in Figure 1.6Figure 1.7.

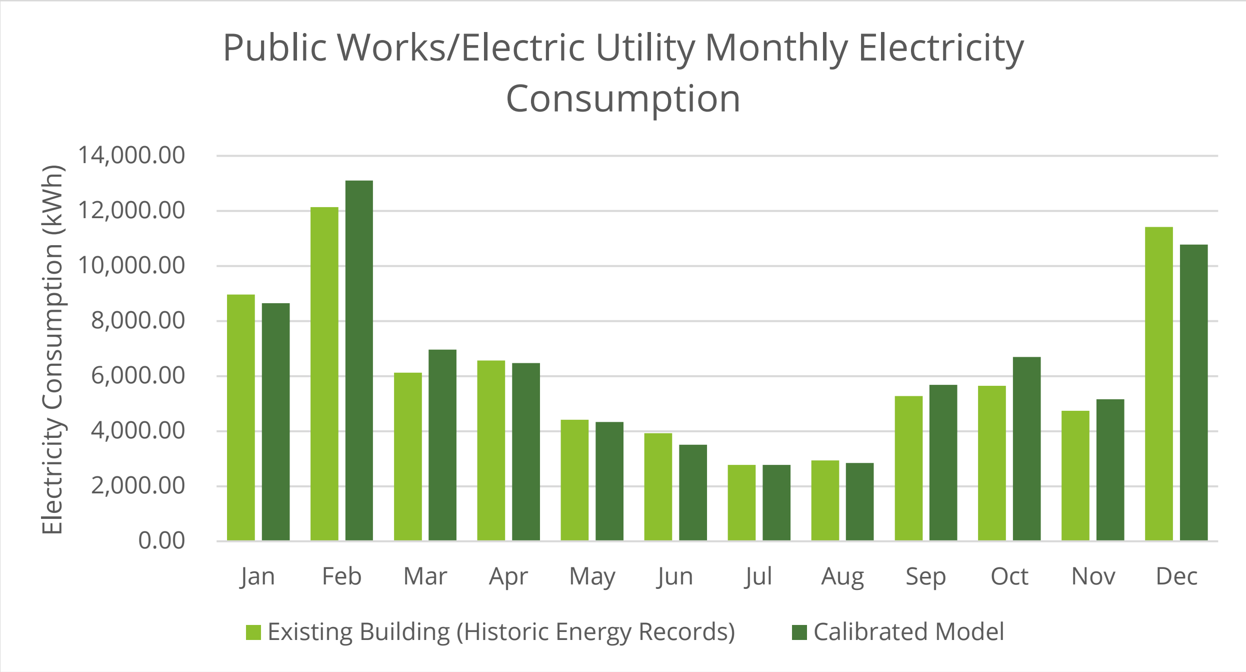


**Figure 1.7: Monthly Electricity Consumption: Calibrated Model vs Historical Energy Records**

Both the CVRMSE and NMBE for the calibrated model are within the range to meet the ASHRAE 14 standard as presented in Table 1.9.

**Table 1.9: Calibration of Antigonish Town Hall to ASHRAE 14 Guidelines**

| CVRMSE (%) [ASHRAE 14: +/-15%] | NMBE (%) [ ASHRAE: +/-5%] |
|---|---|
| 9.37 | -2.97 |

One source of fossil fuel is consumed on site: heating oil. This value was calibrated within 5% on an annual basis as presented in Table 1.10.

**Table 1.10: Calibration of Fossil Fuels on Site within 5%**

| Energy Source | Historic Energy Consumption (L) | Calibrated Model (L) | % Difference |
|---|---|---|---|
| Heating Oil | 17,411.0 | 17,271 | -3% |

# 2 Arena

## 2.1 Facility Description

The Antigonish Arena was constructed in 1969 as the community's indoor ice rink. The facility occupies a gross floor area of 36,300 ft². The ice surface is installed in September and removed in May with an estimated area of 17,000 ft². While the ice is installed, the building is open for 18 hours a day, seven days a week, from 6:00 a.m. to 12:00 a.m. Figure 2.1 presents a photograph of the site.

**Figure 2.1: Antigonish Arena Site**

An onsite refrigeration plant creates and maintains the ice sheet when the facility is used as an ice rink. Waste heat from the ice plant compressors is recovered to preheat service water used for ice resurfacing.

The building is equipped with a hydronic heating system with an oil-fired boiler and circulating pumps. The locker rooms utilize hydronic radiators, the remaining heated spaces have hydronic baseboards, apart from the hospitality room which utilizes electric baseboards. The spectator area in the arena has fire tube propane heaters which are used intermittently. No space cooling is provided to the building. Interior and exterior lighting is provided by a mixture of LED, fluorescent, incandescent, and HID lighting fixtures.

Electricity, heating oil, and propane are the sources of energy consumed on site. Electricity powers lighting, ice refrigeration, space heating, kitchen appliances, and a 3 hp air compressor, as well as other ancillary equipment. Heating oil is consumed in a boiler to produce heating to the administrative spaces and locker rooms, as well as to produce service and domestic hot water. Propane is used to provide heating in the arena's spectator area in addition to being the fuel source for the ice resurfacer.

The building and major existing equipment characteristics include:

- The exterior walls appear to be in fair condition. The estimated R-value for the building is R-5.7.
- The building roof appears to be in fair condition. The estimated R-value is R-6.
- Metal frame, double paned windows are in fair condition. The estimated R value is 1.7.
- The floor is slab-on-grade. The estimated R-value is R-1.4.
- Exterior doors appear in good condition. R-values are estimated to be approximately R-5 for man doors and R-10 for the overhead doors.
- Weatherstripping around the man-doors appears to be in poor condition with some areas showing daylight through the gaps in the weatherstripping.
- The interior lighting is a combination of LED, incandescent, and fluorescent with manual ON/OFF switches.
- Domestic hot water is provided by the oil-fired boiler that serves the building washrooms, kitchens, and locker rooms.
- Hot water used for ice resurfacing is provided by an oil-fired boiler, where water is preheated using waste heat recovered from the ice plant.
- The temperature setpoint is 18°C year-round for the heated spaces with no nighttime setback. All the thermostats in this space are programmable.
- The ammonia/brine loop ice plant utilizes a 60 hp compressor with an estimated COP of 2.2. The compressor motor operates on a VFD.

## 2.2 Review of Historic Energy Performance

Electricity bills were provided for the 24-month period between January 2021 and December 2022. Heating oil bills were available for the same period. Propane bills were provided for January 2022 to December 2022. Energy consumption and demand were reviewed in annual terms to ensure that variation in seasonality was observable. With at least two periods available, a month-to-month comparison of the facility's energy performance was completed from one year to the next. Review of electricity consumption profiles, based on the information obtained from the two periods, was discussed, and is compared in this section.

### 2.2.1 Electricity Use Profiles

Figure 2.2 provides the monthly electricity usage profile which shows the 24-month period from January 2021 to December 2022. For the electricity consumption in 2022, energy consumption for January and February were provided together, the consumption for each individual month was estimated by following the same ratio between months as 2021. No energy consumption was provided for March 2022; values from March 2021 were used as an estimate.

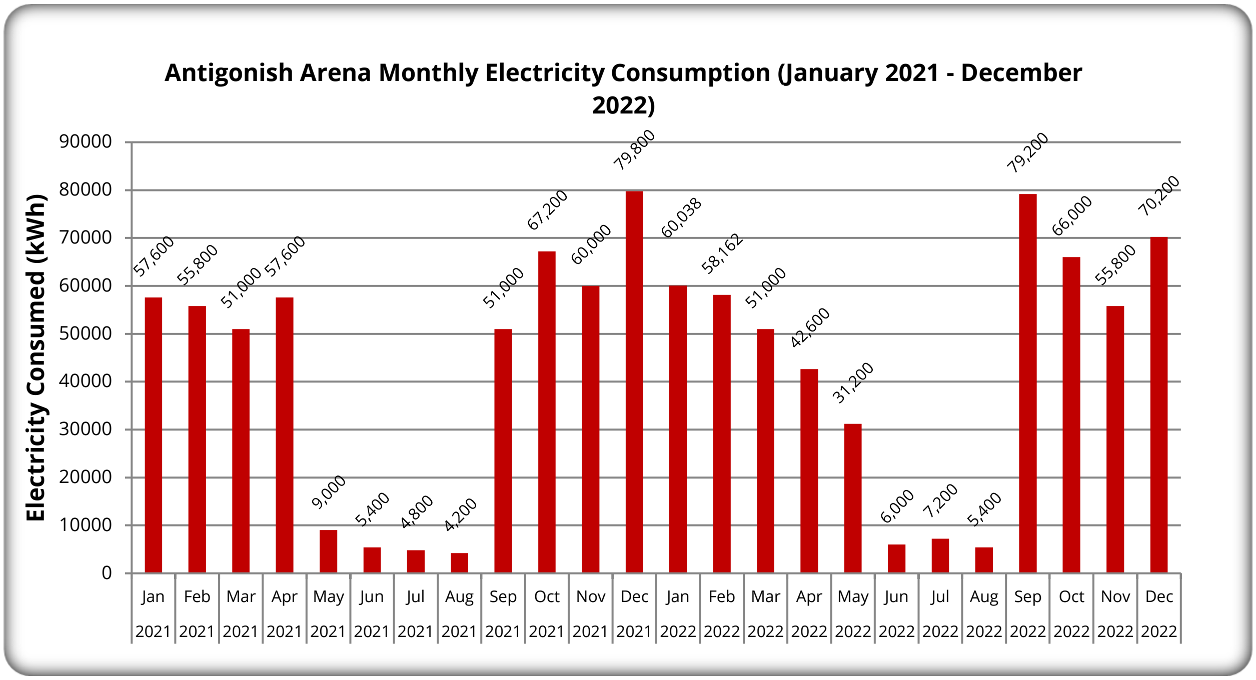


**Figure 2.2: 2021/2022 Monthly Electricity Consumption**

Figure 2.2 depicts a trend with a lower electricity consumption during the summer. Electricity is used to operate the ice plant, which runs from September to May, so this is to be expected. The building usage is also much higher during these months, as well.

Total electricity usage during the period of January/December 2021 was 503,400 kWh and 532,800 kWh from January/December 2022. The average annual energy consumption considering these two 12-month periods was 518,100 kWh.

### 2.2.2 Heating Oil Consumption

The Town of Antigonish provided the heating oil delivery records to the site for the period of January 2021 to December 2022. Total heating oil usage for the period of January/December 2021 was 34,342 L and 36,775 L from January/December 2022. The average annual fuel consumption for this period was 32,625 L. Heating oil is consumed by a boiler to provide space heating as well as domestic hot water heating. The figures are based on delivered quantities each month and do not necessarily reflect quantities consumed each month.

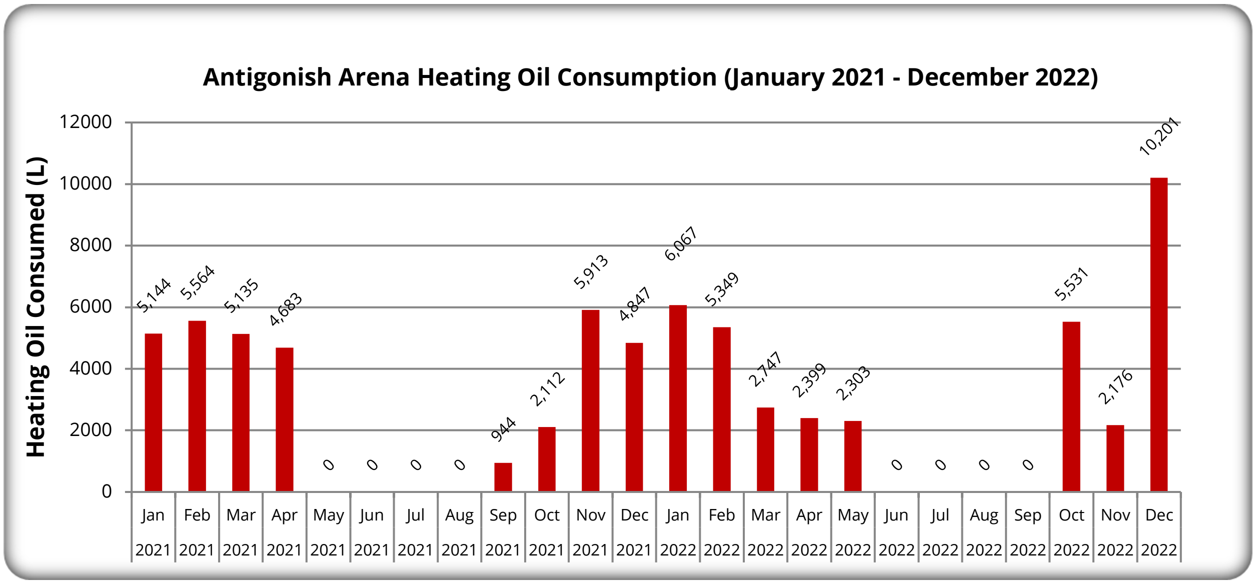


**Figure 2.3: Monthly Heating Oil Consumption in L**

### 2.2.3 Propane Consumption

The Town of Antigonish provided the propane delivery records to the site for the period of January 2022 to December 2022. Propane usage in 2021 was estimated to be the same as 2022. Total heating oil usage for the period of January/December 2022 was 4,310L. Propane is consumed for space heating, 1594.3L, and the ice resurfacer, 2716L.

### 2.2.4 Electricity Cost

Electricity is provided by the Antigonish Electric Utility as a "General Services above 3 kilowatts connected load" electricity rate[17].

| **Above 3 kilowatts connected load:** | |
|---|---|
| Base Rate: | $8.75 per month per kilowatt of maximum demand. |
| Energy Rates: | $0.15945 per kilowatt hour for the first 100 kilowatt hours per month per kilowatt of maximum demand.<br><br>$0.09993 per kilowatt hour for all additional consumption. |
| Base Rate: | $8.75 per kilowatt of maximum demand. |
| Minimum Bill: | The greater of the Base Rate or $10.53. |
| Efficiency Nova Scotia Charges | $0.00 per kilowatt hour for all consumption. |

**Figure 2.4: Antigonish Electric Utility Tariff Rate**

[17] Source file.html (townofantigonish.ca). Retrieved: 2023-11-20

Table 2.1 presents the monthly power bill cost breakdown for the January 2021 to December 2022, 24-month period for the Antigonish Arena.

**Table 2.1: Monthly Power Bill Cost Breakdown for the January 2021 to December 2022**

| Month-Year | Consumption (kWh) | Consumption Cost | Demand (kW) | Demand Cost | Invoice Amount |
|---|---|---|---|---|---|
| January 2021 | 57,600 | $6,720.19 | 162.00 | $1,391.58 | $8,111.77 |
| February 2021 | 55,800 | $6,576.03 | 168.00 | $1,443.12 | $8,019.15 |
| March 2021 | 51,000 | $6,096.37 | 168.00 | $1,443.12 | $7,539.49 |
| April 2021 | 57,600 | $6,755.90 | 168.00 | $1,443.12 | $8,199.02 |
| May 2021 | 9,000 | $1,149.35 | 42.00 | $360.78 | $1,510.13 |
| June 2021 | 5,400 | $543.20 | 0.60 | $5.15 | $548.35 |
| July 2021 | 4,800 | $515.38 | 6.00 | $51.54 | $566.92 |
| August 2021 | 4,200 | $455.42 | 6.00 | $51.54 | $506.96 |
| September 2021 | 51,000 | $6,096.37 | 168.00 | $1,443.12 | $7,539.49 |
| October 2021 | 67,200 | $7,643.81 | 156.00 | $1,340.04 | $8,983.85 |
| November 2021 | 60,000 | $6,995.74 | 168.00 | $1,443.12 | $8,438.86 |
| December 2021 | 79,800 | $8,902.93 | 156.00 | $1,340.04 | $10,242.97 |
| January 2022 | 7,800 | $1,243.71 | 156.00 | $1,340.04 | $2,583.75 |
| February 2022 | 110,400 | $11,960.78 | 156.00 | $1,340.04 | $13,300.82 |
| March 2022 | - | $0.00 | 156.00 | $1,340.04 | $1,340.04 |
| April 2022 | 42,600 | $5,185.53 | 156.00 | $1,340.04 | $6,525.57 |
| May 2022 | 31,200 | $4,046.33 | 156.00 | $1,340.04 | $5,386.37 |
| June 2022 | 6,000 | $671.00 | 12.00 | $103.08 | $774.08 |
| July 2022 | 7,200 | $933.77 | 36.00 | $309.24 | $1,243.01 |
| August 2022 | 5,400 | $682.47 | 24.00 | $206.16 | $888.63 |
| September 2022 | 79,200 | $8,914.39 | 168.00 | $1,443.12 | $10,357.51 |
| October 2022 | 66,000 | $7,523.89 | 156.00 | $1,340.04 | $8,863.93 |
| November 2022 | 55,800 | $6,504.61 | 156.00 | $1,340.04 | $7,844.65 |
| December 2022 | 70,200 | $7,943.60 | 156.00 | $1,340.04 | $9,283.64 |

### 2.2.5 Heating Oil Cost

The Town of Antigonish provided the heating oil delivery records to the site for the period of January 2021 to December 2022. The average cost during this time period was $1.25/L. Due to the significant increase in oil prices since the billing period, the cost savings calculations have been conducted using a value more representative of the current market price of $1.79/L[18].

[18] Source: Weekly Average Retail Prices for Furnace Oil in 2023 | Natural Resources Canada (nrcan.gc.ca). Retrieved: 2023-04-01.

### 2.2.6 Propane Cost

The Town of Antigonish provided the propane delivery records to the site for the period of January 2021 to December 2022. The average cost during this time period for heating propane was $1.06/L and approximately $1.42/L for the ice resurfacer. The cost savings calculations were conducted using a value more representative of the current market price of $0.8/L for heating propane and $0.97/L for propane utilized by the ice resurfacer.

### 2.2.7 Total Energy Use Summary

| Antigonish Arena – Area: 3372 m² | 2021 | 2022 |
|---|---|---|
| **Electricity** | | |
| Annual Electricity and Demand Cost ($) | $70,206.96 | $67,051.96 |
| Annual Electricity Consumption (kWh) | 503,400 | 532,800 |
| Annual Electricity Consumption (GJ) | 1,812 | 1,918 |
| Cost per GJ ($/GJ) | $38.7 | $35.0 |
| Percentage of Total Energy (%) | 57.8% | 55.7% |
| **Heating Oil** | | |
| Annual Heating Oil Cost ($) | $32,434.95 | $57,182.88 |
| Annual Heating Oil Consumption (L) | 34,342 | 36,775 |
| Annual Heating Oil Consumption (GJ) | 1,322.5 | 1416.18 |
| Cost per GJ ($/GJ) | $24.5 | $40.4 |
| Percentage of Total Energy (%) | 42.2% | 41.1% |
| **Propane** | | |
| Annual Propane Cost ($) | $5,544.84 | $5,544.84 |
| Annual Propane Consumption (L) | 4,310 | 4,310 |
| Annual Propane Consumption (GJ) | 109.7 | 109.72 |
| Cost per GJ ($/GJ) | 50.5 | 50.5 |
| Percentage of Total Energy (%) | 3.5% | 3.2% |
| **Summary – Total** | | |
| Annual Energy Costs ($) | $102,641.91 | $124,234.84 |
| Annual Energy Consumption (GJ) | 3,135 | 3,444 |
| Cost per GJ ($/GJ) | 32.7 | 36.1 |
| Percentage of Total Energy (%) | 100.00% | 100.00% |

The baseline energy usage for this study was determined using the January/December 2022 year. This year was selected for the baseline as it was determined that this would more accurately depict each facility's regular operations and energy usage after the COVID-19 pandemic.

### 2.2.8 Benchmarking

The energy use per area or energy use intensity (EUI) for this facility was 1.02GJ/m² in 2022. According to the Energy Star Portfolio Manager for Canada[19],the average EUI for an ice arena is 1.10 GJ/m². Currently, this facility sits approximately 7.3% lower than the average.

### 2.2.9 End-use Breakdown

A building energy model was created in Carrier HAP v6.1 considering the information and data collected from the drawings and the site visit. The energy model was calibrated based on the actual annual energy records for this facility, which allowed us to estimate the energy use breakdown shown in Table 2.2.

This energy use breakdown is an estimation based on information collected during the site visit and from the drawings. This information can only be confirmed with dedicated submetering of the different electrical subpanels and fuel-fired equipment and appliances in the facility. The review of this data allowed us to identify the following:

- The figure depicts that the majority of the energy consumption of the building, 30.8%, can be attributed to the space heating.
- The second largest source of energy usage is the ice plant at approximately 25.2%.
- The third largest source of energy consumption are the pumps at 15.8%.
- Hot water heating makes up 13.7% of the energy use, with 2.8% being attributed to ice resurfacing and 10.9% being service hot water.
- The remaining 14.4% is comprised of electrical equipment, lighting, fans and the ice resurfacer at 2.8%, 7.6%, 2.0%, and 2.0%, respectively.

**Table 2.2: Energy Use Breakdown**

| End-use | Energy Use Breakdown (%) | Site Energy (GJ) |
|---|---|---|
| Fans | 2.0% | 67.3 |
| Space Heating | 30.8% | 1,059.5 |
| Domestic Hot Water | 10.9% | 374.1 |
| Ice Resurfacing Water | 2.8% | 95.7 |
| Lighting | 7.6% | 262.1 |
| Electrical Equipment | 2.8% | 97.0 |
| Ice Plant and dehumidifiers | 25.2% | 865.8 |
| Pumps | 15.8% | 543.9 |
| Electric Resurfacer | 2.0% | 69.1 |
| **Total** | **100%** | **3,434.5** |

[19] Source: https://portfoliomanager.energystar.gov/pdf/reference/Canadian%20National%20Median%20Table.pdf. Retrieved: 2023-01-23

# 2.3 Energy and GHG Reduction Pathway

## 2.3.1 Pathway Components

### 2.3.1.1 Electric Boiler with Outdoor Air Temperature Reset

The building is heated by a hydronic heating system that utilizes an oil-fired boiler with an estimated efficiency of 80%. An electric boiler can provide the same output at an average efficiency of 100%.

The boiler for the hydronic heating system currently heats the supply water to a constant temperature of 82°C (180°F) regardless of the air temperature outside. There is potential for energy consumption reduction in the modulation of supply water temperature for the terminal units according to the outdoor temperature. Outdoor reset control uses the heating curve to set the relationship between the outdoor temperature and the supply water temperature. The heating curve defines the amount the supply water temperature is raised for every 1° drop in outdoor air temperature. During mild outdoor temperatures, the supply water temperature will be low, while during the coldest day of the year the supply water temperature will be at design conditions. Outdoor reset reduces indoor temperature changes by more closely matching the output of the terminal units to the load. It also increases system efficiency by minimizing distribution losses. It is recommended that this system be implemented with the installation of an electric boiler.

### 2.3.1.2 Upgrade Existing Lighting Fixtures to LEDs

The interior and exterior lighting for the facility is a mixture of LED, fluorescent, incandescent, and HID. LEDs can provide the same level of light as other types of fixtures while consuming less energy. Therefore, considering the difference between the consumption levels of the current lamps and LED lamps, the implementation of this recommendation could result in significant energy savings.

Based on the findings from the building condition assessment completed in parallel to the energy study, the lighting fixtures in this facility have reached the end of their expected useful life. Therefore, the recommendation is to replace the existing lighting fixtures with LED fixtures.

When calculating the input power of the existing lighting, we prepared estimates of the quantity and type of lamps (bulbs) based on visual observation of the fixtures. Since it is difficult to know what type of ballast is used in each fixture without disassembly, the analysis team considered a minimum factor of 1.1 for fluorescent fixtures and 1.2 for HID.

The implementation of LED lighting will result in reduced maintenance costs over the following years. This is due to LEDs having a longer lifespan than the existing lighting fixtures. It is estimated that a non-LED lighting fixture has a maintenance cost of $4/yr, while LEDs have an estimated maintenance cost of $2/yr. This leads to a savings of $2/yr in maintenance per fixture.

#### 2.3.1.3 Occupancy Sensors for Lighting Control

Spaces within the facility are currently controlled by manual ON/OFF switches. To reduce the amount of time the lights are left on (or forgotten ON) with spaces unoccupied, it is recommended that occupancy sensors be installed. Occupancy sensors come in a wide range of configurations and characteristics. They can be installed on walls, ceilings, or at the switch location. Detection can be based on sound, infrared heat, or both. The sensor has a relay that interrupts the voltage to the fixtures in the circuit, thus turning them off when no occupancy is detected. The viability for installation of an occupancy sensor depends on the cost of electricity, the size of the load (number and wattage of lights) being controlled, and the approximate number of unoccupied hours they are often being left turned on.

#### 2.3.1.4 Replace Weatherstripping on All Exterior Doors and Seal Exterior Openings

Some of the windows and doors in this facility exhibit gaps and cracks that will allow for outdoor air infiltration. This causes additional heating loads which impact the energy consumption from the HVAC systems. It is recommended that the envelope of conditioned spaces be inspected with caulking applied around the exterior windows, doors, and other exterior wall openings. Damaged and missing weatherstripping on the doors and windows in the facility should also be replaced.

#### 2.3.1.5 Replace Existing Windows with Thermally Insulated Vinyl Windows Minimum R-4

The building has metal frame, double pane windows with an estimated R-value of R-1.7. All windows have exceeded their expected lifespan. It is anticipated that replacing the windows with high efficiency double pane, vinyl frame windows will help reduce energy usage for the building. The implementation of this measure will lower conductive losses through the windows, as well as lower infiltration levels.

#### 2.3.1.6 Electric Radiant Heaters in Stands with Pay Control System

The only source of heating in the spectator area within the arena are propane radiant heaters with an estimated efficiency of 80%. An electric radiant heater can provide the same output at an average efficiency of 100%. It is also recommended that the heaters be pay operated to reduce usage and energy consumption.

#### 2.3.1.7 Repair Exhaust Louvers

Two exhaust louvers located in the arena show some damage and appear to not shut properly. This allows for outdoor air infiltration which cause additional loads on the ice plant and impact the energy consumption of the HVAC systems and dehumidifiers. It is recommended that these louvers be repaired to minimize infiltration.

#### 2.3.1.8 Air Compressor Maintenance Program

Compressed air is an expensive form of energy due to its low efficiency. Most compressed air systems typically have efficiencies of less than 25%, meaning that less than ¼ of the energy input to a compressor results in useable energy at the terminal device utilizing the compressed air. While some inefficiency is impossible to remove, most compressed air systems can improve their efficiency through the elimination of distribution system leaks and improper use of compressed air.

Implementation of a compressed air leak detection and repair program is recommended. Detection and repair of leaks in the compressed air system is an ongoing requirement. The system requires regular inspection to detect leaks on a system and ensure that leaks, once discovered, are recorded and that the repair and confirmation of the repair is also recorded.

#### 2.3.1.9 Hydronic Loop Pipe Insulation

The supply piping for the hydronic heating loop is uninsulated. The insulation of these pipes is recommended to reduce heat loss from the system before the hot water reaches the terminal units. The implementation of this measure will not result in significant savings since the piping is within the heated space and heat lost from the pipe will contribute to space heating, but it will contribute to a slight increase in the efficiency of the heating system. The more important reason to insulate heating piping is that it is a good industrial safety practice.

#### 2.3.1.10 Cold Water Ice Resurfacing with DHW Heat Recovery

Hot water is traditionally used to resurface the ice surface in arenas; heating water removes dissolved gases in the water to improve the ice quality. The Antigonish Arena typically resurfaces the ice surface 13 times a day when the ice is installed. This resurfacing water is heated to approximately 76.7°C. The water is currently being heated by an oil-fired boiler with an efficiency of approximately 80% and utilizes a heat exchanger with an effectiveness of approximately 80%. Currently, resurfacing water is preheated using waste thermal energy recovered by the ice plant.

Dissolved gases can now be removed without heating the water thus allowing ice to be resurfaced with cold water. This reduces the amount of energy required to heat the water and allows for the heat recovered from the ice plant to be used instead to preheat domestic hot water for servicing the locker rooms, washrooms, and canteen. The use of cold water ice-resurfacing would also decrease the operational load of the compressors since the ice plant would no longer have to refreeze high temperature water.

#### 2.3.1.11 Electric Ice Resurfacer

Ice resurfacing is performed by a propane fueled ice resurfacer; combustion engines typically have an efficiency of 40%. An electric vehicle has an efficiency of 70%. It is proposed that the existing propane ice resurfacer be replaced with an electric ice-resurfacer at the end of its life.

### 2.3.2 Energy Rates and Emission Intensity Factors

The following list includes some of the assumptions and variables considered for the technical and financial analysis. The life cycle cost assessment section will include more financial assumptions

- Cost of Electricity: $0.1258/kWh
- Cost of Heating Oil: $1.79/L
- Cost of Heating Propane : $0.8/L
- Cost of Ice Resurfacer Propane: $0.97/L
- Antigonish Electric GHG Emission Intensity Factor 2022: 0.3387 $CO_2$e kg/kWh
- Antigonish Electric GHG Emission Intensity Factor 2033: 0.1565 $CO_2$e kg/kWh
- Antigonish Electric GHG Emission Intensity Factor 2043: 0.03 $CO_2$e kg/kWh
- Heating Oil GHG Emission Intensity Factor: 2.71 $CO_2$e kg/L[20]
- Propane GHG Emission Intensity Factor: 1.52 $CO_2$e kg/L[20]

**Table 2.3: Projected Annual Carbon Emissions, No Measures Implemented**

| Energy Source | 2022 Energy Usage (GJ) | 2022 Emissions (tonnes) | 2033 Projected Emissions (tonnes) | 2043 Projected Emissions |
|---|---|---|---|---|
| Antigonish Electric | 1918.1 | 180.5 | 83.4 | 16.0 |
| Heating Oil | 1416.2 | 99.6 | 99.6 | 99.6 |
| Propane | 109.7 | 6.6 | 6.6 | 6.6 |
| **Totals** | **3444.0** | **286.7** | **189.6** | **122.2** |

The baseline energy consumption, January-December 2022, for the Antigonish Arena resulted in a total energy consumption of 3444 GJ annually and carbon emissions of 286.7 tonnes/year based on 2022 emissions factors. The carbon emission intensity of the electric grid and fossil fuels are projected to decrease during the lifespan of this study. Table 2.3 shows the projected annual emission without the implementation of any energy conservation measures. Compared to the baseline, emissions are expected to decrease by 33.9% and 57.4% by 2033 and 2043, respectively.

[20] Source: Emission Factors for Greenhouse Gas Inventories (epa.gov). Retrieved: 2023-04-01

### 2.3.3 Phase 1 Measurement and Analysis

The baseline HAP was modified to estimate the building's performance considering the efficiency measures listed above. These modifications included:

- Replacement of the oil-fired boiler, efficiency 80%, with an electric boiler, efficiency of 99%, and an outdoor air temperature reset.
- Lighting wattages for spaces without LEDs were modelled with LED equivalent wattages.
- The lighting in intermittently occupied spaces was reduced by 12.5% when modelled to represent the savings from occupancy sensors.
- Infiltration values were decreased by 10% for all spaces to represent weatherstripping and sealing of exterior surfaces.
- Windows were upgraded to an R-value of R-4. In spaces with windows, infiltration was decreased by an additional 5%.

The following measures were calculated separately:

- **Exhaust Fan Louvers:** It was estimated under the assumption that the arena space had an average air temperature of 15°C, with an average outdoor air temperature of 2°C when the building was in operation. The existing air exhaust fans were assumed to have a ¼" gap along the louver and it was estimated to be ⅛" when repaired. Electric radiant heaters, 100%, were assumed to be on 50% of the time during operating hours to determine the savings.
- **Air Compressor Maintenance Program:** It was estimated that the 3 hp air compressor runs an average of six hours per day, with a motor efficiency of 80%. It was estimated that the implementation of this program will result in an 10-15% reduction in energy usage from the air compressor. This estimation is based on repairing five leaks of 0.8 mm in diameter, an inlet pressure of 101.3 kPa, a compressor operating pressure of 700 kPA, a compressor isentropic efficiency of 82%, a compressor motor efficiency of 90%, a specific heat ratio of 1.4, and applying the calculation method defined by Dumus Kaya el at.[21]
- **Pipe Insulation:** The addition of 1.5" of insulation to the hot water piping was considered. Savings were estimated with a 1 m long section of 3" pipe with and without insulation. It was estimated that the interior wall was 82°C (180°F) and the ambient temperature was 18°C (64.4°F). The U-value for uninsulated steel pipe is 5.1 BTU/ft² hr °F, the U-value for 1.5" thick insulation was considered as 0.167 BTU/ ft² hr. A diversity factor of 50% was assumed.

[21] Energy Conservation in Compressed-Air System. Durmus Kaya, Patrick Phelan, David Chaun, and H. Ibrahim sarac. Industrial Assessment Centre, Arizona State University, Tempe, AZ 85287-6160, USA. TUBUTAK-MRC, Energy System and Environmental Research Institute, P.O. Box 21, 41470 Gebze-Kocaelli, Turkey. *International Journal of Energy Research. Int. J. Energy. 2002; 26:837-849 (DOI: 10.1002/er.823)*.

- **Cold Water Ice Resurfacing:** Ice resurfacing was assumed to occur 13 times per day, using an average of 265 L/resurfacing of 76.7°C hot water and the incoming water temperature was assumed to be approximately 8°C.
- **For Savings associated with Water Heating:** A majority of resurfacing water heating comes from energy recovered from the ice plant. It was estimated that 40% of the electricity consumption of the building was the ice plant, 71% being the compressor. It was assumed that 60% of the compressor energy could be recovered as heat and the heat exchanger had an efficiency of 50%. Of the energy calculated for heating the resurfacing water, heat recovered for ice resurfacing was estimated to be 73% of the total load with the remaining 26% being provided by the boiler. The hot water boiler was assumed to have an 80% efficiency and the heat exchanger between the boiler and the incoming water was also assumed to have an efficiency of 80%.
- **For Savings associated with Water Freezing:** Savings associated with the energy required to refreeze the water was considered at 76.7°C and 8°C considering an ice plant COP of 2.2.
- **For Savings associated with Domestic Hot Water Preheating:** The energy available for heat recovery will decrease after the implementation of cold-water ice resurfacing, because the compressors will operate less. To determine how much energy is available to be recovered, the energy savings associated with freezing the water were removed from the baseline ice plant energy usage. It was estimated that 40% of the electricity consumption of the building was the ice plant, 71% being the compressor. It was assumed that 60% of the compressor energy could be recovered as heat and the heat exchanger had an efficiency of 50%. Based on the occupancy patterns of the building and that the demands for hot water could occur sporadically, a conservative estimate is that 10% of the DHW demand of the building could be supplied through the ice plant.
- **For Savings associated with Brine Loop Temperature Increase:** To implement cold water ice resurfacing, the brine loop temperature needs to operate at 3°F higher. It is estimated this will save 2% of the ice plant energy usage.

The implementation of these measures to the Antigonish Arena would result in a reduction of energy consumption from the baseline of 594.6GJ. The total cost to implement Phase 1 measures is approximately $350,125 with a cost savings of an estimated $36,929 for a payback period of 9.5 years. These measures will result in emissions savings of 61.8 tonnes/year in 2033 compared to the baseline building's emissions in the same year as presented in Table 2.4.

**Table 2.4: Antigonish Arena Phase 1 Efficiency Measures**

| ECM | CAPEX ($) | GHG Savings (tonne) | CAPEX/ GHG Reduction ($/tonne) | Energy Savings GJ/yr | Cost Savings $/yr | Cost Savings/ GHG Saved ($/tonne $CO_2$e) | Simple Payback (yr) |
|---|---|---|---|---|---|---|---|
| Electric Boiler with OAT Reset | $45,000 | 51.7 | $5,828 | 362.4 | $28,785 | $557 | 10.5 |
| Electrical Entrance Upgrade | $110,000 | | | | | | |
| LED Lighting | $41,680 | | | | | | |
| Occupancy Sensors for Lighting Control | $2,400 | | | | | | |
| Infiltration Reduction | $3,250 | | | | | | |
| Replace Aluminum Windows with R-4* | $22,000 | | | | | | |
| Electric Radiant Heaters in Stands with Pay Control System* | $77,000 | | | | | | |
| Air Compressor Maintenance Program | $1,000 | 0.1 | $7,456 | 3.1 | $121 | $902 | 8.3 |
| Repair Louvers on Exhaust Fans | $720 | 0.05 | $15,595 | 1.062 | $37 | $804 | 19.4 |
| Hydronic Loop Pipe Insulation (per meter) | $75 | 0.21 | $357 | 4.7 | $183 | $871 | 0.4 |
| Cold Water Ice Resurfacing with DHW Heat Recovery | $47,000 | 9.7 | $4,841.42 | 223.3 | $7,804 | $804 | 6.0 |
| **ECM Implementation Total** | **$350,125** | **61.8** | **$5,665** | **594.6** | **$36,929** | **597.6** | **9.5** |

### 2.3.4 Phase 2 Measurement and Analysis

The following measure was considered:

- **Electric Ice Resurfacer:** The annual energy usage provided was 69.1 GJ/year. Internal combustion engines have an average efficiency of 40%, which allows for the useful energy to be recovered. It was assumed that an electric unit will have an efficiency of approximately 70%.

The implementation of this measure to the Antigonish Arena would result in a reduction of energy consumption from the baseline of 29.8 GJ per year. The total cost to implement the Phase 2 measures is approximately $190,000 with a cost savings of an estimated $1,254 for a payback period of 151.5 years. The simple payback calculation assumes that a zero-cost alternative is available which is untrue since this measure is scheduled to only occur when the current ice resurfacer is at the end of life and must be replaced. These measures would have an emissions savings 3.8 tonnes per year in 2043 compared to the baseline building's emissions in the same year.

**Table 2.5: Antigonish Arena Phase 2 Efficiency Measures**

| ECM | CAPEX ($) | GHG Savings (tonne) | CAPEX/ GHG Reduction ($/tonne) | Energy Savings GJ/yr | Cost Savings $/yr | Cost Savings/ GHG Saved ($/tonne $CO_2$e) | Simple Payback (yr) |
|---|---|---|---|---|---|---|---|
| Electric Zamboni | $190,000 | 3.8 | $49,906 | 29.8 | $1,254 | $329 | 151.5 |
| **ECM Implementation Total** | **$190,000** | **3.8** | **$49,906** | **29.8** | **$1,254** | **$329** | **151.5** |

### 2.3.5 Measures Considered but Not Recommended

The following measures were considered for this building but are ultimately not currently recommended for implementation:

- **Upgrade Exterior Insulation of Heated Spaces and Install Partition Insulation:** The building currently has exterior insulation but not along the partition between the heated spaces to the arena. This allows for heat loss from the conditioned spaces to the to arena. The implementation of insulation to the partition walls and the upgrade of the existing insulation levels would lower conductive losses through the walls, as well as lower infiltration levels. This measure is ultimately not being recommended because the cost of the measure would result in a long payback period.

# 3 Columbus Field Washrooms

## 3.1 Facility Description


**Figure 3.1: Columbus Field Washrooms**

The Columbus field washrooms were constructed in 2005.The building is accessible to the public from 14 hours a day from 8:00 a.m. to 10:00 p.m., seven days a week from March to October. Figure 3.1 presents a photograph of the site.

The building is equipped with electric radiant heaters. Interior and exterior lighting is provided by fluorescent and LED lighting fixtures. Electricity is the only source of energy consumed on site. Electricity powers the space heating, lighting, and service hot water, as well as other ancillary equipment. The building is also the location of an electric vehicle charger. This charger is metered separately from the building.

The building and major existing equipment characteristics include:

- The exterior walls appear to be in fair condition. The estimated R-value for the building is R-21.
- The building roof appears to be in fair condition. The estimated R-value is R-31.
- A vinyl, double paned window is in good condition. The estimated R value is R-2.
- The floor is suspended above grade and supported on concrete columns. The underneath of the floor is not insulated. The estimated R value is R-3.
- Exterior doors appear in good condition. R-values are estimated to be approximately R-3.
- Weatherstripping around the man-doors appears to be in poor condition with some areas showing daylight through gaps in the weatherstripping.
- The interior lighting is fluorescent with manual ON/OFF switches.
- Domestic hot water is provided by a 47 US gallon electric hot water heater.
- The temperature setpoint is assumed to be 15°C year-round with no nighttime setback.

# 3.2 Review of Historic Energy Performance

Electricity bills were provided for the 24-month period between January 2021-2022. Energy consumption and demand were reviewed in annual terms to ensure that variation in seasonality was observable. With at least two periods available, a month-to-month comparison of the facility's energy performance was completed from one year to the next. Review of the electricity consumption profiles, based on the information obtained from the two periods, was discussed, and is compared in this section.

## 3.2.1 Electricity Use Profiles

Figure 3.2 provides the monthly electricity usage profile which shows the 24-month period from January 2021 to December 2022.

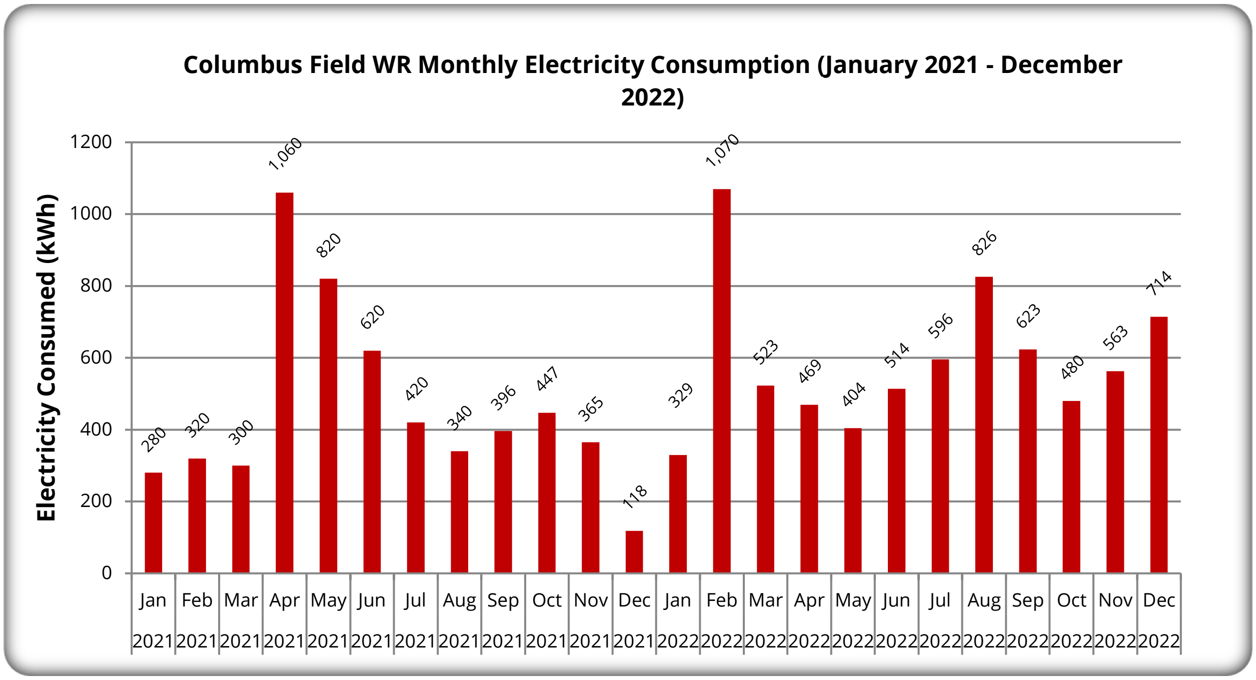


**Figure 3.2: 2021/2022 Monthly Electricity Consumption**

Figure 3.2 depicts a trend with a lower electricity consumption during the shoulder seasons and higher consumption in the summer and winter. Electricity consumption in the winter can be attributed to electric space heating. Increased consumption in the summer may be due to increased usage.

Total electricity consumption during the period of January/December 2021 was 5,486 kWh and 7,111 kWh from January/December 2022. The average annual energy consumption considering these two 12-month periods was 6,299 kWh. This does not include any consumption from the electric vehicle charger, as that is metered separately, and may vary depending on EV charging demands from its users.

### 3.2.2 Electricity Cost

Electricity is provided by the Antigonish Electric Utility as a "General Services above 3 kilowatts connected load" electricity rate[22].

| | |
|---|---|
| **Above 3 kilowatts connected load:** | |
| Base Rate: | $8.75 per month per kilowatt of maximum demand. |
| Energy Rates: | $0.15945 per kilowatt hour for the first 100 kilowatt hours per month per kilowatt of maximum demand.<br><br>$0.09993 per kilowatt hour for all additional consumption. |
| Base Rate: | $8.75 per kilowatt of maximum demand. |
| Minimum Bill: | The greater of the Base Rate or $10.53. |
| Efficiency Nova Scotia Charges | $0.00 per kilowatt hour for all consumption. |

**Figure 3.3: Antigonish Electric Utility Tariff Rate**

Table 3.1 presents the monthly power bill cost breakdown for the January 2021 to December 2022, 24-month period for the Columbus Field Washrooms.

**Table 3.1: Monthly Power Bill Cost Breakdown for the January 2021 to December 2022**

| Month-Year | Consumption (kWh) | Consumption Cost | Demand (kW) | Demand Cost | Invoice Amount |
|---|---|---|---|---|---|
| January 2021 | 280 | $39.88 | 2.00 | $17.18 | $57.06 |
| February 2021 | 320 | $46.26 | 2.40 | $20.62 | $66.88 |
| March 2021 | 300 | $44.27 | 2.40 | $20.62 | $64.89 |
| April 2021 | 1,060 | $160.68 | 9.20 | $79.03 | $239.71 |
| May 2021 | 820 | $115.27 | 5.60 | $48.10 | $163.37 |
| June 2021 | 620 | $92.90 | 5.20 | $44.67 | $137.57 |
| July 2021 | 420 | $66.97 | 4.20 | $36.08 | $103.05 |
| August 2021 | 340 | $54.21 | 4.00 | $34.36 | $88.57 |
| September 2021 | 396 | $63.14 | 4.40 | $37.80 | $100.94 |
| October 2021 | 447 | $68.30 | 3.97 | $34.10 | $102.40 |
| November 2021 | 365 | $58.20 | 4.23 | $36.34 | $94.54 |
| December 2021 | 118 | $18.82 | 1.18 | $10.14 | $28.96 |
| January 2022 | 329 | $32.88 | 1.18 | $10.14 | $43.02 |
| February 2022 | 1,070 | $120.32 | 1.07 | $9.19 | $129.51 |
| March 2022 | 523 | $77.68 | 4.27 | $36.68 | $114.36 |

[22] Source file.html (townofantigonish.ca). Retrieved: 2023-11-20

| Month-Year | Consumption (kWh) | Consumption Cost | Demand (kW) | Demand Cost | Invoice Amount |
|---|---|---|---|---|---|
| April 2022 | 469 | $74.78 | 5.80 | $49.82 | $124.60 |
| May 2022 | 404 | $64.42 | 4.08 | $35.05 | $99.47 |
| June 2022 | 514 | $81.96 | 15.46 | $132.80 | $214.76 |
| July 2022 | 596 | $95.03 | 11.57 | $99.39 | $194.42 |
| August 2022 | 826 | $131.71 | 18.03 | $154.88 | $286.59 |
| September 2022 | 623 | $99.34 | 9.62 | $82.64 | $181.98 |
| October 2022 | 480 | $76.54 | 8.14 | $69.92 | $146.46 |
| November 2022 | 563 | $89.77 | 9.61 | $82.55 | $172.32 |
| December 2022 | 714 | $113.85 | 8.73 | $74.99 | $188.84 |

### 3.2.3 Total Energy Use Summary

| Columbus Field Washrooms – Area: 37 m² | 2021 | 2022 |
|---|---|---|
| **Electricity** | | |
| Annual Electricity and Demand Cost ($) | $1,247.94 | $1,896.33 |
| Annual Electricity Consumption (kWh) | 5,486 | 7,111 |
| Annual Electricity Consumption (GJ) | 20 | 25.6 |
| Cost per GJ ($/GJ) | 63.2 | 74.1 |
| Percentage of Total Energy (%) | 100% | 100% |

The baseline energy usage for this study was determined using the January/December 2022 year. This year was selected for the baseline as it was determined that this would more accurately depict each facility's regular operations and energy usage after the COVID-19 pandemic.

### 3.2.4 Benchmarking

The energy use per area or energy use intensity (EUI) for this facility was 0.69 GJ/m² in 2022. According to the Energy Star Portfolio Manager for Canada[23],the average EUI for a public service-other space is 0.86 GJ/m². Currently, this facility sits approximately 19.8% lower than the average.

### 3.2.5 End-use Breakdown

The energy use breakdown for this building was estimated by assuming the hours of operation of the lighting and exhaust fan based on building occupancy. The domestic hot

[23] Source: https://portfoliomanager.energystar.gov/pdf/reference/Canadian%20National%20Median%20Table.pdf. Retrieved: 2023-01-23

water tank was assumed to have a diversity factor of 10% during months that the building is occupied. The remainder of energy consumption per year was attributed to space heating.

The estimate of the energy use breakdown is shown in Table 3.2. This energy use breakdown is an estimation based on information collected during the site visit and from the drawings. This information can only be confirmed with dedicated submetering of the different electrical subpanels and appliances in the facility. The review of this data allowed us to identify the following:

- The figure depicts that the majority of the energy consumption of the building, 49.1%, can be attributed to heating.
- The second largest source of energy usage is building lighting at approximately 24.8%.
- The remaining 26.1% is comprised of hot water heating and fans 24.6% and 1.4%, respectively.

**Table 3.2: Energy Use Breakdown**

| End-use | Energy Use Breakdown (%) | Site Energy (GJ) |
|---|---|---|
| Space Heating | 24.8% | 6.4 |
| Lights | 24.6% | 6.3 |
| Domestic Hot Water | 1.4% | 0.4 |
| Space Fans | 49.1% | 12.6 |
| **Total** | **100%** | **25.6** |

## 3.3 Energy and GHG Reduction Pathway

### 3.3.1 Pathway Components

#### 3.3.1.1 Upgrade Existing Lighting to LEDs

The interior lighting for the facility are fluorescent fixtures. LEDs can provide the same level of light as other types of fixtures while consuming less energy. Therefore, considering the difference between the consumption levels of the current lamps and LED lamps, the implementation of this recommendation could result in energy savings.

Based on the age of the building, it is expected that the lighting fixtures in this facility will have reached the end of their expected useful life by the end of Phase 1, 2033. Therefore, the recommendation is to replace the existing lighting fixtures with LED fixtures.

When calculating the input power of the existing lighting, we prepared estimates of the quantity and type of lamps (bulbs) based on visual observation of the fixtures. Since it is difficult to know what type of ballast is used in each fixture without disassembly, the analysis team considered a minimum factor of 1.1 for fluorescent fixtures and 1.2 for HID.

The implementation of LED lighting will result in reduced maintenance costs over the following years. This is due to LEDs having a longer lifespan than the existing lighting fixtures. It is estimated that a non-LED lighting fixture has a maintenance cost of $4/yr, while LEDs have an estimated maintenance cost of $2/yr. This leads to a savings of $2/yr in maintenance per fixture.

#### 3.3.1.2 Install Occupancy Sensors for Intermittently Used Spaces

Lights within the facility are currently controlled by manual ON/OFF switches. To reduce the amount of time the lights are left on (or forgotten ON) with spaces unoccupied, it is recommended that occupancy sensors be installed. Occupancy sensors come in a wide range of configurations and characteristics. They can be installed on walls, ceilings, or at the switch location. Detection can be based on sound, infrared heat, or both. The sensor has a relay that interrupts the voltage to the fixtures in the circuit, thus turning them off when no occupancy is detected. The viability for installation of an occupancy sensor depends on the cost of electricity, the size of the load (number and wattage of lights) being controlled, and the approximate number of unoccupied hours they are often being left turned on.

#### 3.3.1.3 Replace Washroom Exhaust On/Off Switch with Timer Switch

Two exhaust fans, assumed to be 150 cfm each, located in the facility are manually controlled and operate at maximum speed when on. Each cubic metre of air extracted from the building must be replaced by one cubic metre of conditioned air. To reduce the amount of time the exhaust fans are left on (or forgotten ON) with spaces unoccupied, it is recommended that timers be installed.

#### 3.3.1.4 Turn off Electric Heating During Seasonal Closure

The facility is operational for an estimated eight months of the year, with a closure in the winter. The water to the building is shut off during this time and heating is not required to prevent the freezing of the pipes. Therefore, since the space is unoccupied, and there is nothing onsite that could be damaged due to the cold temperature, it is recommended that the electric heating is turned off when the building is closed for the winter.

#### 3.3.1.5 Replace Weatherstripping on All Exterior Doors and Seal Exterior Openings

Some of the windows and doors in this facility exhibit gaps and cracks that will allow for outdoor air infiltration. This causes additional heating loads which impact the energy consumption from the HVAC systems. It is recommended that the envelope of conditioned spaces be inspected with caulking applied around the exterior windows, doors, and other exterior wall openings. Damaged and missing weatherstripping on the doors and windows in the facility should also be replaced.

### 3.3.2 Energy Rates and Emission Intensity Factors

The following list includes the assumptions and variables considered for the technical and financial analysis:

- Cost of Electricity 2022: $0.2667/kWh
- Antigonish Electric GHG Emission Intensity Factor 2022: 0.3387 $CO_2e$ kg/kWh
- Antigonish Electric GHG Emission Intensity Factor 2033: 0.1565 $CO_2e$ kg/kWh
- Antigonish Electric GHG Emission Intensity Factor 2043: 0.03 $CO_2e$ kg/kWh

**Table 3.3: Projected Annual Carbon Emissions, No Measures Implemented**

| Energy Source | 2022 Energy Usage (GJ) | 2022 Emissions (tonnes) | 2033 Projected Emissions (tonnes) | 2043 Projected Emissions |
|---|---|---|---|---|
| Antigonish Electric | 25.6 | 2.41 | 1.11 | 0.21 |
| **Total** | **25.6** | **2.41** | **1.11** | **0.21** |

The baseline energy consumption, January-December 2022, for the Columbus Field Washrooms resulted in a total energy consumption of 25.6 GJ annually and carbon emissions of 2.41 tonnes/year based on 2022 emissions factors. The carbon emission intensity of the electric grid and fossil fuels are projected to decrease during the lifespan of this study. Table 3.3 shows the projected annual emission without the implementation of any energy conservation measures. Compared to the baseline, emissions are expected to decrease by 53.8% and 91.1% by 2033 and 2043, respectively.

### 3.3.3 Phase 1 Measurement and Analysis

A HAP model of the building was created and modified to estimate the building's performance considering the efficiency measures listed above. These modifications included:

- **Turn Off Heating when Building is Unoccupied and Provide Weatherstripping:** The building model baseline had heating provided 12 months a year. To account for the energy savings due to these measures, the heating systems were turned off for a four-month period from November to February, and the infiltration to the building was reduced by 10%. The savings percentage was applied to the energy usage of the building to determine savings.

The savings from the following measures were calculated separately:

- **Upgrade the Lighting to LED with Occupancy Sensors:** The baseline building was assumed to have four fixtures that have two 32 W fluorescent bulbs with a ballast factor of 1.1. The LED lighting was assumed to be 25 W per fixture. It was assumed that the lights were on from 8:00 a.m. to 10:00 p.m., seven days per week for eight months per year for the baseline building. The time on was reduced by 12.5% to account for savings from the occupancy sensor.

- **Install Timer Switch to Control Exhaust Fans:** Two 150 cfm fans, at approximately 188 W each are located on site; it is assumed that each fan is on for 270 hours per year. The implementation of a control for the exhaust fan was assumed to reduce the operating hours by 50%.

The implementation of these measures to the Columbus Field Washroom will result in a reduction of energy consumption from the baseline of 12.9 GJ per year. The total cost to implement Phase 1 measures is approximately $2,060 with a cost savings of an estimated $973 for a payback period of 2.1 years. These measures will have an emissions savings 0.56 tonnes/year in 2033 compared to the baseline building's emissions in the same year as seen in Table 3.4.

**Table 3.4: Columbus Field Washrooms Phase 1 Efficiency Measures**

| ECM | CAPEX ($) | GHG Savings (tonne) | CAPEX/ GHG Reduction ($/tonne) | Energy Savings GJ/yr | Cost Savings $/yr | Cost Savings/ GHG Saved ($/tonne $CO_2e$) | Simple Payback (yr) |
|---|---|---|---|---|---|---|---|
| Upgrade Lighting to LED | $960 | 0.17 | $7,931 | 3.9 | $308 | $1,707 | 4.4 |
| Occupancy Sensor for Lighting | $400 | | | | | | |
| Turn off Heat when Building is Closed | $300 | 0.37 | $804 | 8.6 | $636 | $1,704 | 0.5 |
| Infiltration Reduction | | | | | | | |
| Bathroom Exhaust Timers | $400 | 0.02 | $23,666 | 0.4 | $29 | $1,704 | 13.9 |
| **ECM Implementation Total** | **$2,060** | **0.56** | **$3,668** | **12.9** | **$973** | **$1,733** | **2.1** |

### 3.3.4 Phase 2 Measurement and Analysis

The following measures were calculated separately:

- **Instantaneous Water Heater:** The building currently has a 47 US Gallon hot water heater. The water is turned off when the building is closed so it is assumed that the hot water tank operated eight months of the year, with a diversity factor of 10% for a total energy usage of 1752 kWh per year. The only hot water fixtures in the building are lavatories which do not require the higher flow rates that a tank water heater can provide. Instantaneous hot water heaters can save 20% compared to storage tank hot water heaters due to the removal of standby losses resulting in an estimated savings of 350.4 kWh per year. This measure should be implemented when the current domestic water heater is at the end of its life and requires replacement.

The implementation of this measure to the Columbus Field Washrooms will result in a reduction of energy consumption from the baseline of 1.3 GJ per year. The total cost to implement the Phase 2 measures is approximately $6,000 with a cost savings of an estimated $97 for a payback period of 61.6 years. These measures will have an emissions savings of 0.01 tonnes per year in 2043 compared to the baseline building's emissions in the same year.

**Table 3.5: Columbus Field Washrooms Phase 2 Efficiency Measures**

| ECM | CAPEX ($) | GHG Savings (tonne) | CAPEX/ GHG Reduction ($/tonne) | Energy Savings GJ/yr | Cost Savings $/yr | Cost Savings/ GHG Saved ($/tonne $CO_2$e) | Simple Payback (yr) |
|---|---|---|---|---|---|---|---|
| Upgrade Electric Service Entrance | $3,000 | 0.01 | $547,945.21 | 1.3 | $97 | $8,890.0 | 61.6 |
| Install a Tankless Hot Water Heater | $3,000 | | | | | | |
| **ECM Implementation Total** | **$6,000** | **0.01** | **$547,945** | **1.3** | **$97** | **$8,890.0** | **61.6** |

## 3.3.5 Measures Considered but Not Recommended

The following measures were considered for this building but are ultimately not currently recommended for implementation:

- **Insulate the Floor Deck:** The building is currently suspended above the ground with the floor being insulated. This allows for heat loss from the conditioned spaces to the immediate surroundings. The addition of insulation to the floor will lower conductive losses as well as lower infiltration levels. This measure is ultimately not being recommended because the majority of the heating load would occur when the building is unoccupied and unused, and the heating system does not need to be on during this time.

# 4 Antigonish Fire Hall

## 4.1 Facility Description

The Antigonish Fire Hall was built in 1961. The building has undergone renovations since the initial construction, including the addition of a HRV to the fire apartment. The fire chief's office and the activity room were drywalled and are assumed to have received additional insulation. The building is accessible 24/7 in the event of a fire but the majority of the building is primarily unoccupied throughout the week.

**Figure 4.1: Antigonish Fire Hall**

Taekwondo classes are held in the rec room Mondays and Wednesdays for three hours from 5:15 p.m. to 8:15 p.m., Fridays for two hours from 6:00 p.m. to 8:00 p.m. and Saturdays for one and a half hours from 9:00 a.m. to 10:30 a.m. Meetings and practises are held every Monday evening for 2-3 hours, 10 months of the year, between the activity room and truck bay. Additional training is held intermittently throughout the year in the activity room on the weekends. Figure 4.1 presents a photograph of the site.

The building is equipped with a hydronic heating system with an oil-fired boiler and circulating pumps. The administrative space utilizes hydronic baseboards, while the garage has a hydronic unit heater. No cooling is provided to the space. Interior and exterior lighting is provided by a mixture of LED, fluorescent, and halogen lighting fixtures. Electricity and heating oil are the two sources of energy consumed on site. Electricity powers the lighting, refrigeration, kitchen appliances, and a 5 hp air compressor, as well as other ancillary equipment. Heating oil is consumed in a boiler to produce heating to the administrative spaces and garage, as well as to produce service hot water. Mechanical ventilation is provided by a HRV to the fire apartment on the second floor.

The building and major existing equipment characteristics include:

- The exterior walls appear to be in fair condition. The estimated R-value for the building is R-3. Exterior walls in the activity room and fire chief's office are estimated to be R-10.
- The building roof appears to be in fair condition. The estimated R-value is R-11.
- Aluminum frame, double paned windows located in the weight room and fire apartment are in poor condition. The estimated R value is R-1.8. Vinyl frame, double paned windows in the remainder of the building are in fair condition. The estimated R value is R-2.1.
- The floor is slab-on-grade. The estimated R-value is R-1.8.
- Exterior doors appear in good condition. R-values are estimated to be approximately R-3 for the man-doors and R-5 for the overhead doors.
- Weatherstripping around the man-doors appears to be in poor to fair condition with some areas showing daylight through the gaps in the weatherstripping. Weatherstripping around the overhead doors is in good condition.
- The interior lighting is a combination of LED and fluorescent with manual ON/OFF switches except for the truck bays. Truck bay lighting has been converted to LEDs and has an occupancy sensor.
- The exterior lighting is provided by a combination of LED and HID.
- One oil-fired boiler provides hot water up to 82°C (180°F) for the hydronic heating system at an estimated efficiency of approximately 80-90%.
- Domestic hot water is provided by the boiler heater that serves the building washrooms, kitchen, and fire apartment.
- The temperature setpoint is 15°C year-round for all spaces with the exception of the fire chief's office and activity room which are 18°C with no nighttime setback. All the thermostats in this space are manual.
- Cooking appliances are electric.
- A heat recovery ventilator (HRV) serves the fire apartment with an estimated efficiency of 65%. It has a variable speed fan, operates continuously, and is controlled based on relative humidity.

## 4.2 Review of Historic Energy Performance

Electricity bills were provided for the 24-month period between January 2021-2022. Energy consumption and demand were reviewed in annual terms to ensure that variation in seasonality was observable. With at least two periods available, a month-to-month comparison of the facility's energy performance was completed from one year to the next. Review of the electricity consumption profiles, based on the information obtained from the two periods, was discussed, and is compared in this section.

### 4.2.1 Electricity Use Profiles

Figure 4.2 provides the monthly electricity usage profile which shows the 24-month period from January 2021 to December 2022.

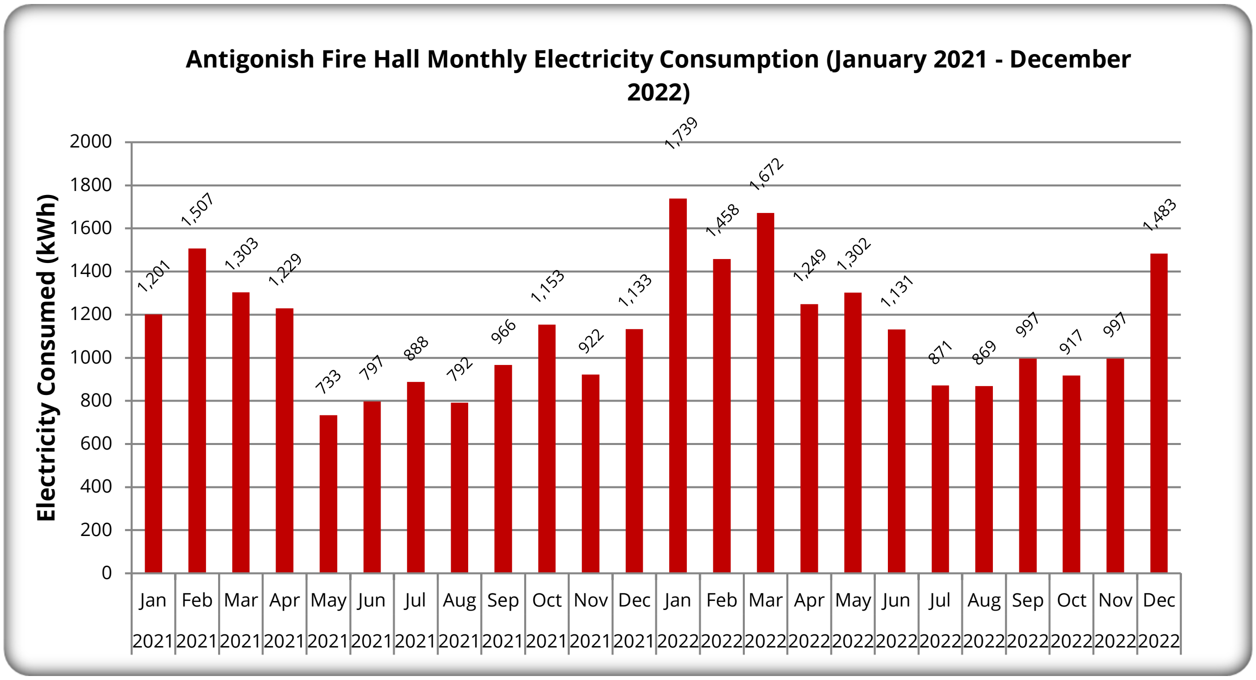


**Figure 4.2: 2021/2022 Monthly Electricity Consumption**

Figure 4.2 depicts a trend with a lower electricity consumption during the summer. Since electricity is not used for heating, this fluctuation is most likely due to lighting energy and hydronic pumping consumption, as well as changes in building operating schedules.

Total electricity usage during the period of January/December 2021 was 12,624 kWh and 14,685 kWh from January/December 2022. The average annual energy consumption considering these two 12-month periods was 13,655 kWh.

### 4.2.2 Heating Oil Consumption

The Town of Antigonish provided the heating oil delivery records to the site for the period of January 2021 to December 2022. Total heating oil usage for the period of January/December 2021 was 11,789 L and 12,985 L from January/December 2022. The average annual fuel consumption for this period was 12,357 L. Heating oil is consumed by a boiler to provide space and service water heating to the building. The figures are based on delivered quantities each month and do not necessarily reflect quantities consumed each month.

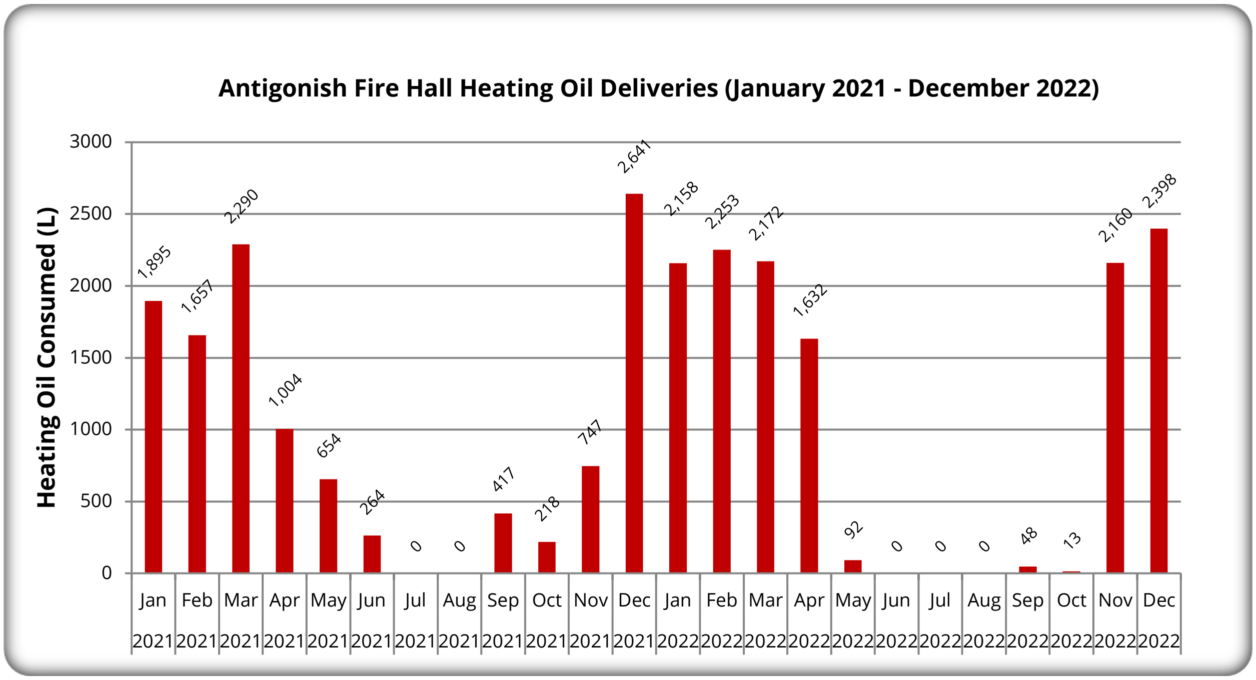


**Figure 4.3: Monthly Heating Oil Deliveries in L**

### 4.2.3 Electricity Cost

Electricity is provided by the Antigonish Electric Utility as a "General Services above 3 kilowatts connected load" electricity rate[24].

| **Above 3 kilowatts connected load:** | |
|---|---|
| Base Rate: | $8.75 per month per kilowatt of maximum demand. |
| Energy Rates: | $0.15945 per kilowatt hour for the first 100 kilowatt hours per month per kilowatt of maximum demand.<br><br>$0.09993 per kilowatt hour for all additional consumption. |
| Base Rate: | $8.75 per kilowatt of maximum demand. |
| Minimum Bill: | The greater of the Base Rate or $10.53. |
| Efficiency Nova Scotia Charges | $0.00 per kilowatt hour for all consumption. |

**Figure 4.4: Antigonish Electric Utility Tariff Rate**

Table 4.1 presents the monthly power bill cost breakdown for the January 2021 to December 2022, 24-month period for the Antigonish Fire Hall.

[24] Source file.html (townofantigonish.ca). Retrieved: 2023-11-20

**Table 4.1: Monthly Power Bill Cost Breakdown for the January 2021 to December 2022**

| Month-Year | Consumption (kWh) | Consumption Cost | Demand (kW) | Demand Cost | Invoice Amount |
|---|---|---|---|---|---|
| January 2021 | 1,201 | $152.93 | 5.53 | $47.50 | $200.43 |
| February 2021 | 1,507 | $195.83 | 7.60 | $65.28 | $261.11 |
| March 2021 | 1,303 | $171.10 | 6.87 | $59.01 | $230.11 |
| April 2021 | 1,229 | $157.63 | 5.85 | $50.25 | $207.88 |
| May 2021 | 733 | $99.08 | 4.34 | $37.28 | $136.36 |
| June 2021 | 797 | $113.33 | 5.66 | $48.62 | $161.95 |
| July 2021 | 888 | $126.41 | 6.33 | $54.37 | $180.78 |
| August 2021 | 792 | $107.00 | 4.68 | $40.20 | $147.20 |
| September 2021 | 966 | $135.22 | 6.50 | $55.84 | $191.06 |
| October 2021 | 1,153 | $150.10 | 5.86 | $50.34 | $200.44 |
| November 2021 | 922 | $131.42 | 6.60 | $56.69 | $188.11 |
| December 2021 | 1,133 | $143.94 | 5.16 | $44.32 | $188.26 |
| January 2022 | 1,739 | $202.70 | 4.86 | $41.75 | $244.45 |
| February 2022 | 1,458 | $186.35 | 6.83 | $58.67 | $245.02 |
| March 2022 | 1,672 | $210.65 | 7.32 | $62.88 | $273.53 |
| April 2022 | 1,249 | $157.84 | 5.55 | $47.67 | $205.51 |
| May 2022 | 1,302 | $180.29 | 8.43 | $72.41 | $252.70 |
| June 2022 | 1,131 | $152.54 | 6.64 | $57.04 | $209.58 |
| July 2022 | 871 | $123.52 | 6.13 | $52.66 | $176.18 |
| August 2022 | 869 | $113.98 | 4.56 | $39.17 | $153.15 |
| September 2022 | 997 | $144.21 | 7.49 | $64.34 | $208.55 |
| October 2022 | 917 | $125.69 | 5.72 | $49.13 | $174.82 |
| November 2022 | 997 | $134.27 | 5.82 | $49.99 | $184.26 |
| December 2022 | 1,483 | $183.79 | 5.98 | $51.37 | $235.16 |

### 4.2.4 Heating Oil Cost

The Town of Antigonish provided the heating oil delivery records to the site for the period of January 2021 to December 2022. The average cost during this time period was $1.23/L. Due to the significant increase in oil prices since the billing period, the cost savings calculations have been conducted using a value more representative of the current market price of $1.79/L[25].

[25] Source: Weekly Average Retail Prices for Furnace Oil in 2023 | Natural Resources Canada (nrcan.gc.ca). Retrieved: 2023-04-01.

### 4.2.5 Total Energy Use Summary

| Antigonish Fire Hall– Area: 686m² | 2021 | 2022 |
|---|---|---|
| **Electricity** | | |
| Annual Electricity and Demand Cost ($) | $2,293.69 | $2,562.91 |
| Annual Electricity Consumption (kWh) | 12,624 | 14,685 |
| Annual Electricity Consumption (GJ) | 45 | 53 |
| Cost per GJ ($/GJ) | 50.5 | 48.5 |
| Percentage of Total Energy (%) | 9.1% | 9.6% |
| **Heating Oil** | | |
| Annual Heating Oil Cost ($) | $10,903.44 | $19,839.60 |
| Annual Heating Oil Consumption (L) | 11,789 | 12,925 |
| Annual Heating Oil Consumption (GJ) | 454.0 | 497.75 |
| Cost per GJ ($/GJ) | 24.0 | 39.9 |
| Percentage of Total Energy (%) | 90.9% | 90.4% |
| **Summary – Total** | | |
| Annual Energy Costs ($) | $13,197.13 | $22,402.51 |
| Annual Energy Consumption (GJ) | 499 | 551 |
| Cost per GJ ($/GJ) | 26.4 | 40.7 |
| Percentage of Total Energy (%) | 100.00% | 100.00% |

The baseline energy usage for this study was determined using the January/December 2022 year. This year was selected for the baseline as it was determined that this would more accurately depict each facility's regular operations and energy usage after the COVID-19 pandemic.

### 4.2.6 Benchmarking

The energy use per area or energy use intensity (EUI) for this facility was 0.8 GJ/m² in 2022. According to the Energy Star Portfolio Manager for Canada[26],the average EUI for a fire station is 0.66 GJ/m². Currently, this facility sits approximately 21.2% higher than the average.

### 4.2.7 End-use Breakdown

A building energy model was created in Carrier HAP V6.1 considering the information and data collected from the drawings and the site visit. The energy model was calibrated based

[26] Source: https://portfoliomanager.energystar.gov/pdf/reference/Canadian%20National%20Median%20Table.pdf. Retrieved: 2023-01-23

on the actual annual energy records for this facility, which allowed us to estimate the energy use breakdown shown in Table 4.2.

This energy use breakdown is an estimation based on information collected during the site visit and from the drawings. This information can only be confirmed with dedicated submetering of the different electrical subpanels and fuel-fired equipment and appliances in the facility. The review of this data allowed us to identify the following:

- The figure depicts that the majority of the energy consumption of the building, 84.9%, can be attributed to heating.
- The second largest source of energy usage is hot water heating at approximately 5.4%.
- The third largest source of energy consumption is lighting at 4.6%.
- The remaining 5.2% is comprised of mechanical equipment, electrical equipment, air system fans, 2.4%, 1.5%, 1.3%, respectively.

**Table 4.2: Energy Use Breakdown**

| End-use | Energy Use Breakdown (%) | Site Energy (GJ) |
|---|---|---|
| Space Heating | 84.9% | 449.0 |
| Lights | 4.6% | 24.2 |
| Electrical Equipment | 1.5% | 7.8 |
| Mechanical Equipment | 2.4% | 12.9 |
| Hot Water | 5.4% | 28.4 |
| Air System Fans | 1.3% | 6.8 |
| **Total** | **100%** | **529.1** |

## 4.3 Energy and GHG Reduction Pathway

### 4.3.1 Pathway Components

#### 4.3.1.1 Implement an Outdoor Air Temperature Reset on the Existing Oil Fired Boiler

The building is heated by a hydronic heating system that utilizes an oil-fired boiler with an estimated efficiency of 80% with supply water being heated to a constant temperature of 82°C (180°F) regardless of the air temperature outside.

There is potential for energy consumption reduction in the modulation of supply water temperature for the terminal units according to the outdoor temperature. Outdoor reset control uses the heating curve to set the relationship between the outdoor temperature and the supply water temperature. The heating curve defines the amount the supply water temperature is raised for every 1° drop in outdoor air temperature. During mild outdoor temperatures, the supply water temperature will be low, while during the coldest day of the year the supply water temperature will be at design conditions. Outdoor reset reduces indoor temperature changes by more closely matching the output of the terminal units to the load. It also increases system efficiency by minimizing distribution losses.

Most standard oil-fired boilers, equipped with outdoor air reset systems, have a minimum temperature cutoff of 160°F. This protects against the risk of accelerated corrosion associated with lower water temperatures due to the products of combustion. Usually, fuel switching from fossil fuels to electricity is recommended to reduce carbon emission. However, considering that this facility is classified as an emergency building, it is more practical to keep the fossil fuel boiler. For example, in case of an emergency and power outage, the existing emergency generation would power the lighting system, the boiler ancillary equipment, and other plug loads. Whereas if the fire hall has an electric boiler, the facility will require a larger generator with a larger fuel tank and electrical main panel to be able to provide heating to the building.

#### 4.3.1.2 Install Air Source Heat Pumps in Administrative and Recreational Spaces

The building is heated by a hydronic heating system that utilizes an oil-fired boiler with an estimated efficiency of 80%.

Air source heat pumps are recommended for installation in the following spaces: activity room, fire chief's office, fire apartment and rec room, to mitigate heating oil usage in the building. In heating mode, heat pumps can have an average efficiency of 200-250% (COP 2-2.5) and peak efficiencies of 300-350%. The warmer the outdoor air, the more heat available, the higher the heat pump efficiency. The heat pump will also provide cooling, if required by the space, with an efficiency of at least EER 17. The availability of cooling will improve occupant comfort.

The heat pumps will be the primary sources of heating and cooling in these spaces, with the oil-fired boiler providing supplemental heating. In the case of an emergency, the spaces should be heated via the oil-fired boiler, which is powered by the existing generator and the heat pumps must remained off.

#### 4.3.1.3 Replace Existing Hydronic Fan Forced Heaters

The vehicle garage is equipped with fan forced heaters, but it is suspected that they are no longer operational. Heating to the space would be provided by uninsulated piping running along the ceiling. It is recommended that new hydronic fan forced heaters be installed in the space.

#### 4.3.1.4 Air Compressor Maintenance Program

Compressed air is an expensive form of energy due to its low efficiency. Most compressed air systems typically have efficiencies of less than 25%, meaning less than ¼ of the energy input to a compressor results in useable energy at the terminal device utilizing the compressed air. While some inefficiency is impossible to remove, most compressed air systems can improve their efficiency through the elimination of distribution system leaks and improper use of compressed air.

Implementation of a compressed air leak detection and repair program is recommended. Detection and repair of leaks in the compressed air system is an ongoing requirement. The system requires regular inspection to detect leaks on a system and ensure that leaks, once discovered, are recorded and that the repair and confirmation of the repair is also recorded.

#### 4.3.1.5 Upgrade Existing Lighting to LEDs

The interior and exterior lighting for the facility is a mixture of LED, fluorescent, and HID lighting fixtures. LEDs can provide the same level of light as other types of fixtures while consuming less energy. Therefore, considering the difference between the consumption levels of the current lamps and LED lamps, the implementation of this recommendation could result in significant energy savings.

Based on the findings from the building condition assessment completed in parallel to the energy study, lighting fixtures in this facility have reached the end of their expected useful life. Therefore, the recommendation is to replace the existing lighting fixtures with LED fixtures.

When calculating the input power of the existing lighting, we prepared estimates of the quantity and type of lamps (bulbs) based on visual observation of the fixtures. Since it is difficult to know what type of ballast is used in each fixture without disassembly, the analysis team considered a minimum factor of 1.1 for fluorescent fixtures and 1.2 for HID.

The implementation of LED lighting will result in reduced maintenance costs over the following years. This is due to LEDs having a longer lifespan than the existing lighting fixtures. It is estimated that a non-LED lighting fixture has a maintenance cost of $4/yr, while LEDs have an estimated maintenance cost of $2/yr. This leads to a savings of $2/yr in maintenance per fixture.

#### 4.3.1.6 Install Occupancy Sensors for Intermittently Used Spaces

With the exception of the truck bay, spaces within the facility are currently controlled by manual ON/OFF switches. To reduce the amount of time the lights are left on (or forgotten ON) with spaces unoccupied, it is recommended that occupancy sensors be installed. Occupancy sensors come in a wide range of configurations and characteristics. They can be installed on walls, ceilings, or at the switch location. Detection can be based on sound, infrared heat, or both. The sensor has a relay that interrupts the voltage to the fixtures in the circuit, thus turning them off when no occupancy is detected. The viability for installation of an occupancy sensor depends on the cost of electricity, the size of the load (number and wattage of lights) being controlled, and the approximate number of unoccupied hours they are often being left turned on.

#### 4.3.1.7 Replace Weatherstripping on All Exterior Doors and Seal Exterior Openings

Some of the windows and doors in this facility exhibit gaps and cracks that will allow for outdoor air infiltration. This causes additional heating loads which impact the energy consumption from the HVAC systems. It is recommended that the envelope of conditioned spaces be inspected and caulking applied around the exterior windows, doors, and other exterior wall openings. Damaged and missing weatherstripping on the doors and windows in the facility should also be replaced.

#### 4.3.1.8 Replace Washroom Exhaust On/Off Switch with Timer Switch

Four exhaust fans, assumed to be 100 cfm each, located in the facility are manually controlled and operate at maximum speed when on. Each cubic metre of air extracted from the building must be replaced by one cubic metre of conditioned air. To reduce the amount of time the exhaust fans are left on (or forgotten ON) with spaces unoccupied, it is recommended that timers be installed.

#### 4.3.1.9 Upgrade Existing Windows to Thermally Insulated Vinyl Windows Minumum R-4

The building has aluminum frame, double pane windows with an estimated R-value of R-1.8 and vinyl frame, double paned windows with an estimated R-value of R-2.1. The aluminum frame windows will have reached the end of their expected lifespan during Phase 1 and are recommended for replacement during this time. The vinyl windows will reach the end of their expected lifespan during Phase 2 and should be replaced at that point. It is anticipated that replacing the windows with high efficiency, double pane, vinyl frame windows will help reduce energy usage for the building. The implementation of this measure will lower conductive losses through the windows, as well as lower infiltration levels.

### 4.3.2 Energy Rates and Emission Intensity Factors

The following list includes the assumptions and variables considered for the technical and financial analysis:

| | |
|---|---|
| Cost of Electricity: | $0.1745/kWh |
| Cost of Heating Oil: | $1.79/L |
| Antigonish Electric GHG Emission Intensity Factor 2022: | 0.3387 $CO_2$e kg/kWh |
| Antigonish Electric GHG Emission Intensity Factor 2033: | 0.1565 $CO_2$e kg/kWh |
| Antigonish Electric GHG Emission Intensity Factor 2043: | 0.03 $CO_2$e kg/kWh |
| Heating Oil GHG Emission Intensity Factor 2022: | 2.71 $CO_2$e kg/L[27] |

[27] Source: Emission Factors for Greenhouse Gas Inventories (epa.gov). Retrieved: 2023-04-01

**Table 4.3:Projected Annual Carbon Emissions, No Measures Implemented**

| Energy Source | 2022 Energy Usage (GJ) | 2022 Emissions (tonnes) | 2033 Projected Emissions (tonnes) | 2043 Projected Emissions |
|---|---|---|---|---|
| Antigonish Electric | 52.9 | 5.0 | 2.3 | 0.44 |
| Heating Oil | 497.7 | 35.0 | 35.0 | 35.0 |
| **Total** | **550.6** | **40.0** | **37.3** | **35.5** |

The baseline energy consumption, January-December 2022, for the Antigonish Fire Hall resulted in a total energy consumption of 550.6 GJ annually and carbon emissions of 40.0 tonnes per year based on 2022 emissions factors. The carbon emission intensity of the electric grid and fossil fuels are projected to decrease during the lifespan of this study. Table 4.3 shows the projected annual emissions without the implementation of any energy conservation measures. Compared to the baseline, emissions are expected to decrease by 6.7% and 11.3% by 2033 and 2043, respectively.

### 4.3.3 Phase 1 Measurement and Analysis

The baseline HAP was modified to estimate the building's performance considering the efficiency measures listed above. These modifications included:

- Implementation of an outdoor air temperature reset on the existing oil-fired boiler.
- In the following spaces: activity room, fire apartment, fire chief's office and the rec room heat pumps were modelled, with a COP of 3.3 and a EER of 17. A cooling setpoint of 24°C was assumed.
- Hydronic heaters located in the garage were replaced with new hydronic fan forced heaters.
- Lighting wattages for spaces without LEDs were modelled with LED equivalent wattages.
- The lighting in intermittently occupied spaces was reduced by 12.5% when modelled to represent the savings from occupancy sensors.
- Infiltration values were decreased by 10% for all spaces to represent weatherstripping and sealing of the exterior surfaces.
- Aluminum windows were upgraded to an R-value of R-4. In spaces with these windows, infiltration was decreased by an additional 5%.
- The exhaust fans had originally been estimated to operate one hour per day. The utilization of a timer is estimated to reduce this by 50%.

The following measures were calculated separately:

- **Air Compressor Maintenance Program:** It is estimated that the 5 hp air compressor runs an average of 4.3 hours per day, with a motor efficiency of 80%. It is estimated that the implementation of this program will result in a 10-15% reduction in energy usage from the air compressor. This estimation was based on repairing five leaks of 0.8 mm in diameter, an inlet pressure of 101.3 kPa, a compressor operating pressure of 700 kPA, a compressor isentropic efficiency of 82%, a compressor motor efficiency of 90%, a specific heat ratio of 1.4, and applying the calculation method defined by Dumus Kaya el at.[28]

The implementation of these measures at the Antigonish Fire Hall will result in a reduction of energy consumption from the baseline of 132.4 GJ per year. The total cost to implement Phase 1 measures is approximately $195,060 with a cost savings of an estimated $6,147 for a payback period of 31.7 years. These measures will have an emissions savings 11.6 tonnes per year in 2033 compared to the baseline building's emissions in the same year as seen in Table 4.4.

**Table 4.4: Antigonish Fire Hall Phase 1 Efficiency Measures**

| ECM | CAPEX ($) | GHG Savings (tonne) | CAPEX/ GHG Reduction ($/tonne) | Energy Savings GJ/yr | Cost Savings $/yr | Cost Savings/ GHG Saved ($/tonne $CO_2$e) | Simple Payback (yr) |
|---|---|---|---|---|---|---|---|
| Upgrade Lighting to LEDs | $8,210 | 11.4 | $16,969 | 128.7 | $5,968 | $522 | 32.5 |
| Occupancy Sensors for Lighting | $2,000 | | | | | | |
| Bathroom Exhaust Timers | $800 | | | | | | |
| Install New Fan Forced in the Garage | $40,000 | | | | | | |
| Implement OAT Reset on Boiler | $2,500 | | | | | | |
| Install Air Source Heat Pumps in: Activity Room, Fire Chiefs Office, Fire Apartment and Rec Room | $40,000 | | | | | | |
| Electrical Service Upgrade | $80,000 | | | | | | |

[28] Energy Conservation in Compressed-Air System. Durmus Kaya, Patrick Phelan, David Chaun, and H. Ibrahim sarac. Industrial Assessment Center, Arizona State University, Tempe, AZ 85287-6160, USA. TUBUTAK-MRC, Energy System and Environmental Research Institute, P.O. Box 21, 41470 Gebze-Kocaelli, Turkey. *International Journal of Energy Research. Int. J. Energy. 2002; 26:837-849 (DOI: 10.1002/er.823).*

| ECM | CAPEX ($) | GHG Savings (tonne) | CAPEX/ GHG Reduction ($/tonne) | Energy Savings GJ/yr | Cost Savings $/yr | Cost Savings/ GHG Saved ($/tonne $CO_2e$) | Simple Payback (yr) |
|---|---|---|---|---|---|---|---|
| Replace Aluminum Windows with Minimum R-4 | $21,500 | | | | | | |
| Infiltration Reduction | $1,550 | | | | | | |
| Air Compressor Maintenance Program | $1,000 | 0.16 | $6,098 | 3.70 | $179 | $1,094 | 5.6 |
| **ECM Implementation Total** | **$195,060** | **11.6** | **$16,820** | **132.4** | **$6,147** | **$530.1** | **31.7** |

## 4.3.4 Phase 2 Measurement and Analysis

The Phase 1 HAP model was modified to estimate the building's performance considering the efficiency measures listed above. These modifications included:

- Vinyl windows were upgraded to an R-value of R-4. In spaces with these windows, infiltration was decreased by an additional 5% compared to baseline levels.

The implementation of this measures at the Antigonish Fire Hall will result in a reduction of energy consumption from the baseline of 2.1 GJ per year. The total cost to implement Phase 2 measures is approximately $34,500 with a cost savings of an estimated $489 for a payback period of 336.8 years. The simple payback calculation assumes that a zero-cost alternative is available which is untrue since this measure is scheduled to only occur when the vinyl windows would be at the end of life and must be replaced. These measures will have an emissions savings of 0.04 tonnes per year in 2043 compared to the baseline building's emissions in the same year as seen in Table 4.4.

**Table 4.5 Antigonish Fire Hall Phase 2 Efficiency Measures**

| ECM | CAPEX ($) | GHG Savings (tonne) | CAPEX/ GHG Reduction ($/tonne) | Energy Savings GJ/yr | Cost Savings $/yr | Cost Savings/ GHG Saved ($/tonne $CO_2e$) | Simple Payback (yr) |
|---|---|---|---|---|---|---|---|
| Existing Vinyl Windows with Vinyl R-4 | $34,500 | 0.04 | $936,980 | 2.1 | $102 | $2,782 | 336.8 |
| **ECM Implementation Total** | **$34,500** | **0.04** | **$936,980** | **2.1** | **$102** | **$2,782** | **336.8** |

### 4.3.5 Measures Considered but Not Recommended

The following measures were considered for this building but are ultimately not currently recommended for implementation:

- **Upgrade Exterior Insulation of Heated Spaces:** The building currently has minimal exterior insulation. This allows for heat loss from the conditioned spaces to the immediate surroundings. The upgrade of the exterior wall and roof insulation levels would lower conductive losses through the building envelope, as well as lower infiltration levels. This measure is ultimately not being recommended because the cost of the measure would result in a long payback period with minimal additional GHG reductions.

# 5 Antigonish Town and County Library

## 5.1 Facility Description


**Figure 5.1: Antigonish Town and Country Library**

The facility was originally built in the 1940s. In 2011, the building underwent extensive renovations to be able to house the Antigonish Public Library, which included a new addition of approximately 1,400 ft² on the east facing side of the building. Renovations included a new a 3.69 kWDC PV array on the roof and vacuum tube solar water heaters to preheat service water. The building is open seven days a week, from 1:00 p.m. to 4:00 p.m. on Sundays, 9:00 a.m. to 5:00 p.m. on Mondays, Fridays, and Saturdays, and 9:00 a.m. to 9:00 p.m. on Tuesdays, Wednesdays, and Thursdays. Figure 5.1 presents a photograph of the site.

The building is equipped with a forced air system that provides ventilation, heating (hydronic), and cooling (DX). Supply air is a mixture of recirculated and fresh air provided by two HRVs. Heating and cooling of supply air is provided by water-to-air heat pumps and in floor radiant heating to the new addition is provided by a water-to-water heat pump. The heat pumps are part of a vertical closed geothermal loop system. An electric boiler is utilized as a supplementary heat source for the hydronic loop.

Interior and exterior lighting is provided by a mixture of fluorescent and LED lighting. Electricity is the only source of energy on site. Electricity powers the space heating, cooling, lighting, refrigeration, and kitchen appliances, as well as any other ancillary equipment.

The building and major existing equipment characteristics include:

- The exterior walls appear to be in good condition. The estimated R-value for the building is R-20.
- The building roof appears to be in good condition. The estimated R-value is R-30.
- Aluminum frame windows appear in good condition. The estimated R value is R-3.
- The floor is slab-on-grade. The estimated R-value is R-1.5.
- Exterior doors appear in good condition. R-values are estimated to be approximately R-3.
- Weatherstripping around the man-doors appears to be in good condition.
- The interior lighting is a combination of LED and fluorescent with manual ON/OFF switches.
- The exterior lighting is provided by a combination of LED and fluorescent lighting.
- Continuous ventilation is provided to the building with supply air being a mixture fresh and return air. Hydronic heating coils are supplied by water-to-air heat pumps (15) providing hot water up to 49°C (120°F) with an estimated COP of 3.6. DX cooling is also provided by the water-to-air heat pumps with an estimated EER of 17.
- In floor radiant heating is provided by a water-to water heat pump which provides hot water up to 49°C (120°F) with an estimated COP of 2.85.
- Two Heat Recovery Ventilators (HRVs) serve the facility with an estimated flow rate of 1200 cfm each and an estimated efficiency of 65%. They have variable speed fans, operate continuously, and are controlled based on relative humidity.
- The building loop and ground loop sides of the heat exchanger operate using variable frequency drive (VFD) pumps. The zone valves for each heat pump were manually set to open and currently do not actuate.
- Two electric boilers act as a supplemental heating source for the hydronic heating loops with an estimated efficiency of approximately 90-99%.
- The temperature setpoint is assumed to be 21°C in the winter and be 23°C in the summer. All spaces have programmable thermostats; no nighttime setback has been implemented.
- Domestic hot water is provided by a 75-gallon electric water heater that serves the building washrooms, kitchens, and café. Service water is preheated by using vacuum tube solar water heaters.
- Cooking appliances are electric.

## 5.2 Review of Historic Energy Performance

Electricity bills were provided for the 24-month period between January 2021-2022. Energy consumption and demand were reviewed in annual terms to ensure that variation in seasonality was observable. With at least two periods available, a month-to-month comparison of the facility’s energy performance was completed from one year to the next. Review of electricity consumption profiles, based on the information obtained from the two periods, was discussed, and is compared in this section.

## 5.2.1 Electricity Use Profiles

Figure 5.2 provides the monthly electricity usage profile which shows the 24-month period from January 2021 to December 2022.

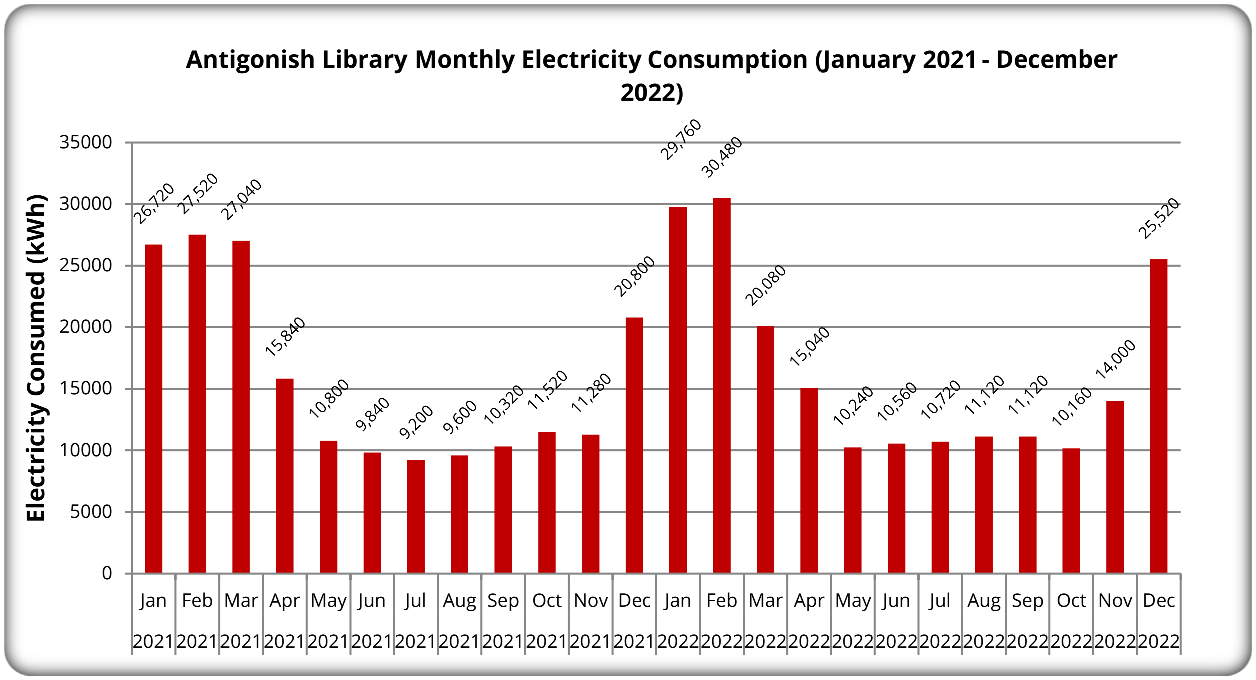


**Figure 5.2: 2021/2022 Monthly Electricity Consumption from Antigonish Electric Grid**

Figure 5.2 depicts a trend with a lower electricity consumption during the summer. Electricity is used for heating in the facility, so, as expected, the consumption is higher during the winter than it is in the summer months.

Total electricity purchased from the Antigonish Electric Utility in the period of January/December 2021 was 190,480 kWh and 198,800 kWh from January/December 2022. The average annual energy consumption considering these two 12-month periods was 194,460 kWh. It is assumed that the electricity produced by the PV array was not included in the electricity bills and this would include an additional estimated 3,690 kWh per year.

## 5.2.2 Electricity Cost

Electricity is provided by the Antigonish Electric Utility as a "General Services above 3 kilowatts connected load" electricity rate[29].

[29] Source: file.html (townofantigonish.ca). Retrieved: 2023-11-20

| **Above 3 kilowatts connected load:** | |
|---|---|
| Base Rate: | $8.75 per month per kilowatt of maximum demand. |
| Energy Rates: | $0.15945 per kilowatt hour for the first 100 kilowatt hours per month per kilowatt of maximum demand.<br><br>$0.09993 per kilowatt hour for all additional consumption. |
| Base Rate: | $8.75 per kilowatt of maximum demand. |
| Minimum Bill: | The greater of the Base Rate or $10.53. |
| Efficiency Nova Scotia Charges | $0.00 per kilowatt hour for all consumption. |

**Figure 5.3: Antigonish Electric Utility Tariff Rate**

Table 5.1 presents the monthly power bill cost breakdown for the January 2021 to December 2022, 24-month period for the Antigonish Arena.

**Table 5.1: Monthly Power Bill Cost Breakdown for the January 2021 to December 2022**

| Month-Year | Consumption (kWh) | Consumption Cost | Demand (kW) | Demand Cost | Invoice Amount |
|---|---|---|---|---|---|
| January 2021 | 26,720 | $3,162.00 | 82.64 | $709.88 | $200.43 |
| February 2021 | 27,520 | $3,210.04 | 77.28 | $663.84 | $261.11 |
| March 2021 | 27,040 | $3,173.50 | 79.20 | $680.33 | $230.11 |
| April 2021 | 15,840 | $2,002.38 | 70.48 | $605.42 | $207.88 |
| May 2021 | 10,800 | $1,458.74 | 63.76 | $547.70 | $136.36 |
| June 2021 | 9,840 | $1,119.49 | 22.88 | $196.54 | $161.95 |
| July 2021 | 9,200 | $1,076.49 | 26.40 | $226.78 | $180.78 |
| August 2021 | 9,600 | $1,141.22 | 30.56 | $262.51 | $147.20 |
| September 2021 | 10,320 | $1,169.36 | 23.20 | $199.29 | $191.06 |
| October 2021 | 11,520 | $1,306.43 | 26.08 | $224.03 | $200.44 |
| November 2021 | 11,280 | $1,541.00 | 69.52 | $597.18 | $188.11 |
| December 2021 | 20,800 | $2,612.32 | 89.68 | $770.35 | $188.26 |
| January 2022 | 29,760 | $3,446.27 | 79.36 | $681.70 | $244.45 |
| February 2022 | 30,480 | $3,520.12 | 79.68 | $684.45 | $245.02 |
| March 2022 | 20,080 | $2,477.99 | 79.20 | $680.33 | $273.53 |
| April 2022 | 15,040 | $1,929.59 | 71.68 | $615.73 | $205.51 |
| May 2022 | 10,240 | $1,176.13 | 25.68 | $220.59 | $252.70 |
| June 2022 | 10,560 | $1,236.67 | 30.48 | $261.82 | $209.58 |
| July 2022 | 10,720 | $1,254.09 | 30.72 | $263.88 | $3,871.88 |
| August 2022 | 11,120 | $1,301.69 | 32.00 | $274.88 | $3,873.88 |
| September 2022 | 11,120 | $1,287.40 | 29.60 | $254.26 | $3,853.83 |
| October 2022 | 10,160 | $1,198.13 | 30.72 | $263.88 | $2,607.80 |
| November 2022 | 14,000 | $1,851.85 | 76.08 | $653.53 | $2,006.44 |
| December 2022 | 25,520 | $2,988.28 | 73.60 | $632.22 | $1,316.03 |

### 5.2.3 Total Energy Use Summary

| Antigonish Town and County Library – Area: 1858 m² | 2021 | 2022 |
|---|---|---|
| **Electricity** | | |
| Annual Electricity and Demand Cost ($) | $28,656.82 | $29,155.48 |
| Annual Electricity Consumption (kWh) | 194,170 | 202,490 |
| Annual Electricity Consumption (GJ) | 699 | 729 |
| Cost per GJ ($/GJ) | 41.0 | 40.0 |
| Percentage of Total Energy (%) | 100.0% | 100.0% |

The baseline energy usage for this study was determined using the January/December 2022 year. This year was selected for the baseline as it was determined that this would more accurately depict each facility's regular operations and energy usage after the COVID-19 pandemic.

### 5.2.4 Benchmarking

The energy use per area or energy use intensity (EUI) for this facility is 0.39GJ/m². According to the Energy Star Portfolio Manager for Canada[30],the average EUI for a library is 1.03 GJ/m². Currently, this facility sits approximately 62.1% lower than the average.

### 5.2.5 End-use Breakdown

A building energy model was created in HAPv6.1 considering the information and data collected from the drawings and the site visit. The energy model allowed us to estimate the energy use breakdown, shown in Table 5.2, by applying the energy use breakdown modelled to the annual energy use of the building. This energy use breakdown is an estimation based on the information collected during the site visit and from the drawings. This information can only be confirmed with dedicated submetering of the different electrical subpanels and appliances in the facility. The review of this data allowed us to identify the following:

- The figure depicts that the majority of the energy consumption of the building, 38.5%, can be attributed to heating.
- The second largest source of energy usage is building lighting at approximately 26.4%.
- The third largest source of energy consumption is the mechanical equipment at 9.4%.
- The remaining 25.5% is comprised of electrical equipment, space cooling, and air system fans at 6.1%, 7.3%, and 12.1%, respectively.

[30] Source: https://portfoliomanager.energystar.gov/pdf/reference/Canadian%20National%20Median%20Table.pdf. Retrieved: 2023-01-23

**Table 5.2: Energy Use Breakdown**

| End-use | Energy Use Breakdown (%) | Site Energy (GJ) |
|---|---|---|
| Air System Fans | 12.1 | 88.2 |
| Space Cooling | 6.1 | 44.5 |
| Space Heating | 38.5 | 280.7 |
| Mechanical Equipment | 9.4 | 68.5 |
| Lights | 26.5 | 193.2 |
| Electric Equipment | 7.3 | 53.2 |
| **Total** | 100.0 | **728.2** |

## 5.3 Energy and GHG Reduction Pathway

### 5.3.1 Pathway Components

#### 5.3.1.1 Reactivate and Access Existing Building Automation System (BAS)

The facility currently has an existing building automation system (BAS) that allows for the building wide control and observation of the HVAC systems. The staff currently do not have access to the existing BAS. It is recommended that the control system be recommissioned and staff both receive access and training to operate the system.

#### 5.3.1.2 Reconnect Electronic Control Valves for Each Heat Pump

The pumps that are part of the hydronic heating system have VFD controls. VFDs slow the speed of a pump as required to meet the load, and every single speed reduction below nominal results in energy savings. The ground-source heat pumps located on site have electronic valves that are currently manually set to operate in the open position. The pumps are not connected to a control system; therefore, they cannot be modulated based on heating/cooling requirements. Currently, even when the demand for heat is low, the valves remain open, and the pumps need to operate at higher speeds. By reconnecting the controls to these valves, it will allow them to actuate between open and closed as designed and allow the VFDs to reduce speeds as they will not have to maintain as high a pressure. Pump affinity laws state that the pumping energy is directly related to pump speed. Savings can be determined by applying a factor that is equivalent to the ratio of the pump speeds cubed.

#### 5.3.1.3 Implement a Nighttime Setback

The facility currently has programmable thermostats. These thermostats have the capability to control temperature setpoints for occupied or unoccupied periods and will adjust the temperature accordingly. These thermostats are programmed to reduce or increase the setpoint temperature during unoccupied periods depending upon whether they are controlling heating or cooling equipment. Currently, no heating or cooling setbacks have been programmed. Generally, the setpoint can be decreased by 3°F to 5°F for at least eight (8) hours a day (in heating mode), which can lead to significant savings.

### 5.3.2 Energy Rates and Emission Intensity Factors

The following list includes all the assumptions and variables considered for the technical and financial analysis:

- Cost of Electricity: $0.1467/kWh
- Annual Maintenance Cost of BAS Controls Contract: $1,701/year
- Antigonish Electric GHG Emission Intensity Factor 2022: 0.3387 $CO_2e$ kg/kWh
- Antigonish Electric GHG Emission Intensity Factor 2033: 0.1565 $CO_2e$ kg/kWh
- Antigonish Electric GHG Emission Intensity Factor 2043: 0.03 $CO_2e$ kg/kWh
- PV Electricity GHG Emission Intensity[31]: 0.046 $CO_2e$ kg/kWh

**Table 5.3:Projected Annual Carbon Emissions, No Measures Implemented**

| Energy Source | 2022 Energy Usage (GJ) | 2022 Emissions (tonnes) | 2033 Projected Emissions (tonnes) | 2043 Projected Emissions |
|---|---|---|---|---|
| Antigonish Electric | 715.7 | 67.3 | 31.1 | 6.0 |
| PV System | 13.3 | 0.17 | 0.17 | 0.17 |
| **Total** | **729.0** | **67.5** | **31.3** | **6.1** |

The baseline energy consumption, January-December 2022, for the Antigonish Town and County Library resulted in a total energy consumption of 729.0 GJ annually and carbon emissions of 67.5 tonnes per year based on 2022 emissions factors. The carbon emission intensity of the electric grid and fossil fuels are projected to decrease during the lifespan of this study. Table 5.3 shows the projected annual emission without the implementation of any energy conservation measures. Compared to the baseline, emissions are expected to decrease by 53.7% and 90.9% by 2033 and 2043, respectively.

### 5.3.3 Phase 1 Measurement and Analysis

A HAP model was created based on the existing equipment in the building and was modified to be able to estimate the building's performance considering the efficiency measures listed above. The percentage savings found was applied to the existing buildings energy consumption.

- **Reconnect Existing Control Valve and Implement a Nighttime Setback:** During the site visit in May, it was observed that the VFDs were operating at 50% of a full load. The HAP model estimated that the building was using 33% more energy for pumping than necessary compared to the current pumping energy use. The pumping energy for the HAP model was then increased by this percentage to create a baseline that more accurately estimated the current operation of the building. Another model was then created to determine the savings from the implementation of this measure. It includes an unoccupied setpoint for heating and cooling and no increase in pumping energy.

[31] Source: Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics (Fact Sheet), NREL (National Renewable Energy Laboratory). Retrieved 2023-11-20

The heating setpoint during this period was decreased by 5°F from the baseline; for cooling the temperature setpoint was increased by 1.8°F. The unoccupied cooling setpoint should be determined by considering the temperature and humidity required to preserve the books and other documents in the building.

The following measures were calculated separately:

- **Reactivate and Access the Existing BAS Controls:** BAS allows for a better control of the building equipment. The data gathered by the BAS system can also be used to identify malfunctions from equipment and unwanted changes of the sequence of operation. Therefore, if unusual energy consumption is observed, action can be taken to solve the issue. Usually, when data from the BAS is used to keep track of the energy consumption, it results in an energy savings between 3% to 8%. Therefore, an additional savings of 5% in electricity consumption was estimated for the BAS controls savings applied.

The implementation of these measures to the Antigonish Town and County Library will result in a reduction of energy consumption from the baseline of 185.7 GJ. The total cost to implement Phase 1 measures is approximately $8,000 with a cost savings of an estimated $5,867 for a payback period of 1.4 years. These measures will have an emissions savings of 8.1 tonnes per year in 2033 compared to the baseline building's emissions in the same year as seen in Table 5.4.

**Table 5.4: Antigonish Town and Country Library Phase 1 Efficiency Measures**

| ECM | CAPEX ($) | GHG Savings (tonne) | CAPEX/ GHG Reduction ($/tonne) | Energy Savings GJ/yr | Cost Savings $/yr | Cost Savings/ GHG Saved ($/tonne $CO_2$e) | Simple Payback (yr) |
|---|---|---|---|---|---|---|---|
| Implement Nighttime Setback | $8,000 | 8.1 | $991 | 185.7 | $5,867 | $727 | 1.4 |
| Re-connect Electronic Controlled Valves to Each Heat Pump | | | | | | | |
| Reactivate Existing BAS | | | | | | | |
| **ECM Implementation Total** | **$8,000** | **8.1** | **$991** | **185.7** | **$5,867** | **$727** | **1.4** |

### 5.3.4 Phase 2 Measurement and Analysis

No additional measures were considered for implementation in this facility in Phase 2.

# 6 Antigonish Public Works/Electric Utility

## 6.1 Facility Description

Figure 6.1: Antigonish Public Works/Electric Utility

The Antigonish Public Works/Electric Utility building was built in 1976. Since the initial construction of the building an electrical utility garage has been added to the building.

Additionally, within the last five years a partition was installed to separate the Public Works office from the Public Works garage. The Public Works and electric utility sections of the building are both open eight and a half (8.5) hours per day, Monday to Friday from 8:00 a.m. to 4:30 p.m. Figure 6.1 presents a photograph of the site.

The building is equipped with a forced air heating system and an oil-fired furnace on the electric utility side. The Public Works portion of the building utilizes electric radiant baseboards in administrative spaces, and an oil-fired furnace venting directly into the garage space. No cooling is provided to either side of the building. Interior and exterior lighting is provided by a mixture of fluorescent, incandescent, LED, and HID lighting. Electricity and heating oil are the two sources of energy consumed on site. Electricity powers the space heating, service hot water, lighting, refrigeration, kitchen appliances, and a 6.5 hp air compressor, as well as other ancillary equipment. Heating oil is consumed in two furnaces on site to heat the electric utility administrative areas and both garages. Mechanical ventilation is provided by two HRVs to the Public Works' administrative area.

The building and major existing equipment characteristics include:

- The exterior walls appear to be in poor condition. The estimated R-value for the building is R-14 for the original building and R-20 for the new addition.

- The building roof appears to be in good condition. The estimated R-value on the new addition is estimated to be R-20. The estimated R-value for the original building is estimated to be R-12.
- The facility has wood frame and aluminum frame, double paned windows in fair condition. The estimated R value is R-1.8 for both. Vinyl frame, double paned windows in the remainder of the building are in good condition. The estimated R value is R-2.1.
- The floor is slab-on-grade. The estimated R-value is R-1.8.
- The exterior doors appear in good condition. R-values are estimated to be approximately R-3 for the man-doors and R-10 for the overhead doors.
- Weatherstripping around the man-doors and overhead doors appears to be in poor condition with some areas showing daylight through the gaps in the weatherstripping.
- The interior lighting is a combination of fluorescent, incandescent, and LED lighting with manual ON/OFF switches.
- The exterior lighting is provided by a combination of LED and HID lighting.
- Two oil-fired furnaces provide hot air. The forced air heating system has an estimated efficiency of approximately 80-90% to the electric utility's administrative spaces and all garage spaces.
- Domestic hot water is provided by three electric hot water heaters, all 47 US gallons, that serve the building washrooms, laundry, and kitchens.
- The temperature setpoint is 18°C year-round for the administrative spaces with no nighttime setback, except for the electric utility kitchen which is at 21°C. All the thermostats in this space are programmable.
- The temperature setpoint is 15°C in the winter for the garage spaces, with no nighttime setback. The thermostat for this space is manual.
- Cooking appliances are electric.
- Two Heat Recovery Ventilators (HRVs) serve the Public Work's administrative areas with an estimated efficiency of 65%. They have a variable speed fan, operate continuously, and are controlled based on relative humidity.

## 6.2 Review of Historic Energy Performance

Electricity bills were provided for the 24-month period between January 2021-2022. Energy consumption and demand were reviewed in annual terms to ensure that variation in seasonality was observable. With at least two periods available, a month-to-month comparison of the facility's energy performance was completed from one year to the next. Review of electricity consumption profiles, based on the information obtained from the two periods, was discussed, and is compared in this section.

### 6.2.1 Electricity Use Profiles

Figure 6.2 provides the monthly electricity usage profile which shows the 24-month period from January 2021 to December 2022. No electricity usage was provided for October 2022, so it was assumed to be the same as the previous year.

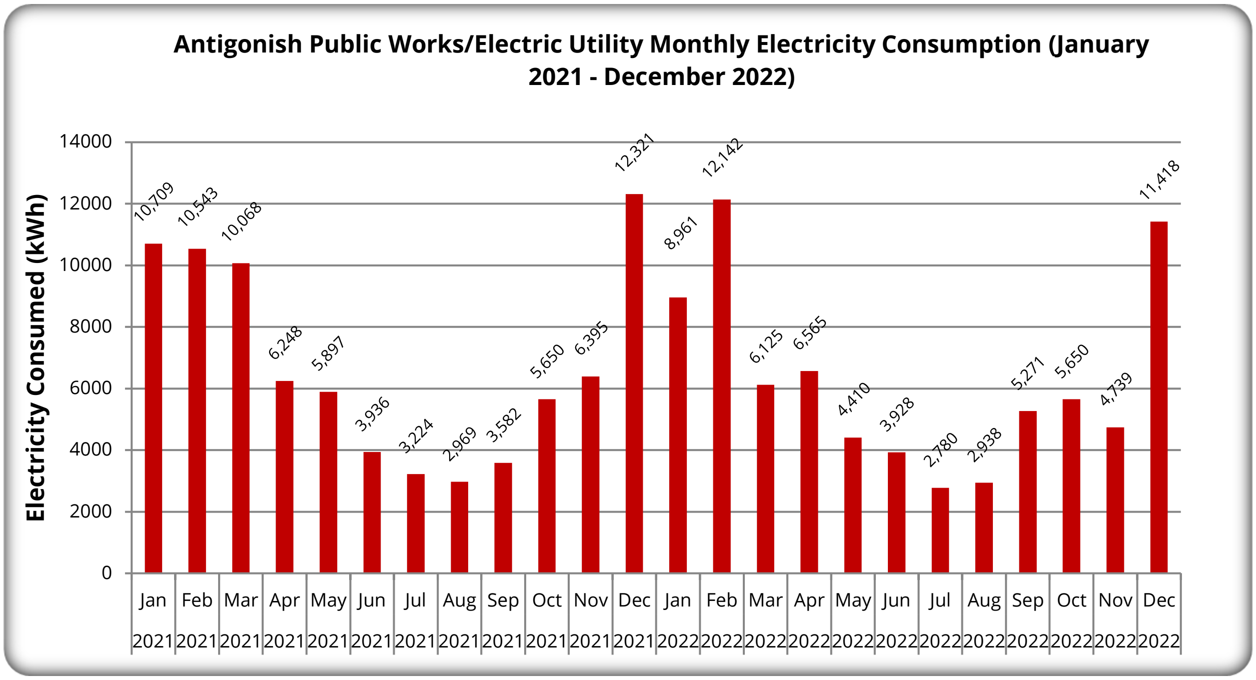


**Figure 6.2: 2021/2022 Monthly Electricity Consumption**

Figure 6.2 depicts a trend with a lower electricity consumption during the summer, than in the winter. Electricity is for space heating in the Public Works' offices so this is to be expected.

Total electricity usage in the period of January/December 2021 was 81,542 kWh and 74,927 kWh from January/December 2022. The average annual energy consumption considering these two 12-month periods was 78,235 kWh.

### 6.2.2 Heating Oil Consumption

The Town of Antigonish provided the heating oil delivery records to the site for the period of January 2021 to December 2022. Total heating oil usage for the period of January/December 2021 was 18,435 L and 17,777 L from January/December 2022. The average annual fuel consumption for this period was 18,106 L. Heating oil is consumed by a boiler to provide space and service water heating to the building. The figures are based on delivered quantities each month and do not necessarily reflect the quantities consumed each month.

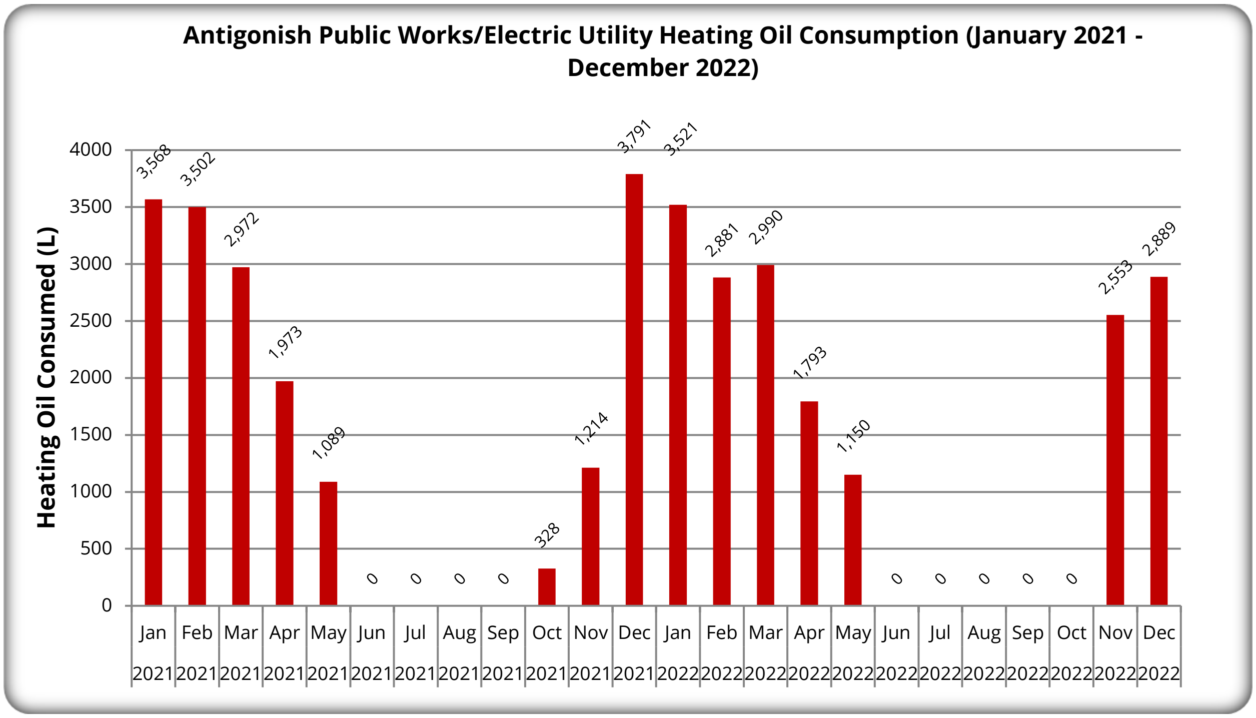


**Figure 6.3: Monthly Heating Oil Consumption in L**

### 6.2.3 Electricity Cost

Electricity is provided by the Antigonish Electric Utility as a "General Services above 3 kilowatts connected load" electricity rate[32].

| | |
|---|---|
| **Above 3 kilowatts connected load:** | |
| Base Rate: | $8.75 per month per kilowatt of maximum demand. |
| Energy Rates: | $0.15945 per kilowatt hour for the first 100 kilowatt hours per month per kilowatt of maximum demand. |
| | $0.09993 per kilowatt hour for all additional consumption. |
| Base Rate: | $8.75 per kilowatt of maximum demand. |
| Minimum Bill: | The greater of the Base Rate or $10.53. |
| Efficiency Nova Scotia Charges | $0.00 per kilowatt hour for all consumption. |

**Figure 6.4: Antigonish Electric Utility Tariff Rate**

[32] Source file.html (townofantigonish.ca). Retrieved: 2023-11-20

Table 6.1 presents the monthly power bill cost breakdown for the January 2021 to December 2022, 24-month period for the Antigonish Pubic Works and Electric Utility.

**Table 6.1: Monthly Power Bill Cost Breakdown for the January 2021 to December 2022**

| Month-Year | Consumption (kWh) | Consumption Cost | Demand (kW) | Demand Cost | Invoice Amount |
|---|---|---|---|---|---|
| January 2021 | 10,709 | $1,216.92 | 24.66 | $211.83 | 1,429 |
| February 2021 | 10,543 | $1,216.76 | 27.42 | $235.54 | 1,452 |
| March 2021 | 10,068 | $1,154.18 | 24.88 | $213.72 | 1,368 |
| April 2021 | 6,248 | $735.90 | 18.74 | $160.98 | 897 |
| May 2021 | 5,897 | $704.93 | 19.43 | $166.90 | 872 |
| June 2021 | 3,936 | $502.84 | 18.40 | $158.06 | 661 |
| July 2021 | 3,224 | $400.21 | 13.11 | $112.61 | 513 |
| August 2021 | 2,969 | $378.06 | 13.67 | $117.43 | 495 |
| September 2021 | 3,582 | $431.82 | 12.41 | $106.60 | 538 |
| October 2021 | 5,650 | $680.25 | 19.43 | $166.90 | 847 |
| November 2021 | 6,395 | $762.32 | 20.71 | $177.90 | 940 |
| December 2021 | 12,321 | $1,395.57 | 27.61 | $237.17 | 1,633 |
| January 2022 | 8,961 | $1,062.67 | 28.09 | $241.29 | 1,304 |
| February 2022 | 12,142 | $1,372.45 | 26.73 | $229.61 | 1,602 |
| March 2022 | 6,125 | $744.15 | 22.19 | $190.61 | 935 |
| April 2022 | 6,565 | $788.12 | 22.19 | $190.61 | 979 |
| May 2022 | 4,410 | $548.96 | 18.19 | $156.25 | 705 |
| June 2022 | 3,928 | $503.59 | 18.66 | $160.29 | 664 |
| July 2022 | 2,780 | $359.58 | 13.74 | $118.03 | 478 |
| August 2022 | 2,938 | $374.78 | 13.64 | $117.17 | 492 |
| September 2022 | 5,271 | $641.79 | 19.33 | $166.04 | 808 |
| October 2022 | 5,650 | $680.25 | 19.43 | $166.90 | 847 |
| November 2022 | 4,739 | $593.74 | 23.08 | $173.43 | 767 |
| December 2022 | 11,418 | $1,278.37 | - | $198.26 | 1,477 |

### 6.2.4 Heating Oil Cost

The Town of Antigonish provided the heating oil delivery records to the site for the period of January 2021 to December 2022. The average cost during this time period was $1.22/L. Due to the significant increase in oil prices since the billing period, the cost savings calculations have been conducted using a value more representative to current market prices of $1.79/L[33].

[33] Source: Weekly Average Retail Prices for Furnace Oil in 2023 | Natural Resources Canada (nrcan.gc.ca). Retrieved: 2023-04-01.

### 6.2.5 Total Energy Use Summary

| Antigonish Public Works/Electric Utility– Area: 689 m² | 2021 | 2022 |
|---|---|---|
| **Electricity** | | |
| Annual Electricity and Demand Cost ($) | $11,645.40 | $11,056.94 |
| Annual Electricity Consumption (kWh) | 81,542 | 74,927 |
| Annual Electricity Consumption (GJ) | 294 | 270 |
| Cost per GJ ($/GJ) | 39.7 | 41.0 |
| Percentage of Total Energy (%) | 29.3% | 28.3% |
| **Heating Oil** | | |
| Annual Heating Oil Cost ($) | $16,833.15 | $27,253.20 |
| Annual Heating Oil Consumption (L) | 18,435 | 17,777 |
| Annual Heating Oil Consumption (GJ) | 709.9 | 684.6 |
| Cost per GJ ($/GJ) | 23.7 | 39.8 |
| Percentage of Total Energy (%) | 70.7% | 71.7% |
| **Summary – Total** | | |
| Annual Energy Costs ($) | $28,478.55 | $38,310.14 |
| Annual Energy Consumption (GJ) | 1,003 | 954 |
| Cost per GJ ($/GJ) | 28.4 | 40.1 |
| Percentage of Total Energy (%) | 100.00% | 100.00% |

The baseline energy usage for this study was determined using the January/December 2022 year. This year was selected for the baseline as it was determined that this would more accurately depict each facility's regular operations and energy usage after the COVID-19 pandemic.

### 6.2.6 Benchmarking

The energy use per area or energy use intensity (EUI) for this facility was 1.38 GJ/m² in 2022. According to the Energy Star Portfolio Manager for Canada[34],the average EUI for a 'Public Services - Other' is 0.86 GJ/m². Currently, this facility sits approximately 60.5% higher than the average.

### 6.2.7 End-use Breakdown

A building energy model was created in Carrier HAP V6.1 considering the information and data collected from the drawings and the site visit. The energy model was calibrated based on the actual annual energy records for this facility, which allowed us to estimate the

[34] Source: https://portfoliomanager.energystar.gov/pdf/reference/Canadian%20National%20Median%20Table.pdf. Retrieved: 2023-01-23

energy use breakdown shown in Table 6.2. This energy use breakdown is an estimation based on information collected during the site visit and from the drawings. This information can only be confirmed with dedicated submetering of the different electrical subpanels and fuel-fired equipment and appliances in the facility. The review of this data allowed us to identify the following:

- The figure depicts that the majority of the energy consumption of the building, 78.1%, can be attributed to heating.
- The second largest source of energy usage is the electrical equipment at approximately 9.6%.
- The third largest source of energy consumption is the lighting at 5.8%.
- The remaining 6.5 % is comprised of air systems fans and domestic hot water.

**Table 6.2: Energy Use Breakdown**

| End-use | Energy Use Breakdown (%) | Site Energy (GJ) |
|---|---|---|
| Space Heating | 78.1% | 736.0 |
| Lights | 5.8% | 54.6 |
| Electrical Equipment | 9.6% | 90.3 |
| Air System Fans | 5.4% | 50.6 |
| Hot Water | 1.1% | 10.5 |
| **Total** | **100%** | **942.0** |

## 6.3 Energy and GHG Reduction Pathway

### 6.3.1 Pathway Components

#### 6.3.1.1 Upgrade Existing Windows to Thermally Insulated Vinyl Windows Minimum R-4

The building has a combination of wood frame, aluminum frame, and vinyl frame, double pane windows with estimated R-values of R-1.8, R-1.8, and R-2.1, respectively . All wood and aluminum windows have exceeded their expected lifespans and the vinyl windows are expected to be at the end of their life before 2043. It is anticipated that replacing the windows with high efficiency double pane, vinyl frame windows with a minimum R-value of R-4 will help reduce energy usage for the building. The implementation of this measure will lower conductive losses through the windows, as well as lower infiltration levels. It is recommended that this measure be implemented as the windows reach the end of their life. It is recommended that the wood and aluminum frame windows be replaced during Phase 1 and vinyl windows be replaced during Phase 2.

### 6.3.1.2 Replace Weatherstripping on All Exterior Doors and Seal Exterior Openings

Some of the windows and doors in this facility exhibit gaps and cracks that will allow for outdoor air infiltration. This causes additional heating loads which impact the energy consumption from the HVAC systems. It is recommended that the envelope of conditioned spaces be inspected, and caulking applied around the exterior windows, doors, and other exterior wall openings. Damaged and missing weatherstripping on the doors and windows in the facility should also be replaced.

### 6.3.1.3 Upgrade Existing Lighting to LEDs

The interior and exterior lighting for the facility is a mixture of LED, fluorescent, incandescent, and HID. LEDs can provide the same level of light as other types of fixtures while consuming less energy. Therefore, considering the difference between the consumption levels of the current lamps and LED lamps, the implementation of this recommendation could result in significant energy savings.

Based on the findings from the building condition assessment completed in parallel to the energy study, the lighting fixtures in this facility have reached their expected useful life. Therefore, the recommendation is to replace the existing lighting fixtures with LED fixtures.

When calculating the input power of the existing lighting, we prepared estimates of the quantity and type of lamps (bulbs) based on visual observation of the fixtures. Since it is difficult to know what type of ballast is used in each fixture without disassembly, the analysis team considered a minimum factor of 1.1 for fluorescent fixtures and 1.2 for HID.

The implementation of LED lighting will result in reduced maintenance costs over the following years. This is due to LEDs having a longer lifespan than the existing lighting fixtures. It is estimated that a non-LED lighting fixture has a maintenance cost of $4/yr, while LEDs have an estimated maintenance cost of $2/yr. This leads to a savings of $2/yr in maintenance per fixture.

### 6.3.1.4 Install Occupancy Sensors for Intermittently Used Spaces

With the exception on the truck bay, spaces within the facility are currently controlled by manual ON/OFF switches. To reduce the amount of time the lights are left on (or forgotten ON) with spaces unoccupied, it is recommended that occupancy sensors be installed. Occupancy sensors come in a wide range of configurations and characteristics. They can be installed on walls, ceilings, or at the switch locations. Detection can be based on sound, infrared heat, or both. The sensor has a relay that interrupts the voltage to the fixtures in the circuit, thus turning them off when no occupancy is detected. The viability for installation of an occupancy sensor depends on the cost of electricity, the size of the load (number and wattage of lights) being controlled, and the approximate number of unoccupied hours they are often being left turned on.

### 6.3.1.5 Replace Existing Oil Fired Furnaces with Baseboard Electric Heating and Heat Pumps in Administrative Spaces and Electric Radiant Heaters in Garage Spaces

Currently, electric radiant heaters provide heating to the Public Works office space within the building with an efficiency of 99%. An oil-fired furnace with an efficiency of approximately 80%, provides heating to the Electric Utility administrative areas and both garages. Electric radiant heaters can provide heat with an efficiency of 99% and are recommended for the garage spaces, with controls that will turn off the heaters if the bay doors are open for a period exceeding five (5) minutes.

Heat pumps are recommended for the administrative areas. In heating mode, heat pumps can have an average efficiency of 200-250% (COP 2-2.5) and peak efficiencies of 300-350%. The warmer the outdoor air, the more heat available, the higher the heat pump efficiency. The heat pump will also provide cooling, if required by the space, with an efficiency of at least EER 17. The availability of cooling will improve occupant comfort. It is also recommended that electric baseboard heaters be installed as a backup heat source in areas receiving heat pumps and not already equipped with electric baseboards.

## 6.3.2 Energy Rates and Emission Intensity Factors

The following list includes all the assumptions and variables considered for the technical and financial analysis:

- Cost of Electricity: $0.1476/kWh
- Cost of Heating Oil: $1.79/L
- Antigonish Electric GHG Emission Intensity Factor 2022: 0.3387 $CO_2$e kg/kWh
- Antigonish Electric GHG Emission Intensity Factor 2033: 0.1565 $CO_2$e kg/kWh
- Antigonish Electric GHG Emission Intensity Factor 2043: 0.03 $CO_2$e kg/kWh
- Heating Oil GHG Emission Intensity Factor: 2.71 $CO_2$e kg/L[35]

**Table 6.3: Projected Annual Carbon Emissions, No Measures Implemented**

| Energy Source | 2022 Energy Usage (GJ) | 2022 Emissions (tonnes) | 2033 Projected Emissions (tonnes) | 2043 Projected Emissions |
|---|---|---|---|---|
| Antigonish Electric | 269.7 | 25.4 | 11.7 | 2.2 |
| Heating Oil | 684.6 | 48.1 | 48.1 | 48.1 |
| **Total** | **954.3** | **73.5** | **59.9** | **50.4** |

The baseline energy consumption, January-December 2022, for the Antigonish Public Works Building/Electric Utility resulted in a total energy consumption of 954.3 GJ annually and carbon emissions of 73.5 tonnes per year based on 2022 emissions factors. The carbon

[35] Source: Emission Factors for Greenhouse Gas Inventories (epa.gov). Retrieved: 2023-04-01

emission intensity of the electric grid and fossil fuels are projected to decrease during the lifespan of this study. Table 6.4 shows the projected annual emissions without the implementation of any energy conservation measures. Compared to the baseline, emissions are expected to decrease by 18.6% and 31.5% by 2033 and 2043, respectively.

### 6.3.3 Phase 1 Measurement and Analysis

The baseline HAP model was modified to estimate the building's performance considering the efficiency measures listed above. These modifications included:

- In spaces heated with an of oil-fired furnace, efficiency was 80%, with electric radiant heaters for garage spaces, and electric baseboards for administrative spaces efficiency was 99%.
- In the office spaces and breakrooms heat pumps, with a COP of 3.3 and a EER of 17, were modelled. A cooling setpoint of 24°C was assumed.
- Lighting wattages for spaces without LEDs were modelled with LED equivalent wattages.
- The lighting in intermittently occupied spaces was reduced by 12.5% when modelled to represent the savings from occupancy sensors.
- Infiltration values were decreased by 10% to all spaces to represent weatherstripping and sealing of the exterior surfaces.
- Aluminum and wood frame windows were upgraded to an R-value of R-4, and in spaces with these windows, infiltration was decreased by an additional 5%.

The implementation of these measures to the Antigonish Public Works/Electric Utility will result in a reduction of energy consumption from the baseline of 218 GJ. The total cost to implement Phase 1 measures is approximately $227,882 with a cost savings of an estimated $12,363 for a payback period of 18.4 years. These measures will have an emissions savings 27.4 tonnes per year in 2033 compared to the baseline building's emissions in the same year as seen in Table 6.4.

**Table 6.4: Antigonish Public Works/Electric Utility Phase 1 Efficiency Measures**

| ECM | CAPEX ($) | GHG Savings (tonne) | CAPEX/ GHG Reduction ($/tonne) | Energy Savings GJ/yr | Cost Savings $/yr | Cost Savings/ GHG Saved ($/tonne $CO_2$e) | Simple Payback (yr) |
|---|---|---|---|---|---|---|---|
| Upgrade Lighting to LEDs | $3,472 | 27.4 | $8,329 | 218.0 | $12,363 | $452 | 18.4 |
| Occupancy Sensors for Lighting | $1,600 | | | | | | |
| Install Electric Radiant Heaters in the Garage with | $62,000 | | | | | | |

| ECM | CAPEX ($) | GHG Savings (tonne) | CAPEX/ GHG Reduction ($/tonne) | Energy Savings GJ/yr | Cost Savings $/yr | Cost Savings/ GHG Saved ($/tonne $CO_2$e) | Simple Payback (yr) |
|---|---|---|---|---|---|---|---|
| Electric Baseboard heating in Electric Utility. Install Control Program to Turn Heaters Off when Garage Door is Open. | | | | | | | |
| Install Split Source Heat Pumps in Office Spaces and Breakrooms | $20,000 | | | | | | |
| Electrical Upgrades | $130,000 | | | | | | |
| Replace Aluminum Frame and Wood Frame Windows with R-4 | $5,750 | | | | | | |
| Infiltration Reduction | $5,000 | | | | | | |
| **ECM Implementation Total** | **$228,822** | **27.4** | **$8,329** | **218.0** | **$12,363** | **$452** | **18.4** |

### 6.3.4 Phase 2 Measurement and Analysis

The Phase 1 HAP model was modified to estimate the building's performance considering the efficiency measures listed above. These modifications included:

- Vinyl frame windows were upgraded to an R-value of R-4. In spaces with these windows, infiltration was decreased by an additional 5% compared to the baseline.

The implementation of these measures to the Antigonish Public Works/Electric Utility will result in a reduction of energy consumption from the baseline of 11.1 GJ. The total cost to implement Phase 2 measures is approximately $13,000 with a cost savings of an estimated $791 for a payback period of 16.4 years. These measures will have an emissions savings 0.16 tonnes per year in 2043 compared to the baseline building's emissions in the same year as seen in Table 6.5.

**Table 6.5: Antigonish Public Works/Electric Utility Phase 2 Efficiency Measures**

| ECM | CAPEX ($) | GHG Savings (tonne) | CAPEX/ GHG Reduction ($/tonne) | Energy Savings GJ/yr | Cost Savings $/yr | Cost Savings/ GHG Saved ($/tonne $CO_2$e) | Simple Payback (yr) |
|---|---|---|---|---|---|---|---|
| Upgrade Vinyl Windows to Minimum R4 | $13,000 | 0.16 | $80,846 | 19.3 | $791 | $4,920 | 16.4 |
| **ECM Implementation Total** | **$13,000** | **0.16** | **$80,846** | **19.3** | **$791** | **$4,920** | **16.4** |

# 7 Antigonish Wastewater Treatment Plant

## 7.1 Facility Description


Figure 7.1: Antigonish Wastewater Plant

The Antigonish Wastewater Plant consists of two buildings: the treatment plant building or filter building and the pumping station. The filter building was built in 2006. The building is available to employees eight (8) hours a day, seven days a week, from 8:30 a.m. to 4:30 p.m. year-round. However, the building is typically occupied for about two (2) hours per day. The pumping station houses two large pumps and electrical panels and is typically unoccupied. Figure 7.1 presents a photograph of the site.

The Town of Antigonish Wastewater Treatment Plant (WWTP) is a lagoon-based treatment system that discharges to Wright River. The treatment process in the warmer months also includes sand filtration and UV disinfection prior to discharge. Raw wastewater from the collection system enters an influent wet well and passes through a grinder to break down large debris. The water is then pumped up to the lagoons. The lagoons consist of six aerated lagoon cells separated by a concrete wall/berm and several floating baffles. The total lagoon surface area is 38,500 m² and has a depth of 5.15 m.

Process air is supplied to the lagoon cells via four positive-displacement blowers and fine bubble diffusers, suspended from a floating lateral connected to the main aeration header. The majority of the aeration for BOD reduction is supplied to Cell 1A with 60 aerators on six (6) aeration chains. Cell 1B includes 30 aerators on 3 aeration chains. Cells 2A and 2B are equipped with 20 and 10 aerators on two (2) and one (1) aeration chains, respectively.

Aeration is reduced in the final cells to promote settling for TSS removal. Cell 3A has three (3) aerators and 3B has only one (1).

The lagoon effluent enters the process room from a series of pipes and manholes to a main header ahead of the filter trough. There are three sand filters, arranged in parallel. The filters are only used in the summer to provide effluent polishing and are bypassed in the winter when the effluent limits are less stringent, and the flows exceed the design capacity of the filters. The filters are rated for a flow of 6,800 $m^3$/d each. Traditionally, the filters have been aided with the use of alum for coagulation. The plant has an average daily flow of 9,027$m^3$.

Following the sand filters is the UV disinfection system, which is rated for a flow of 6,800 $m^3$/d. The UV system is a Trojan UV3000B system which consists of two banks, each with 72 lamps rated at 85.2 Watts/lamp as presented in Table 7.1. Once effluent has been treated by UV, it is discharged into the Wright River via a submerged outfall.

**Table 7.1: Wastewater Treatment Plant Existing UV Arrays**

| Equipment | Wattage (W) | Estimated Percentage of Year Operating | Efficiency |
|---|---|---|---|
| UV Lights Bank 1 | 6134.4 | 100% | - |
| UV Lights Bank 2 | 6134.4 | 100% | - |

A summary of major process equipment using electric motors, the respective motor size, estimated efficiencies, and operating schedules, is listed below in Table 7.2. Currently pump 1 and submersible pump 3 are equipped with VFDs.

**Table 7.2: Wastewater Treatment Plant Existing Mechanical Process Equipment**

| Equipment | Motor HP | Estimated Percentage of Year Operating | Motor Efficiency |
|---|---|---|---|
| Blower 1 | 25 | 100.00% | 93.6 |
| Blower 2 | 25 | 100.00% | 93.6 |
| Blower 3 | 50 | 100.00% | 94.5 |
| Blower 4 | 50 | 100.00% | 94.5 |
| Compressor (main) | 15 | 10.00% | 90.2 |
| Compressor (backup) | 7.5 | 50.00% | 90.2 |
| Pump 1 | 50 | 100.00% | 94.5 |
| Pump 2 | 50 | <1.00% | 94.5 |
| Submersible Pump 3 | 40 | 100.00% | 94.1 |
| Submersible Pump 4 | 40 | 25.00% | 92 |
| Submersible Pump 5 | 40 | 25.00% | 92 |
| Grinder | 5 | 100.00% | 87 |

Diffusers are used to distribute air into the aeration tanks for the biological treatment of wastewater. If the existing diffusers are clogged or worn out, they may impede the proper distribution of air, resulting in increased resistance and higher blower static pressure. The plant uses fine bubble diffusers for aeration, which consist of a nozzle with a membrane to facilitate air transfer into the lagoons as small bubbles, with a high surface area to volume ratio. As these diffusers age, they foul, and the membrane stretches resulting in reduced OTE. OTE losses from fouling can range between 10% and 30% at the diffuser end-of-life condition. As these diffusers age, they should be replaced with new fine bubble diffusers to improve OTE, resulting in lower blower output requirements.

The pumping station is equipped with one electric unit heater. No cooling or service water is provided to the building. Interior lighting is provided by LED lighting; exterior lighting is provided by HID. Electricity is the only source of energy consumed onsite. Electricity powers space heating, lighting, and all process equipment. Mechanical ventilation is provided by one wall mounted exhaust fan.

The filter building is equipped with electric unit heaters. No cooling is provided to the space. Interior and exterior lighting is provided by a mixture of LED, and fluorescent lighting fixtures. Electricity is the only source of energy consumed on site. Electricity powers space heating, water heating, lighting, lab equipment, and all sanitation process equipment. Mechanical ventilation is provided by multiple exhaust fans on site.

The building and major existing equipment characteristics include:

- **Pumping Station:**
  - The exterior walls appear in fair condition. The estimated R-value is R-11.
  - The building roof appears to be in fair condition. The estimated R-value is R-12.
  - The floor is slab-on-grade and in poor condition. The estimated R-value is R-1.4.
  - No windows are present in the space.
  - The exterior doors appear to be in good condition. R-values are estimated to be approximately R-3.
  - Weatherstripping around the man-doors appears to be in good condition.
  - One electric unit heater provides heating to the space; the size is assumed to be 3 kW.
  - The temperature setpoint is 15°C year-round. The thermostat in the space is manual.
  - There is one wall mounted exhaust fan; the fan louvers are non-operational.
  - This facility has no service water.
- **Filter Building:**
  - The exterior walls appear to be in fair condition. Estimated R-value is R-11.
  - The building roof appears to be in fair condition. The estimated R-value is R-12.
  - The floor is slab-on-grade and in poor condition. The estimated R-value is R-1.4.
  - Windows in the building are vinyl, double paned windows with an estimated R-value of R-1.7.

- The exterior doors appear to be in good condition. R-values are estimated to be approximately R-3.
- Weatherstripping around the man-doors appears to be in good condition.
- The electric unit heater provides heating to the space the size is assumed to be 3 kW.
- The temperature setpoint is 15°C year-round for most spaces; the lab space is assumed to be at 18°C. The thermostats in the spaces are manual.
- Domestic hot water is provided by one 47 US gallon electric hot water heater that serves the building washrooms and the lab space.

## 7.2 Review of Historic Energy Performance

Electricity bills were provided for the 24-month period between January 2021-2022. Energy consumption and demand were reviewed in annual terms to ensure that variation in seasonality was observable. With at least two periods available, a month-to-month comparison of the facility's energy performance was completed from one year to the next. Review of electricity consumption profiles, based on the information obtained from the two periods, was discussed, and is compared in this section.

### 7.2.1 Electricity Use Profiles

Figure 7.2 provides the monthly electricity usage profile which shows the 24-month period from January 2021 to December 2022.

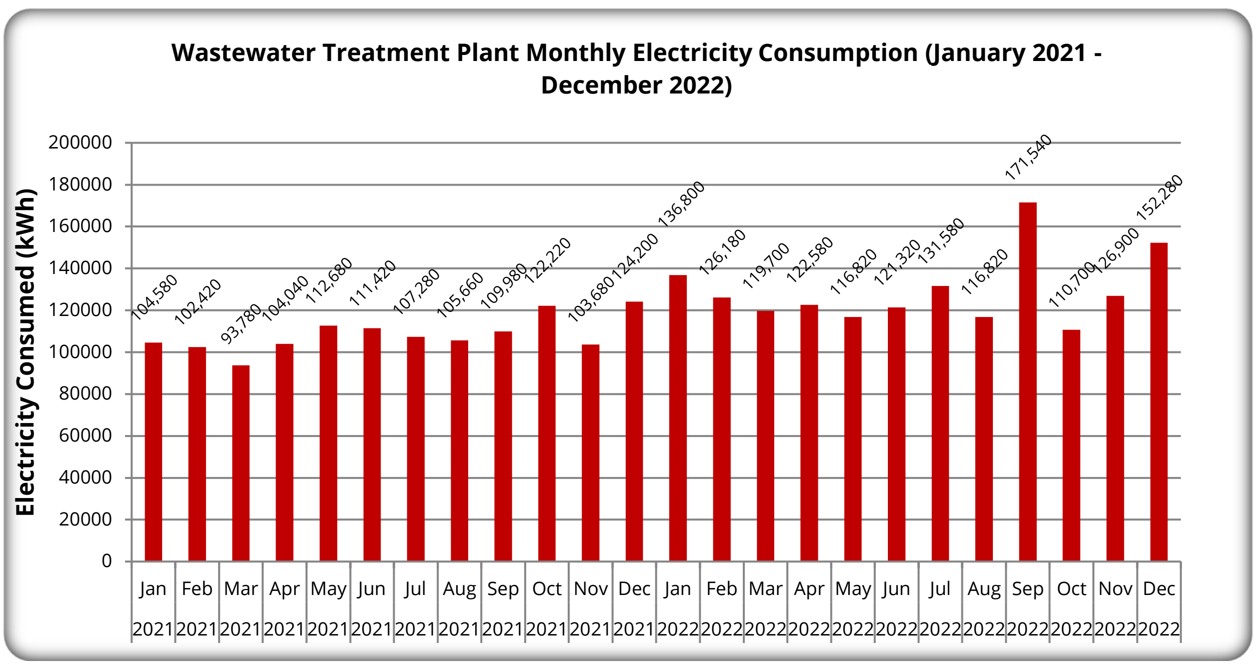


**Figure 7.2: 2021/2022 Monthly Electricity Consumption**

The energy consumption varies from month to month with no significant patterns or trends. Electricity consumed is directly impacted by the amount of effluent that needs to be processed.

Total electricity usage for the period of January/December 2021 was 1,301,940 kWh and 1,553,220 kWh from January/December 2022. The average annual energy consumption considering these two 12-month periods was 1,427,580 kWh.

### 7.2.2 Electricity Cost

Electricity is provided by the Antigonish Electric Utility as a "General Services above 3 kilowatts connected load" electricity rate[36].

| **Above 3 kilowatts connected load:** | |
|---|---|
| Base Rate: | $8.75 per month per kilowatt of maximum demand. |
| Energy Rates: | $0.15945 per kilowatt hour for the first 100 kilowatt hours per month per kilowatt of maximum demand.<br><br>$0.09993 per kilowatt hour for all additional consumption. |
| Base Rate: | $8.75 per kilowatt of maximum demand. |
| Minimum Bill: | The greater of the Base Rate or $10.53. |
| Efficiency Nova Scotia Charges | $0.00 per kilowatt hour for all consumption. |

**Figure 7.3: Antigonish Electric Utility Tariff Rate**

Table 7.3 and Table 7.4 present the monthly power bill cost breakdown for both meters for the January 2021 to December 2022, 24-month period for the Wastewater Treatment Plant.

**Table 7.3: Monthly Power Bill Cost Breakdown for the January 2021 to December 2022 Meter 1**

| Month-Year | Consumption (kWh) | Consumption Cost | Demand (kW) | Demand Cost | Invoice Amount |
|---|---|---|---|---|---|
| January 2021 | 16,560 | $2,113.38 | 77.04 | $661.77 | $2,775.15 |
| February 2021 | 21,780 | $2,681.09 | 84.78 | $728.26 | $3,409.35 |
| March 2021 | 20,880 | $2,425.09 | 56.88 | $488.6 | $2,913.69 |
| April 2021 | 20,520 | $2,390.18 | 57.06 | $490.15 | $2,880.33 |
| May 2021 | 30,420 | $3,595.90 | 93.42 | $802.48 | $4,398.38 |
| June 2021 | 16,560 | $1,915.18 | 43.74 | $375.73 | $2,290.91 |

[36] Source file.html (townofantigonish.ca). Retrieved: 2023-11-20

| Month-Year | Consumption (kWh) | Consumption Cost | Demand (kW) | Demand Cost | Invoice Amount |
|---|---|---|---|---|---|
| July 2021 | 15,300 | $1,856.76 | 55.08 | $473.14 | $2,329.90 |
| August 2021 | 16,380 | $2,016.12 | 63.72 | $547.35 | $2,563.47 |
| September 2021 | 15,120 | $1,816.28 | 51.3 | $440.67 | $2,256.95 |
| October 2021 | 17,280 | $2,089.98 | 61.02 | $524.16 | $2,614.14 |
| November 2021 | 15,840 | $2,036.07 | 76.14 | $654.04 | $2,690.11 |
| December 2021 | 34,380 | $4,003.41 | 95.4 | $819.49 | $4,822.90 |
| January 2022 | 39,780 | $4,591.25 | 103.5 | $889.07 | $5,480.32 |
| February 2022 | 36,360 | $4,251.63 | 103.86 | $892.16 | $5,143.79 |
| March 2022 | 29,520 | $3,535.96 | 98.46 | $845.77 | $4,381.73 |
| April 2022 | 28,080 | $3,343.86 | 90.36 | $776.19 | $4,120.05 |
| May 2022 | 18,540 | $2,111.97 | 43.56 | $374.18 | $2,486.15 |
| June 2022 | 19,620 | $2,527.37 | 95.22 | $817.94 | $3,345.31 |
| July 2022 | 18,540 | $2,132.33 | 46.98 | $403.56 | $2,535.89 |
| August 2022 | 16,380 | $2,126.47 | 82.26 | $706.61 | $2,833.08 |
| September 2022 | 27,540 | $3,265.26 | 86.22 | $740.63 | $4,005.89 |
| October 2022 | 17,820 | $2,295.01 | 86.4 | $742.18 | $3,037.19 |
| November 2022 | 25,380 | $2,931.56 | 66.42 | $570.55 | $3,502.11 |
| December 2022 | 33,660 | $3,740.77 | 63.36 | $544.26 | $4,285.03 |

**Table 7.4: Monthly Power Bill Cost Breakdown for the January 2021 to December 2022 Meter 2**

| Month-Year | Consumption (kWh) | Consumption Cost | Demand (kW) | Demand Cost | Lighting Cost | Total Cost |
|---|---|---|---|---|---|---|
| January 2021 | 88,020 | $9,544.72 | 125.82 | $1,080.79 | $48.43 | $10,799.76 |
| February 2021 | 80,640 | $8,782.60 | 121.68 | $1,045.23 | $48.43 | $9,997.94 |
| March 2021 | 72,900 | $8,017.71 | 123.12 | $1,057.60 | $48.43 | $9,246.86 |
| April 2021 | 83,520 | $9,067.18 | 121.14 | $1,040.59 | $48.43 | $10,277.34 |
| May 2021 | 82,260 | $9,043.05 | 138.24 | $1,187.48 | $48.43 | $10,417.20 |
| June 2021 | 94,860 | $10,298.95 | 137.7 | $1,182.84 | $48.43 | $11,667.92 |
| July 2021 | 91,980 | $9,998.30 | 135.54 | $1,164.29 | $48.43 | $11,346.56 |
| August 2021 | 89,280 | $9,680.27 | 127.44 | $1,094.71 | $48.43 | $10,950.85 |
| September 2021 | 94,860 | $10,260.38 | 131.22 | $1,127.18 | $48.43 | $11,567.21 |
| October 2021 | 104,940 | $11,307.32 | 137.88 | $1,184.39 | $56.50 | $12,686.09 |
| November 2021 | 87,840 | $9,606.02 | 139.14 | $1,195.21 | $40.36 | $10,980.73 |
| December 2021 | 89,820 | $9,792.09 | 137.16 | $1,178.20 | $48.43 | $11,155.88 |
| January 2022 | 97,020 | $10,520.16 | 138.6 | $1,190.57 | $58.12 | $11,907.45 |
| February 2022 | 89,820 | $9,812.45 | 140.58 | $1,207.58 | $48.43 | $11,209.04 |
| March 2022 | 90,180 | $9,907.34 | 150.48 | $1,292.62 | $48.43 | $11,398.87 |
| April 2022 | 94,500 | $10,286.55 | 141.66 | $1,216.86 | $48.43 | $11,693.50 |

| Month-Year | Consumption (kWh) | Consumption Cost | Demand (kW) | Demand Cost | Lighting Cost | Total Cost |
|---|---|---|---|---|---|---|
| May 2022 | 98,280 | $10,711.42 | 149.58 | $1,284.89 | $48.43 | $12,194.32 |
| June 2022 | 101,700 | $11,048.89 | 148.86 | $1,278.71 | $48.43 | $12,524.89 |
| July 2022 | 113,040 | $12,188.53 | 149.94 | $1,287.98 | $48.43 | $13,674.88 |
| August 2022 | 100,440 | $10,928.34 | 149.76 | $1,286.44 | $48.43 | $12,412.97 |
| September 2022 | 144,000 | $15,294.14 | 151.92 | $1,304.99 | $64.58 | $16,815.63 |
| October 2022 | 92,880 | $10,183.58 | 151.56 | $1,301.90 | $48.43 | $11,685.47 |
| November 2022 | 101,520 | $11,078.05 | 156.78 | $1,346.74 | $48.43 | $12,630.00 |
| December 2022 | 118,620 | $12,740.78 | 149.04 | $1,280.25 | $61.34 | $14,231.41 |

### 7.2.3 Total Energy Use Summary

| Antigonish WWTP – Area: 167 m² | 2021 | 2022 |
|---|---|---|
| **Electricity** | | |
| Annual Electricity and Demand Cost ($) | $165,463.54 | $195,756.21 |
| Annual Electricity Consumption (kWh) | 1,301,940 | 1,553,220 |
| Annual Electricity Consumption (GJ) | 4,687 | 5,592 |
| Cost per GJ ($/GJ) | $35.3 | $35.0 |
| Percentage of Total Energy (%) | 100% | 100% |

The baseline energy usage for this study was determined using the January/December 2022 year. This year was selected for the baseline as it was determined that this would more accurately depict each facility's regular operations and energy usage after the COVID-19 pandemic.

### 7.2.4 Benchmarking

The energy use per area or energy use intensity (EUI) for this facility is 0.62 GJ/ average daily flow in m3. According to the Energy Star Portfolio Manager for Canada[37], the average EUI for wastewater treatment plant is 0.80 GJ/ average daily flow in m³. Currently, this facility sits approximately 25% lower than the average.

### 7.2.5 End-use Breakdown

The energy use breakdown for this building was estimated by assuming the hours of operation for the process equipment, lighting, and average electrical loads for the space type. For the purpose of the energy breakdown, pumps with VFDs were estimated to be operating at 70% of full load on average. The remaining energy was estimated to be

[37] Source: Canadian Energy Use Intensity by Property Type – Technical Reference (canada.ca). Retrieved: 2023-01-23

heating. This energy use breakdown is an estimation based on information collected during the site visit and from the drawings. This information can only be confirmed with dedicated submetering of the different electrical subpanels and appliances in the facility. The review of this data allowed us to identify the following:

- The figure depicts that the majority of the energy consumption of the building, 97.2%, can be attributed to the process equipment.
- The second largest source of energy usage is space heating at approximately 2.7%.
- Electrical equipment and lighting both comprise 0.1% of the energy usage.

**Table 7.5: Energy Use Breakdown**

| End-use | Energy Use Breakdown (%) | Site Energy (GJ) |
|---|---|---|
| Process Equipment | 97.2% | 5434.5 |
| Lighting | 0.07% | 4.1 |
| Heating | 2.7% | 149.3 |
| Electrical Equipment | 0.07% | 3.7 |
| **Total** | **100.0%** | **5,591.6** |

## 7.3 Energy and GHG Reduction Pathway

### 7.3.1 Pathway Components

#### 7.3.1.1 Filter Building: Upgrade Existing Lighting to LEDs

The interior lighting for the facility is a combination of LED and fluorescent lighting fixtures. LEDs can provide the same level of light as other types of fixtures while consuming less energy. Therefore, considering the difference between the consumption levels of the current lamps and LED lamps, the implementation of this recommendation could result in energy savings.

Based on the age of the building, it is expected that the lighting fixtures in this facility will have reached the end of their expected useful life by the end of Phase 1, 2033. Therefore, the recommendation is to replace the existing lighting fixtures with LED fixtures.

When calculating the input power of the existing lighting, we prepared estimates of the quantity and type of lamps (bulbs) based on visual observation of the fixtures. Since it is difficult to know what type of ballast is used in each fixture without disassembly, the analysis team considered a minimum factor of 1.1 for fluorescent fixtures and 1.2 for HID.

The implementation of LED lighting will result in reduced maintenance costs over the following years. This is due to LEDs having a longer lifespan than the existing lighting fixtures. It is estimated that a non-LED lighting fixture has a maintenance cost of $4/yr, while LEDs have an estimated maintenance cost of $2/yr. This leads to a savings of $2/yr in maintenance per fixture.

#### 7.3.1.2 Filter Building and Pumping Station: Install Occupancy Sensors for Intermittently Used Spaces

Lights within the facility are currently controlled by manual ON/OFF switches. To reduce the amount of time the lights are left on (or forgotten ON) with spaces unoccupied, it is recommended that occupancy sensors be installed. Occupancy sensors come in a wide range of configurations and characteristics. They can be installed on walls, ceilings, or at the switch location. Detection can be based on sound, infrared heat, or both. The sensor has a relay that interrupts the voltage to the fixtures in the circuit, thus turning them off when no occupancy is detected. The viability for installation of an occupancy sensor depends on the cost of electricity, the size of the load (number and wattage of lights) being controlled, and the approximate number of unoccupied hours they are often being left turned on.

#### 7.3.1.3 Filter Building and Pumping Station: Repair Exhaust Louvers

Exhaust louvers located on the building show some damage and do not appear to shut properly. This allows for outdoor air infiltration; this results in additional heating loads and increases the energy demand to maintain the temperature set point for heating. It is recommended that these louvers be repaired to minimize infiltration.

#### 7.3.1.4 Filter Building: Repair Broken Window in Process Area

A window located in the process area shows some damage and does not appear to shut properly. This allows for outdoor air infiltration; this results in additional heating loads and increases the energy demand to maintain the temperature set point for heating. It is recommended that this window be repaired to minimize infiltration.

#### 7.3.1.5 Filter Building: Install Programmable Thermostats with Nighttime Setback in Lab Space

The heating zones in the building are controlled by manual thermostats. An alternative to manual thermostats are programmable thermostats. They are set once considering temperature setpoints for occupied or unoccupied periods and will adjust the temperature. These thermostats are programmed to reduce the set point temperature during unoccupied periods. Generally, the setpoint can be decreased by 3°F to 5°F for at least eight (8) hours a day (in heating mode), which can lead to significant savings (between 3% to 5% in heating). It is recommended that a programmable thermostat with a nighttime setback be implemented in the lab.

### 7.3.1.6 Filter Building: Upgrade 25 HP Positive Displacement Blowers to Turbo Blowers

Replacing the two existing 25HP positive displacement blowers with more energy efficient models (turbo blowers) will allow for a reduction of energy use. These blowers appear to be at the end of their useful life and should be replaced during Phase 1.

Turbo blowers have a centrifugal design that enables them to deliver higher volumes of air with significantly lower power consumption compared to positive displacement blowers. Another key advantage is that variable speed control is typically incorporated into this style of blowers, allowing for blower output to match the specific aeration requirements of the plant at any given time. Turbo blowers are able to achieve up to a 30% reduction in energy usage to deliver an equal amount of air to the lagoons. Energy reductions were based on the efficiency of the turbo blowers, as well as the ability to lower air output since new blowers are equipped with VFDs.

## 7.3.2 Energy Rates and Emission Intensity Factors

The following list includes all the assumptions and variables considered for the technical and financial analysis:

- Cost of Electricity: $0.1268/kWh
- Antigonish Electric GHG Emission Intensity Factor 2022: 0.3387 $CO_2$e kg/kWh
- Antigonish Electric GHG Emission Intensity Factor 2033: 0.1565 $CO_2$e kg/kWh
- Antigonish Electric GHG Emission Intensity Factor 2043: 0.03 $CO_2$e kg/kWh

**Table 7.6: Projected Annual Carbon Emissions, No Measures Implemented**

| Energy Source | 2022 Energy Usage (GJ) | 2022 Emissions (tonnes) | 2033 Projected Emissions (tonnes) | 2043 Projected Emissions |
|---|---|---|---|---|
| Antigonish Electric | 5591.6 | 526.1 | 243.1 | 46.6 |
| **Total** | **5591.6** | **526.1** | **243.1** | **46.6** |

The baseline energy consumption, January-December 2022, for the Antigonish Wastewater Treatment Plant resulted in a total energy consumption of 5591.6 GJ annually and carbon emissions of 526.1 tonnes/year based on 2022 emissions factors. The carbon emission intensity of the electric grid and fossil fuels are projected to decrease during the lifespan of this study. Table 7.6 shows the projected annual emissions without the implementation of any energy conservation measures. Compared to the baseline, emissions are expected to decrease by 53.8% and 91.1% by 2033 and 2043, respectively.

### 7.3.3 Phase 1 Measurement and Analysis

A baseline HAP was created of the lab space to be able to estimate the building's performance considering the implementation of a nighttime setback.

- The temperature setpoint in the lab space was decrease from 18°C to 15°C. between the hours of 4:00p.m -8:00am daily.

The following measures were calculated separately:

- **Upgrade Lighting to LED with Occupancy Sensors:** Lighting wattages for spaces without LEDs were compared to LED equivalent wattages. It was assumed that the lights were on from 2.5 hours per day, seven days/week year-round for the baseline to correspond with the estimated occupancy of the building; exterior lighting was assumed to be on 12 hours per day. The time on was reduced by 12.5% to account for savings from the occupancy sensor.
- **Upgrade Positive Displacement Blowers to Turbo Blowers:** Baseline energy consumption for the blowers was calculated. The two 25 hp blowers operate 24 hours/day, seven days/week year-round. Turbo blowers can offer up to a 30% savings when compared to a positive displacement blower due to the built in VFD; however, since further study would need to be conducted to ensure that the plant is meeting necessary aeration targets with a reduced flow, only the efficiency increases between the current blower and the turbo blower, estimated to be 5%, were considered.
- **Repair Exhaust Louvers:** It was assumed that the filter building and pumping station had an average air temperature of 15°C, with an average outdoor air temperature of 2°C when the building was in operation. The existing air exhaust fans were assumed to have a ¼" gap along the louver and were estimated to be ⅛" when repaired. Electric radiant heaters were assumed to be on 60% of the time during the heating season which was assumed to be eight months. The operating hours should reduce once louvers are repaired.
- **Repair the Broken Window in the Process Spaces:** It was assumed that the filter building had an average air temperature of 15°C, with an average outdoor air temperature of 2°C when the building was in operation. The 3/32" gap along the frame was estimated to be 1/64" gap when repaired. Electric radiant heaters were assumed to be on 60% of the time during the heating season which was assumed to be eight months. The operating hours should reduce once the windows are repaired.

The implementation of these measures to the Antigonish Wastewater Treatment Plant will result in a reduction of energy consumption from the baseline of 70.8 GJ. The total cost to implement Phase 1 measures is approximately $213,780 with a cost savings of an estimated $2,530 for a payback period of 84.5 years. These measures will have an emissions savings 3.1 tonnes/year in 2033 compared to the baseline building's emissions in the same year as presented in Table 7.7.

**Table 7.7: Antigonish Wastewater Treatment Plant Phase 1 Efficiency Measures**

| ECM | CAPEX ($) | GHG Savings (tonne) | CAPEX/ GHG Reduction ($/tonne) | Energy Savings GJ/yr | Cost Savings $/yr | Cost Savings/ GHG Saved ($/tonne $CO_2e$) | Simple Payback (yr) |
|---|---|---|---|---|---|---|---|
| **Pumping Station** | | | | | | | |
| Upgrade Lighting to LEDs | $410 | 0.08 | $8,123 | 1.7 | $62.8 | $837 | 9.7 |
| Occupancy Sensors for Lighting | $1,000 | | | | | | |
| Repair Exhaust Louvres | $1,400 | 0.15 | $9,147 | 3.5 | $124.0 | $810 | 11.3 |
| **Filter Building** | | | | | | | |
| Upgrade Lighting to LED | $2,600 | 0.10 | $23,013 | 2.3 | $115.0 | $1,150 | 20.0 |
| Occupancy Sensors for Lighting | $1,000 | | | | | | |
| Repair Louver for Exhaust Fans | $7,250 | 0.04 | $170,316 | 1.0 | $32.9 | $756.0 | 210.2 |
| Repair Damaged Window | $720 | 0.13 | $5,368 | 3.1 | $103.4 | $756.0 | 6.6 |
| Nighttime Setback in Lab | $200 | 0.02 | $11,210 | 0.4 | $14.5 | $794.9 | 13.8 |
| Turbo Blowers to Replace 25HP Blowers | $200,000 | 2.56 | $78,254 | 58.8 | $1,969.5 | $756.0 | 96.6 |
| **ECM Implementation Total** | **$213,780** | **3.10** | **$68,905** | **70.8** | **$2,530** | **$821.9** | **854.5** |

## 7.3.4 Phase 2 Measurement and Analysis

No additional measures were considered for implementation in this facility in Phase 2.

# 8 Antigonish Town Hall

## 8.1 Facility Description

**Figure 8.1: Antigonish Town Hall**

The Antigonish Town Hall was built in 1905. Later on, three spaces at the back of the building were added to the original construction. Some elements of the building were renovated in the 1980s, such as windows. The building is open Monday to Friday eight (8) hours a day from 8:30 a.m. to 4:30 p.m. Council meetings are held on the third Monday of every month for approximately two (2) hours from 6:00 p.m. to 8:00 p.m. Figure 8.1 presents a photograph of the site.

The building is equipped with a hydronic heating system with two oil-fired boilers and circulating pumps. Hydronic baseboards and radiators provide heating to most of the spaces. The council chambers and open office utilize air source heat pumps for heating and cooling. Cooling is provided to the remainder of the office and meeting room rooms by portable air-conditioning units. Dehumidification is provided in the basement, as well as in the first-floor corridor. Interior and exterior lighting is provided by a mixture of LED, fluorescent, and CFL lighting fixtures. Electricity and heating oil are the two sources of energy consumed on site. Electricity powers the space heating/cooling, lighting, refrigeration, service water, and kitchen appliances, as well as other ancillary equipment. Heating oil is consumed by the boilers to produce heat. No mechanical ventilation is provided to the building.

The building and major existing equipment characteristics include:

- The exterior walls appear to be in poor to fair condition. The estimated R-value for the building is R-10-15 for above ground exterior walls. Basement walls have an estimated R-value of R-11

- The building roof appears to be in poor to fair condition. The estimated R-value is R-21.
- The single and double paned, wood frame windows are in poor condition and have an estimated R value of R-0.96 and R-1.7, respectively.
- The floor is slab-on-grade. The estimated R-value is R-1.4.
- The exterior doors appear in fair condition. R-values are estimated to be R-1.4.
- Weatherstripping around the man-doors appears to be in poor to fair condition with some areas showing daylight through the gaps in the weatherstripping.
- The interior lighting is a combination of LED, fluorescent, and CFL with manual ON/OFF switches.
- The exterior lighting is provided by LED lighting.
- Two oil-fired boilers provide hot water up to 82°C (180°F) for the hydronic heating system at an estimated efficiency of approximately 80-90% to the administrative spaces and the garage.
- The split system heat pumps providing heating and cooling to the council chambers and open office operate with an estimated COP of 3.3 and EER of 11.
- Portable air-conditioning units are estimated to operate with an EER of 11.
- The relative humidity setpoint for dehumidification is estimated to be 60%.
- Domestic hot water is provided by a 50-gallon electric water heater that serves the building washrooms and kitchens.
- The temperature setpoint is 21°C for heating and 23°C for cooling. All the thermostats in this space are programmable. No setback is implemented for heating and cooling is assumed to only occur during occupied hours.
- Cooking appliances are electric.

## 8.2 Review of Historic Energy Performance

Electricity bills were provided for the 24-month period between January 2021-2022. Energy consumption and demand were reviewed in annual terms to ensure that variation in seasonality was observable. With at least two periods available, a month-to-month comparison of the facility's energy performance was completed from one year to the next. Review of electricity consumption profiles, based on the information obtained from the two periods, was discussed, and is compared in this section.

### 8.2.1 Electricity Use Profiles

Figure 8.2 provides the monthly electricity usage profile which shows the 24-month period from January 2021 to December 2022.

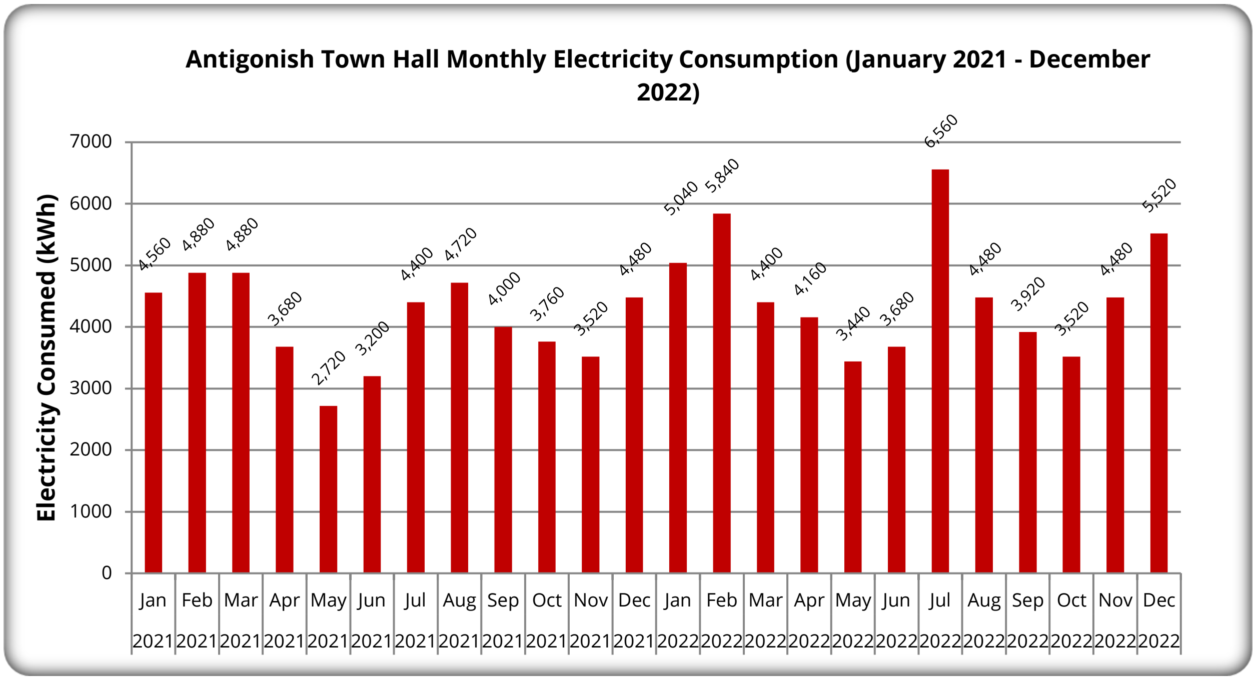


**Figure 8.2: 2021/2022 Monthly Electricity Consumption**

Figure 8.2 depicts a trend with a lower electricity consumption during the shoulder seasons in comparison to the summer and winter months. Electricity is used for heating, cooling, and dehumidification so this trend is to be expected.

Total electricity usage for the period of January/December 2021 was 48,800 kWh and 55,040 kWh from January/December 2022. The average annual energy consumption considering these two 12-month periods was 51,920 kWh.

### 8.2.2 Heating Oil Consumption

The Town of Antigonish provided the heating oil delivery records to the site for the period of January 2021 to December 2022. Total heating oil usage for the period of January/December 2021 was 15,220 L and 17,411 L from January/December 2022. The average annual fuel consumption for this period was 16,315 L. Heating oil is consumed by a boiler to provide space heating to the building. The figures are based on delivered quantities each month and do not necessarily reflect quantities consumed each month.

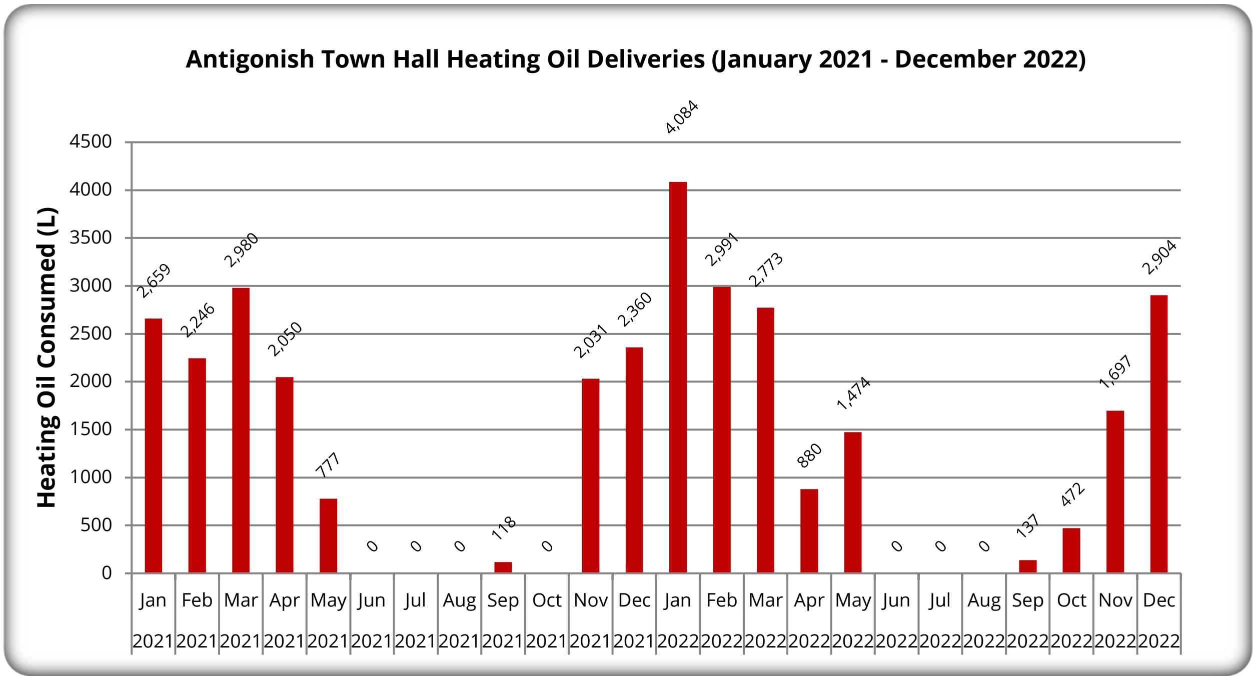


**Figure 8.3: 2021/2022 Monthly Heating Oil Deliveries**

### 8.2.3 Electricity Cost

Electricity is provided by the Antigonish Electric Utility as a "General Services above 3 kilowatts connected load" electricity rate[38].

| **Above 3 kilowatts connected load:** | |
|---|---|
| Base Rate: | $8.75 per month per kilowatt of maximum demand. |
| Energy Rates: | $0.15945 per kilowatt hour for the first 100 kilowatt hours per month per kilowatt of maximum demand.<br><br>$0.09993 per kilowatt hour for all additional consumption. |
| Base Rate: | $8.75 per kilowatt of maximum demand. |
| Minimum Bill: | The greater of the Base Rate or $10.53. |
| Efficiency Nova Scotia Charges | $0.00 per kilowatt hour for all consumption. |

**Figure 8.4: Antigonish Electric Utility Tariff Rate**

Table 8.1 presents the monthly power bill cost breakdown for the January 2021 to December 2022, 24-month period for the Antigonish Town Hall.

[38] Source file.html (townofantigonish.ca). Retrieved: 2023-11-20

**Table 8.1: Monthly Power Bill Cost Breakdown for the January 2021 to December 2022**

| Month-Year | Consumption (kWh) | Demand (kW) | Invoice Amount |
|---|---|---|---|
| January 2021 | 4,560 | 16.24 | $691.84 |
| February 2021 | 4,880 | 19.04 | $764.53 |
| March 2021 | 4,880 | 18.16 | $751.74 |
| April 2021 | 3,680 | 14.56 | $579.47 |
| May 2021 | 2,720 | 12.72 | $456.78 |
| June 2021 | 3,200 | 19.60 | $604.79 |
| July 2021 | 4,400 | 18.48 | $708.42 |
| August 2021 | 4,720 | 17.68 | $728.77 |
| September 2021 | 4,000 | 18.30 | $673.11 |
| October 2021 | 3,760 | 14.72 | $589.79 |
| November 2021 | 3,520 | 16.72 | $594.89 |
| December 2021 | 4,480 | 16.48 | $687.33 |
| January 2022 | 5,040 | 16.40 | $742.14 |
| February 2022 | 5,840 | 17.52 | $838.37 |
| March 2022 | 4,400 | 17.52 | $694.47 |
| April 2022 | 4,160 | 16.40 | $654.20 |
| May 2022 | 3,440 | 16.48 | $583.40 |
| June 2022 | 3,680 | 17.28 | $619.03 |
| July 2022 | 6,560 | 19.36 | $937.08 |
| August 2022 | 4,480 | 17.36 | $700.14 |
| September 2022 | 3,920 | 18.72 | $663.95 |
| October 2022 | 3,520 | 15.36 | $575.12 |
| November 2022 | 4,480 | 16.56 | $688.50 |
| December 2022 | 5,520 | 16.16 | $786.61 |

### 8.2.4 Heating Oil Cost

The Town of Antigonish provided the heating oil delivery records to the site for the period of January 2021 to December 2022. The average cost during this time period was $1.22/L. Due to the significant increase in oil prices since the billing period, the cost savings calculations have been conducted using a value more representative to current market prices of $1.79/L[39].

[39] Source: Weekly Average Retail Prices for Furnace Oil in 2023 | Natural Resources Canada (nrcan.gc.ca). Retrieved: 2023-04-01.

### 8.2.5 Total Energy Use Summary

| Antigonish Town Hall – Area: 899 m² | 2021 | 2022 |
|---|---|---|
| **Electricity** | | |
| Annual Electricity and Demand Cost ($) | $7,831.46 | $8,483.01 |
| Annual Electricity Consumption (kWh) | 48,800 | 55,040 |
| Annual Electricity Consumption (GJ) | 176 | 198 |
| Cost per GJ ($/GJ) | $44.6 | $42.8 |
| Percentage of Total Energy (%) | 23.1% | 22.8% |
| **Heating Oil** | | |
| Annual Heating Oil Cost ($) | $13,956.34 | $26,502.30 |
| Annual Heating Oil Consumption (L) | 15,220 | 17,411 |
| Annual Heating Oil Consumption (GJ) | 586.1 | 670.5 |
| Cost per GJ ($/GJ) | $23.8 | $39.5 |
| Percentage of Total Energy (%) | 76.9% | 77.2% |
| **Summary – Total** | | |
| Annual Energy Costs ($) | $21,787.80 | $34,985.31 |
| Annual Energy Consumption (GJ) | 762 | 869 |
| Cost per GJ ($/GJ) | 28.6 | 40.3 |
| Percentage of Total Energy (%) | 100.00% | 100.00% |

The baseline energy usage for this study was determined using the January/December 2022 year. This year was selected for the baseline as it was determined that this would more accurately depict each facility's regular operations and energy usage after the COVID-19 pandemic.

### 8.2.6 Benchmarking

The energy use per area or energy use intensity (EUI) for this facility is 0.91 GJ/m². According to the Energy Star Portfolio Manager for Canada[40],the average EUI for 'Other-Public Services' is 0.86 GJ/m². Currently, this facility sits approximately 5.8% higher than the average.

### 8.2.7 End-use Breakdown

A building energy model was created in Carrier HAPV6.1 considering the information and data collected from the drawings and the site visit. The energy model was calibrated based on the actual annual energy records for this facility, which allowed us to estimate the

[40] Source:
https://portfoliomanager.energystar.gov/pdf/reference/Canadian%20National%20Median%20Table.pdf
Retrieved: 2023-01-23

energy use breakdown shown in Table 8.2. This energy use breakdown is an estimation based on information collected during the site visit and from drawings. This information can only be confirmed with dedicated submetering of the different electrical subpanels and fuel-fired equipment and appliances in the facility. The review of this data allowed us to identify the following:

- The figure depicts that the majority of the energy consumption of the building, 76.7%, can be attributed to space heating.
- The second largest source of energy usage is building lighting at approximately 9.6%.
- The third largest source of energy consumption is electrical equipment at 7.4%.
- The remaining 6.4% is comprised of mechanical equipment, space cooling, hot water, and miscellaneous equipment at 1.7%, 2.2%, 2.0% and 0.4%, respectively.

**Table 8.2: Energy Use Breakdown**

| End-use | Energy Use Breakdown (%) | Site Energy (GJ) |
|---|---|---|
| Space Heating | 76.7% | 672.4 |
| Lights | 9.6% | 84.1 |
| Electrical Equipment | 7.4% | 64.5 |
| Mechanical Equipment | 1.7% | 15.2 |
| Hot Water | 2.0% | 17.8 |
| Cooling | 2.2% | 19.5 |
| Miscellaneous | 0.4% | 3.1 |
| **Total** | **100%** | **876.7** |

## 8.3 Energy and GHG Reduction Pathway

### 8.3.1 Pathway Components

#### 8.3.1.1 Replace Existing Oil Fired Boiler with an Electric Boiler at End of Life with Outdoor Air Temperature Reset

The majority of the building is heated by a hydronic heating system that utilizes oil-fired boilers with an estimated efficiency of 80%. An electric boiler can provide the same output at an average efficiency of 100%.

The boiler for the hydronic heating system currently heats the supply water to a constant temperature of 82°C (180°F) regardless of the air temperature outside. There is potential for energy consumption reduction in the modulation of supply water temperature for the terminal units according to the outdoor temperature. Outdoor reset control uses the heating curve to set the relationship between the outdoor temperature and the supply water temperature. The heating curve defines the amount the supply water temperature is raised for every 1° drop in outdoor air temperature. During mild outdoor temperatures, the supply water temperature will be low, while during the coldest day of the year the supply water temperature will be at design conditions. Outdoor reset reduces indoor temperature changes by more closely matching the output of the terminal units to the load. It also increases system efficiency by minimizing distribution losses. It is recommended that this system be implemented with the installation of an electric boiler.

It is recommended that the boilers be upgraded either at the end of their lifespan or prior to the end of Phase 1 in 2032, whichever occurs first.

#### 8.3.1.2 Upgrade Existing Lighting to LEDs

The interior and exterior lighting for the facility is a mixture of LED, fluorescent, and CFL fixtures. LEDs can provide the same level of light as other types of fixtures while consuming less energy. Therefore, considering the difference between the consumption levels of the current lamps and LED lamps, the implementation of this recommendation could result in significant energy savings.

Based on the findings from the building condition assessment completed in parallel to the energy study, lighting fixtures in this facility have reached the end of their expected useful life. Therefore, the recommendation is to replace the existing lighting fixtures with LED fixtures.

When calculating the input power of the existing lighting, we prepared estimates of the quantity and type of lamps (bulbs) based on visual observation of the fixtures. Since it is difficult to know what type of ballast is used in each fixture without disassembly, the analysis team considered a minimum factor of 1.1 for fluorescent fixtures and 1.2 for HID.

The implementation of LED lighting will result in reduced maintenance costs over the following years. This is due to LEDs having a longer lifespan than the existing lighting fixtures. It is estimated that a non-LED lighting fixture has a maintenance cost of $4/yr, while LEDs have an estimated maintenance cost of $2/yr. This leads to a savings of $2/yr in maintenance per fixture.

#### 8.3.1.3 Install Occupancy Sensors for Intermittently Used Spaces

Spaces within the facility are currently controlled by manual ON/OFF switches. To reduce the amount of time the lights are left on (or forgotten ON) with spaces unoccupied, it is recommended that occupancy sensors be installed. Occupancy sensors come in a wide range of configurations and characteristics. They can be installed on walls, ceilings, or at the switch location. Detection can be based on sound, infrared heat, or both. The sensor has a relay that interrupts the voltage to the fixtures in the circuit, thus turning them off when no occupancy is detected. The viability for installation of an occupancy sensor depends on the cost of electricity, the size of the load (number and wattage of lights) being controlled, and the approximate number of unoccupied hours they are often being left turned on.

#### 8.3.1.4 Install Programmable Thermostats with Nighttime Setback

The heating zones in the building are controlled by manual thermostats. An alternative to manual thermostats is programmable thermostats. They are set once considering temperature setpoints for occupied or unoccupied periods and will adjust the temperature. These thermostats are programmed to reduce the set point temperature during unoccupied periods. Generally, the setpoint can be decreased by 3°F to 5°F for at least eight (8) hours a day (in heating mode), which can lead to significant savings (between 3% to 5% in heating).

#### 8.3.1.5 Replace Weatherstripping on All Exterior Doors and Seal Exterior Openings

Some of the windows and doors in this facility exhibit gaps and cracks that will allow for outdoor air infiltration. This causes additional heating loads which impact the energy consumption from the HVAC systems. It is recommended that the envelope of conditioned spaces be inspected and caulking applied around the exterior windows, doors, and other exterior wall openings. Damaged and missing weatherstripping on the doors and windows in the facility should also be replaced.

#### 8.3.1.6 Upgrade Wood Frame Windows to Thermally Insulated Vinyl Windows Minimum R-4

The building has single and double paned, wood frame windows with an estimated R value of R-0.96 and R-1.7, respectively. All wood frame windows have exceeded their expected lifespan. It is anticipated that replacing the windows with high efficiency double pane, vinyl frame windows will help reduce energy usage for the building. The implementation of this measure will lower conductive losses through the windows, as well as lower infiltration levels. It is recommended that these windows be replaced during Phase 1.

### 8.3.2 Energy Rates and Emission Intensity Factors

The following list includes all the assumptions and variables considered for the technical and financial analysis:

- Cost of Electricity: $0.1541/kWh
- Cost of Heating Oil: $1.79/L
- Antigonish Electric GHG Emission Intensity Factor 2022: 0.3387 $CO_2$e kg/kWh
- Antigonish Electric GHG Emission Intensity Factor 2033: 0.1565 $CO_2$e kg/kWh
- Antigonish Electric GHG Emission Intensity Factor 2043: 0.03 $CO_2$e kg/kWh
- Heating Oil GHG Emission Intensity Factor 2022: 2.71 $CO_2$e kg/L[41]
- Heating Oil GHG Emission Intensity Factor 2033-2043: 2.17 $CO_2$e kg/L

[41] Source: Emission Factors for Greenhouse Gas Inventories (epa.gov). Retrieved: 2023-04-01

**Table 8.3: Projected Annual Carbon Emissions, No Measures Implemented**

| Energy Source | 2022 Energy Usage (GJ) | 2022 Emissions (tonnes) | 2033 Projected Emissions (tonnes) | 2043 Projected Emissions |
|---|---|---|---|---|
| Antigonish Electric | 198.1 | 18.6 | 8.6 | 1.7 |
| Heating Oil | 650.5 | 47.2 | 47.2 | 47.2 |
| **Total** | **868.6** | **65.8** | **55.5** | **48.8** |

The baseline energy consumption, January-December 2022, for the Antigonish Town Hall resulted in a total energy consumption of 868.6 GJ annually and carbon emissions of 65.8 tonnes/year based on 2022 emissions factors. The carbon emission intensity of the electric grid and fossil fuels are projected to decrease during the lifespan of this study. Table 8.3 shows the projected annual emission without the implementation of any energy conservation measures. Compared to the baseline, emissions are expected to decrease by 15.2 and 38.3% by 2033 and 2043, respectively.

### 8.3.3 Phase 1 Measurement and Analysis

The baseline HAP model was modified to be able to estimate the building's performance considering the efficiency measures listed above. These modifications included:

- Replacement of the 80% efficient oil-fired boilers with 99% efficient electric boilers and an outdoor air temperature reset.
- Implement a nighttime setback of 5°F during unoccupied hours for heating.
- Lighting wattages for spaces without LEDs were modelled with LED equivalent wattages.
- The lighting in intermittently occupied spaces was reduced by 12.5% when modelled to represent the savings from occupancy sensors.
- Infiltration values were decreased by 10% to all spaces to represent weatherstripping and sealing of exterior surfaces.
- Windows were upgraded to an R-value of R-4 and in spaces with windows infiltration, was decreased by an additional 5%.

The implementation of these measures to the Antigonish Town Hall will result in a reduction of energy consumption from the baseline of 357.0 GJ. The total cost to implement Phase 1 measures is approximately $340,410 with a cost savings of an estimated $18.159/year for a payback period of 18.3 years. These measures will have an emissions savings 34.3 tonnes/year in 2033 compared to the baseline building's emissions in the same year as seen in Table 8.4.

**Table 8.4:Antigonish Town Hall Phase 1 Efficiency Measures**

| ECM | CAPEX ($) | GHG Savings (tonne) | CAPEX/ GHG Reduction ($/tonne) | Energy Savings GJ/yr | Cost Savings $/yr | Cost Savings/ GHG Saved ($/tonne $CO_2$e) | Simple Payback (yr) |
|---|---|---|---|---|---|---|---|
| Install Electric Boiler Early and Implement Outdoor Air Reset | $73,500 | 34.3 | $9,655 | 357.0 | $18,159 | $529 | 18.3 |
| Electrical Entrance Upgrades | $90,000 | | | | | | |
| Upgrade Lighting to LED* | $15,110 | | | | | | |
| Occupancy Sensors for Lighting Controls | $4,600 | | | | | | |
| Install Programmable Thermostats with Nighttime Setback | $7,200 | | | | | | |
| Upgrade Windows to a Minimum of R4 | $150,000 | | | | | | |
| Infiltration Reduction | $2,700 | | | | | | |
| **ECM Implementation Total** | **$331,610** | **34.3** | **$9,655** | **357.0** | **$18,159** | **$529** | **18.3** |

## 8.3.4 Phase 2 Measurement and Analysis

No additional measures were considered for implementation in this facility in Phase 2.

## 8.3.5 Measures Considered but Not Recommended

The following measures were considered for this building but are ultimately not currently recommended to be completed:

- **Convert Existing Oil-Fired Boiler to Propane:** The majority of the building is heated by a hydronic heating system that utilizes oil-fired boilers with an estimated efficiency of 80%. Converting the oil-fired boiler to propane will allow for the same efficiency but uses a fuel that produces less carbon emissions/GJ. This would have been implemented as a transitional step before converting to electric boilers as both oil-fired boilers had been installed more recently in 2017. Instead, it has been recommended to replace the oil-fired boiler at the end of Phase 1, in 2032, as it would be nearing their end of life.

# 9 Antigonish Water Treatment Plant

## 9.1 Facility Description

**Figure 9.1: DNR Antigonish Office Site**

The Antigonish Water Treatment Plant (WTP) building was built in 2006. Throughout the week, the administrative areas of the building are open for eight and a half (8.5) hours a day, seven days a week, from 8:00 a.m. to 4:30 p.m. year-round. Table 9.1 presents a photograph of the site. A roof mounted 61.6 kWDc PV array was installed in 2019.

Raw water from the James River is gravity fed to the WTP, entering the plant through a 16" transmission main. The treatment system is comprised of chemical addition prior to a rapid mix tank which splits the flow into two treatment trains. Each train consists of 2-stage tapered flocculation basins and DAF clarifiers. Each flocculation tank contains top mounted, adjustable speed vertical turbine flocculators (mixers) which are designed to induce decreasing velocity gradients within the basins.

The clarifier uses dissolved air flotation (DAF) technology to separate the solid flocs from the water. Clarified water is recycled to the front of the DAF basin through a saturator tank, which forces pressurized air to mix with the recycle water to facilitate dissolution. The recycle water is injected at the entrance to the DAF basin, where the drop in pressure causes micro-bubbles to form and float to the surface of the tank. As the bubbles rise, they contact and attach to floc particles and carry them to the surface, creating a sludge blanket (or float) which is then removed via a mechanical skimmer. The DAF water is withdrawn from the bottom of the clarifier basin and flows into a common trough which feeds three dual media (anthracite/sand) rapid filters. After filtration, chlorine gas is added to the water before flowing to the chlorine contact chamber. The water is then pumped from the clearwell to the distribution system. An average flow of 4000m³ of water runs through the plant per day.

One filter is backwashed per day, where filters are drained and undergo an air scour via the blower, low flow, high flow, settling, and then rinsing. Backwashes take around 15 minutes per cycle. Backwash waste streams are first directed into onsite holding tanks and then are pumped into a series of settling lagoons located outside the WTP.

A summary of the major process equipment using electric motors, the respective motor size, estimated efficiencies, and operating schedules, is listed below in Table 9.1. Currently the rapid mixer, treatment water pumps, and service water pumps are equipped with VFDs.

**Table 9.1: Water Treatment Plant Existing Mechanical Process Equipment**

| Equipment | Motor HP | Estimated Percentage of Year Operating | Motor Efficiency |
|---|---|---|---|
| Air Compressor 1 | 3 | 5.00% | 86.5% |
| Air Compressor 2 | 3 | 0.00% | 86.5% |
| Rapid Mixer | 3 | 100.00% | 86.5% |
| Blower | 20 | <1% | 91% |
| Recycle Pumps | 10 | 100.00% | 90.2% |
| Recycle Pumps | 10 | 50.00% | 90.2% |
| Recycle Pump | 10 | 50.00% | 89.5% |
| Backwash Pumps | 50 | <1% | 93% |
| Backwash Pumps | 50 | <1% | 93% |
| Treated Water Pumps | 15 | 100.00% | 93% |
| Treated Water Pumps | 15 | 25.00% | 91% |
| Treated Water Pumps | 15 | 25.00% | 92.4% |
| Service Water Pumps 1 | 3 | 33.00% | 85.5% |
| Service Water Pumps 2 | 3 | 33.00% | 85.5% |
| Service Water Pumps 3 | 3 | 33.00% | 85.5% |

Existing motors are comprised of a mix of standard and premium efficiency units.

The building itself, is equipped with a hydronic heating system with an oil-fired boiler and circulation system. The administrative spaces utilize radiant floor heating. Process areas are equipped with hydronic unit heaters. Hydronic baseboards are in the washrooms and soda ash room. An air handling unit (AHU) provides ventilation and cooling (DX) to the administrative areas. Interior and exterior lighting are provided by a combination of LED, fluorescent, and HPS Lighting. Electricity and heating oil are the two sources of energy consumed on site. Electricity powers the space cooling, ventilation, lighting, refrigeration, kitchen appliances, and domestic hot water, as well as all process equipment. Heating oil is consumed in a boiler to produce heating to the administrative spaces and process areas.

Mechanical ventilation is provided to the administration areas by an AHU, and by roof mounted exhaust fans interlocked with fresh air dampers to the process areas. Wall mounted exhaust fans serve the chlorine storage and chemical feed room.

The building and major existing equipment characteristics include:

- The exterior walls appear to be in good condition. The estimated R-value for the above grade exterior walls is R-20. Below grade exterior walls are estimated to be R-11.
- The building roof appears to be in good condition. The estimated R-value for the roof is R-30.
- A 61.6 kWDc PV array is installed on the roof. This array is a part of a power purchase agreement with NSPI and does not supply electricity to the building.
- Vinyl frame, double paned windows appear in good condition with an estimated R-value of R-3.
- The floor is slab-on-grade. The estimated R-value is R-1.4.
- Exterior doors appear in good condition. R-value is estimated to be R-3.
- Weatherstripping around the man-doors appears to be in fair condition.
- The interior lighting is a combination of LED, fluorescent, and HPS with manual ON/OFF switches. Exterior light is provided by LEDs.
- One oil-fired boiler provides hot water up to 82°C (180°F), for the hydronic heating system, at an estimated efficiency of approximately 80-90% to the administrative spaces and process areas.
- The temperature setpoint is 22°C year-round for the administrative spaces with a nighttime setback of 18°C. All the thermostats in this space are programmable.
- The temperature setpoint is 15°C in the winter for the process spaces, except the soda ash room which is set to 24°C. The thermostat for this space is manual.
- Domestic hot water is provided by a 38 US Gallon electric hot water heater that serves the building washrooms and lunchroom.
- Cooking appliances are electric.

## 9.2 Review of Historic Energy Performance

Electricity bills were provided for the 24-month period between January 2021-2022. Energy consumption and demand were reviewed in annual terms to ensure that variation in seasonality was observable. With at least two periods available, a month-to-month comparison of the facility's energy performance was completed from one year to the next. Review of electricity consumption profiles, based on the information obtained from the two periods, was discussed, and is compared in this section.

### 9.2.1 Electricity Use Profiles

Figure 9.2 provides the monthly electricity usage profile which shows the 24-month period from January 2021 to December 2022.

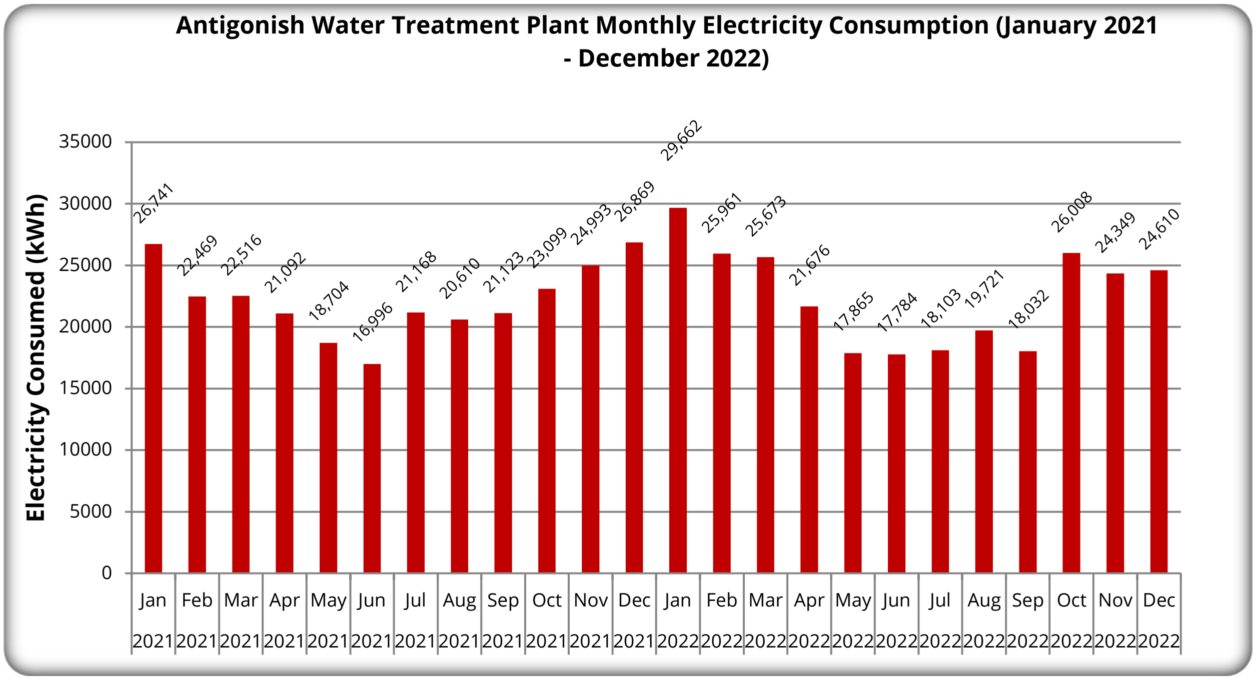


**Figure 9.2: 2021/2022 Monthly Electricity Consumption**

Figure 9.2 depicts a trend with a higher electricity consumption in the winter than in the summer. Electricity consumed is directly impacted by the amount of water that needs to be processed.

Total electricity usage in the period of January/December 2021 was 266,380 kWh and 269,444 kWh from January/December 2022. The average annual energy consumption considering these two 12-month periods was 267,912kWh.

### 9.2.2 Heating Oil Consumption

The Town of Antigonish provided the heating oil delivery records to the site for the period of January 2021 to December 2022. Total heating oil usage for the period of January/December 2021 was 42,138 L and 43,694 L from January/December 2022. The average annual fuel consumption for this period was 42,916.3 L. Heating oil is consumed by a boiler to provide space heating to the building. The figures are based on delivered quantities each month and do not necessarily reflect quantities consumed each month.

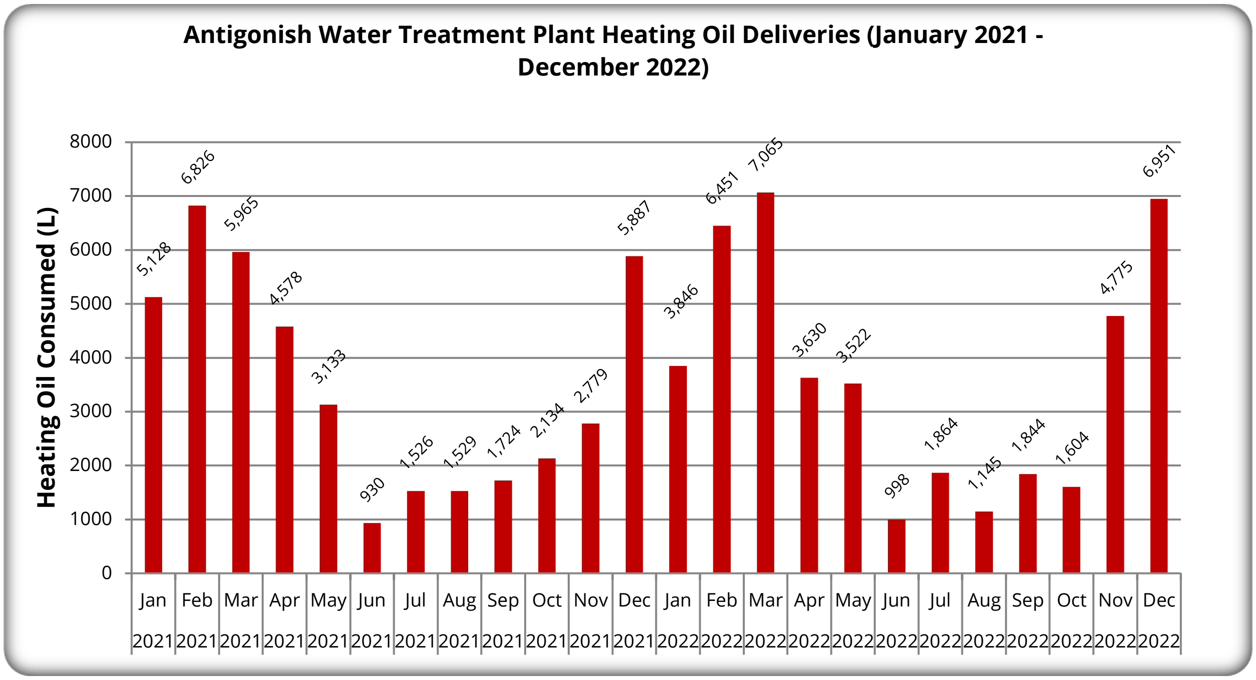

**Figure 9.3: 2021/2022 Monthly Heating Oil Deliveries**

### 9.2.3 Electricity Cost

Electricity is provided by NS Power at a "Commercial General Tariff Rate"[42].

| **Above 3 kilowatts connected load:** | |
|---|---|
| Base Rate: | $8.75 per month per kilowatt of maximum demand. |
| Energy Rates: | $0.15945 per kilowatt hour for the first 100 kilowatt hours per month per kilowatt of maximum demand.<br><br>$0.09993 per kilowatt hour for all additional consumption. |
| Base Rate: | $8.75 per kilowatt of maximum demand. |
| Minimum Bill: | The greater of the Base Rate or $10.53. |
| Efficiency Nova Scotia Charges | $0.00 per kilowatt hour for all consumption. |

**Figure 9.4: NS Power Tariff Rate**

Table 9.2 presents the monthly power bill cost breakdown for the January 2021 to December 2022, 24-month period. Electricity consumption was provided from January 2021 to December 2022. Billing costs were provided from January 2021 to March 2022.

[42] Source: General Tariff| Nova Scotia Power (nspower.ca). Retrieved: 2022-12-13

**Table 9.2: Monthly Power Bill Cost Breakdown for the January 2021 to December 2022**

| Month-Year | Consumption (kWh) | Consumption Amount | Demand (kW) | Demand Amount | Additional Charges ($) | HST ($) | Invoice Amount |
|---|---|---|---|---|---|---|---|
| January 2021 | 26,741 | $2,759.22 | 71.5 | $551.55 | $65.53 | $506.45 | $3,882.75 |
| February 2021 | 22,469 | $2,381.92 | 73.4 | $566.21 | $220.35 | $475.27 | $3,643.75 |
| March 2021 | 22,516 | $2,410.48 | 78.5 | $605.55 | $549.58 | $534.84 | $4,100.45 |
| April 2021 | 21,092 | $2,270.25 | 76.1 | $587.04 | $527.02 | $507.65 | $3,891.96 |
| May 2021 | 18,704 | $2,040.94 | 73.3 | $565.44 | $688.03 | $494.16 | $3,788.57 |
| June 2021 | 16,996 | $1,895.05 | 75.1 | $579.32 | $743.55 | $482.69 | $3,700.61 |
| July 2021 | 21,168 | $2,272.37 | 75.1 | $579.32 | $636.59 | $523.24 | $4,011.52 |
| August 2021 | 20,610 | $2,213.79 | 73.4 | $566.21 | $715.59 | $524.34 | $4,019.93 |
| September 2021 | 21,123 | $2,270.67 | 75.6 | $583.18 | $471.85 | $498.86 | $3,824.56 |
| October 2021 | 23,099 | $2,434.61 | 72.5 | $559.27 | $387.79 | $507.25 | $3,888.92 |
| November 2021 | 24,993 | $2,625.92 | 76.7 | $591.66 | $199.87 | $512.62 | $3,930.07 |
| December 2021 | 26,869 | $2,795.58 | 76.7 | $591.66 | $90.62 | $521.68 | $3,999.54 |
| January 2022 | 29,662 | $3,121.26 | 76.1 | $587.04 | $29.18 | $560.62 | $4,298.10 |
| February 2022 | 25,961 | $2,770.39 | 74.7 | $576.24 | $114.26 | $519.13 | $3,980.02 |
| March 2022 | 25,673 | $2,760.77 | 78.3 | $604.01 | $382.98 | $562.16 | $4,309.92 |
| April 2022 | 21,676 | $2,378.56 | 76.1 | $587.04 | $533.11 | $524.81 | $4,023.52 |
| May 2022 | 17,865 | $2,016.52 | 74.5 | $574.69 | $899.20 | $523.56 | $4,013.97 |
| June 2022 | 17,784 | $2,001.35 | 72.9 | $562.35 | $821.95 | $507.85 | $3,893.50 |
| July 2022 | 18,103 | $2,021.49 | 70.9 | $546.92 | $937.51 | $525.89 | $4,031.81 |
| August 2022 | 19,721 | $2,183.40 | 73.3 | $565.44 | $670.42 | $512.89 | $3,932.15 |
| September 2022 | 18,032 | $2,026.80 | 73.4 | $566.21 | $471.87 | $459.73 | $3,524.61 |
| October 2022 | 26,008 | $2,772.85 | 74.3 | $573.15 | $185.64 | $529.75 | $4,061.39 |
| November 2022 | 24,349 | $2,612.85 | 73.1 | $563.89 | $243.92 | $513.10 | $3,933.76 |
| December 2022 | 24,610 | $2,638.55 | 73.4 | $566.21 | $113.46 | $497.73 | $3,815.95 |

### 9.2.4 Heating Oil Cost

The Town of Antigonish provided the heating oil delivery records to the site for the period of January 2021 to December 2022. The average cost during this time period was $1.26/L. Due to the significant increase in oil prices since the billing period, the cost savings calculations have been conducted using a value more representative to current market prices of $1.79/L[43].

### 9.2.5 Total Energy Use Summary

Electricity costs were incomplete for the January/December 2022 year.

| Antigonish Water Treatment Plant – Area: 931 m² | 2021 | 2022 |
|---|---|---|
| **Electricity** | | |
| Annual Electricity and Demand Cost ($) | $46,682.62 | $47,818.70 |
| Annual Electricity Consumption (kWh) | 266,380 | 269,444 |
| Annual Electricity Consumption (GJ) | 959 | 970 |
| Cost per GJ ($/GJ) | $48.7 | $49.3 |
| Percentage of Total Energy (%) | 37.1% | 36.6% |
| **Heating Oil** | | |
| Annual Heating Oil Cost ($) | $39,041.15 | $69,340.95 |
| Annual Heating Oil Consumption (L) | 42,138 | 43,694 |
| Annual Heating Oil Consumption (GJ) | 1,622.7 | 1682.64 |
| Cost per GJ ($/GJ) | 24.1 | 41.2 |
| Percentage of Total Energy (%) | 62.9% | 63.4% |
| **Summary – Total** | | |
| Annual Energy Costs ($) | $85,723.77 | $117,159.65 |
| Annual Energy Consumption (GJ) | 2,582 | 2,653 |
| Cost per GJ ($/GJ) | $33.2 | $44.2 |
| Percentage of Total Energy (%) | 100.00% | 100.00% |

The baseline energy usage for this study was determined using the January/December 2022 year. This year was selected for the baseline as it was determined that this would more accurately depict each facility's regular operations and energy usage after the COVID-19 pandemic.

[43] Source: Weekly Average Retail Prices for Furnace Oil in 2023 | Natural Resources Canada (nrcan.gc.ca) Retrieved: 2023-04-01.

### 9.2.6 Benchmarking

The energy use per area or energy use intensity (EUI) for this facility is 0.66 GJ/average daily flow in m³. According to the Energy Star Portfolio Manager for Canada[44],the average EUI for a water treatment plant is 0.63 GJ/average daily flow in m³. Currently, this facility sits approximately 4.8% higher than the average.

### 9.2.7 End-use Breakdown

The energy use breakdown for this building was estimated by assuming the hours of operation for the process equipment, lighting, and average electrical loads for the space type. A model of the building was created which allowed us to estimate the energy use breakdown shown. Lighting and process equipment were estimated separately from information obtained during the site visit. This energy use breakdown is an estimation based on the information collected during the site visit and from the drawings. This information can only be confirmed with dedicated submetering of the different electrical subpanels and appliances in the facility. The review of this data allowed us to identify the following:

- The figure depicts that the majority of the energy consumption of the building, 64.4%, can be attributed to space heating.
- The second largest source of energy usage is the process equipment at approximately 30.6%.
- The third largest source of energy consumption is lighting at 2.8%.
- The remaining 2.2% is comprised of electrical equipment, mechanical equipment, and fans at 0.6%, 1.0%, and 0.6%, respectively.

**Table 9.3: Energy Use Breakdown**

| End-use | Energy Use Breakdown (%) | Site Energy (GJ) |
|---|---|---|
| Space Heating | 64.4% | 1682.2 |
| Process Equipment | 30.6% | 800.8 |
| Lighting | 2.8% | 73.9 |
| Electrical Equipment | 0.6% | 15.5 |
| Air System Fans | 0.6% | 14.4 |
| Pumping | 1.0% | 26.8 |
| **Total** | **100%** | **2613.7** |

[44] Source: Canadian Energy Use Intensity by Property Type – Technical Reference (canada.ca). Retrieved: 2023-01-23

# 9.3 Energy and GHG Reduction Pathway

## 9.3.1 Pathway Components

### 9.3.1.1 Replace Existing Oil-Fired Boiler with a Propane Boiler at End of Life with Outdoor Air Temperature Reset

The building is heated by a hydronic heating system that utilizes an oil-fired boiler with an estimated efficiency of 85%. This facility is on the NSPI grid and based on the emissions projections used in this study, the emission intensity for electricity produces more greenhouses gases than propane for the entirety of the study, even when accounting for efficiency. An electric boiler will only produce less greenhouse gases when the grid reaches an emission intensity less than 0.194 $kgCO_2e/kWh$.

For this reason, an electric boiler has not been recommended and instead a propane boiler is recommended. A propane boiler can provide the same output at the same average efficiency as the current boiler while also having a lower carbon emission intensity than heating oil per unit of energy.

The boiler for the hydronic heating system currently heats the supply water to a constant temperature of 82°C (180°F) regardless of the air temperature outside. There is potential for energy consumption reduction in the modulation of the supply water temperature for the terminal units according to the outdoor temperature. Outdoor reset control uses the heating curve to set the relationship between the outdoor temperature and the supply water temperature. The heating curve defines the amount the supply water temperature is raised for every 1° drop in outdoor air temperature. During mild outdoor temperatures, the supply water temperature will be low, while during the coldest day of the year the supply water temperature will be at design conditions. Outdoor reset reduces indoor temperature changes by more closely matching the output of the terminal units to the load. It also increases system efficiency by minimizing distribution losses. It is recommended that this system be implemented with the installation of a propane boiler.

### 9.3.1.2 Upgrade Existing Lighting to LEDs

The interior and exterior lighting for the facility is a mixture of LED, fluorescent, and HPS fixtures. LEDs can provide the same level of light as other types of fixtures while consuming less energy. Therefore, considering the difference between the consumption levels of the current lamps and LED lamps, the implementation of this recommendation could result in significant energy savings.

Based on the findings from the building condition assessment completed in parallel to the energy study, lighting fixtures in this facility have reached the end of their expected useful life. Therefore, the recommendation is to replace the existing lighting fixture with LED fixtures.

When calculating the input power of the existing lighting, we prepared estimates of the quantity and type of lamps (bulbs) based on visual observation of the fixtures. Since it is difficult to know what type of ballast is used in each fixture without disassembly, the analysis team considered a minimum factor of 1.1 for fluorescent fixtures and 1.2 for HID.

The implementation of LED lighting will result in reduced maintenance costs over the following years. This is due to LEDs having a longer lifespan than the existing lighting fixtures. It is estimated that a non-LED lighting fixture has a maintenance cost of $4/yr, while LEDs have an estimated maintenance cost of $2/yr. This leads to a savings of $2/yr in maintenance per fixture.

#### 9.3.1.3 Install Occupancy Sensors for Intermittently Used Spaces

Spaces within the facility are currently controlled by manual ON/OFF switches. To reduce the amount of time the lights are left on (or forgotten ON) with spaces unoccupied, it is recommended that occupancy sensors be installed. Occupancy sensors come in a wide range of configurations and characteristics. They can be installed on walls, ceilings, or at the switch location. Detection can be based on sound, infrared heat, or both. The sensor has a relay that interrupts the voltage to the fixtures in the circuit, thus turning them off when no occupancy is detected. The viability for installation of an occupancy sensor depends on the cost of electricity, the size of the load (number and wattage of lights) being controlled, and the approximate number of unoccupied hours they are often being left turned on.

#### 9.3.1.4 Repair Exhaust Louvers

Exhaust louvers located on the building show some damage and do not appear to shut properly. This allows for outdoor air infiltration, which causes additional heating loads and results in higher energy demand to heat spaces. It is recommended that these louvers be repaired to minimize infiltration.

#### 9.3.1.5 Replace Weatherstripping on All Exterior Doors and Seal Exterior Openings

Some of the windows and doors in this facility exhibit gaps and cracks that will allow for outdoor air infiltration. This causes additional heating loads which impact the energy consumption from the HVAC systems. It is recommended that the envelope of conditioned spaces be inspected and caulking applied around the exterior windows, doors, and other exterior wall openings. Damaged and missing weatherstripping on the doors and windows in the facility should also be replaced.

#### 9.3.1.6 Variable Frequency Drive on Recycling Pumps

The recycle system consists of three recycle pumps (normally in a duty/duty/standby arrangement when two clarifiers are in operation). The recycle pumps are not equipped with VFDs. In normal operations, the two pumps together produce a total flow of 26 $m^3/h$. During normal operation, the pump discharge pressure is 79 psi and the saturator tank is maintained at a pressure of 56 psi. This pressure drop of 23 psi is primarily induced by the saturator tank inlet valve. Since pumps are not equipped with VFDs, two pumps are run at full speed to supply enough recycle water to maintain flow and pressure. The addition of VFDs on the pumps will allow for lower speeds of the pumps to deliver the required flow to the saturator tank, instead of using the inlet valve to control flow. The addition of VFDs will allow modulation of the pumps' speed and output, ensuring that energy is used only when necessary.

#### 9.3.1.7 Install Ground Mounted PV System

The installation of a ground mounted solar PV system facing south could provide a fraction of the power consumed in the building. PV systems will help to improve the energy supply reliability, reduce energy costs, lower facility carbon footprint, and reduce the environmental impact of operating the building. The estimated size of the additional PV is 26.3 kWp DC.

### 9.3.2 Energy Rates and Emission Intensity Factors

The following list includes all the assumptions and variables considered for the technical and financial analysis:

- Cost of Electricity 2022 (Estimated): $0.1775/kWh
- Cost of Electricity PV: $0.10521/kWh
- Cost of Propane: $0.64/L
- NSPI GHG Emission Intensity Factor 2022: 0.5572 $CO_2$e kg/kWh[45]
- NSPI GHG Emission Intensity Factor 2033: 0.3164 $CO_2$e kg/kWh
- NSPI Electric GHG Emission Intensity Factor 2043: 0.1760 $CO_2$e kg/kWh
- PV Electricity GHG Emission Intensity[46]: 0.046 $CO_2$e kg/kWh
- Heating Oil GHG Emission Intensity Factor: 2.71 $CO_2$e kg/L[47]
- Propane GHG Emission Intensity Factor: 1.52 $CO_2$e kg/L[47]

**Table 9.4: Projected Annual Carbon Emissions, No Measures Implemented**

| Energy Source | 2022 Energy Usage (GJ) | 2022 Emissions (tonnes) | 2033 Projected Emissions (tonnes) | 2043 Projected Emissions |
|---|---|---|---|---|
| NSPI | 970.0 | 150.1 | 85.3 | 47.4 |
| Heating Oil | 1682.6 | 118.4 | 118.4 | 118.4 |
| **Total** | **2652.6** | **268.5** | **203.6** | **165.8** |

[45] Source: Air Emissions Reporting | Nova Scotia Power (nspower.ca). Retrieved: 2023-09-01
[46] Source: Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics (Fact Sheet), NREL (National Renewable Energy Laboratory). Retrieved 2023-11-20
[47] Source: Emission Factors for Greenhouse Gas Inventories (epa.gov). Retrieved: 2023-04-01

The baseline energy consumption, January-December 2022, for the Antigonish Water Treatment Plant is 2652.6 GJ annually and results in carbon emissions of 268.5 tonnes/year based on 2022 emissions factors. The carbon emission intensity of the electric grid and fossil fuels are projected to decrease during the lifespan of this study. Table 9.4 shows the projected annual emission without the implementation of any energy conservation measures. Compared to the baseline, emissions are expected to decrease by 24.2% and 38.3% by 2033 and 2043, respectively.

### 9.3.3 Phase 1 Measurement and Analysis

A simplified HAP model of the building was created, and the model was calibrated to have the annual heating oil usage of the facility within +/- 5%. To simulate the heating load for the process space the cold-water sensible load was input, the load size was estimated by using an average ground water temperature of 8°C and an estimated exposed area for the processing tanks. This allowed for a more accurate assessment of how the HVAC system provided energy to each space. This model was modified to estimate the savings on the building's performance and considering the efficiency measures listed below. The percent savings was then applied to the building's overall energy usage. These modifications included:

- Replacement of the 85% efficient oil-fired boiler with an 85% efficient propane boiler and an outdoor air temperature reset.
- Infiltration values were decreased by 10% in the office spaces and 5% for all process areas to represent weatherstripping and sealing of exterior surfaces.

The following measures were calculated separately:

- **Variable Frequency Drive for Recycling Pumps:** The baseline for the recycling pumps was determined by calculating the energy usage of one 10 hp pump running at the rated capacity 24 hours per day every day and two additional 10 hp pumps operating 12 hours per day everyday. The savings were determined by assuming two pumps will operate at 62.5% of their rated rpm 24 hours per day all year.
- **Repair Louvers for Exhaust Fans:** It was assumed that the process area had an average air temperature of 15°C, with an average outdoor air temperature of 2°C when the building was in operation. The existing air exhaust fans were assumed to have a ¼" gap along the louver and was estimated to be ⅛" when repaired. The oil-fired boiler was assumed to have an efficiency of 85%.
- **Upgrade Lighting to LED with Occupancy Sensors:** Lighting wattages for spaces without LEDs were compared to LED equivalent wattages. It was assumed that the lights were on from 6.4 hours per day, seven days/week year-round in all spaces, with the exception of the mechanical/electrical rooms which were estimated to be on three hours per week on average, as well as the chlorine storage room and Tankage room (florescent fixtures), which were estimated to be on 24 hours per day for the baseline to correspond with the estimated occupancy of the building. The operating hours of then lighting systems was reduced by 12.5% to account for savings if occupancy sensors are installed.

- **Ground Mounted PV System:** The PV System energy production was estimated by determining an area on-site that would be suitable for the installation of the system. Assuming that the system was facing due south with panels at a slope of between 40-45°, a production rate of 0.6 kW/m² was used with an estimated ground area of 4725 ft² was assumed, based on this a 26.3 kWp DC system could be installed. An annual output of 1250 kWh/kWp DC install was estimated.

The implementation of these measures to the Antigonish Water Treatment Plant will result in a reduction of energy consumption from the baseline of 436.6GJ. The total cost to implement Phase 1 measures is approximately $210,565 with a cost savings of an estimated $59,129/year for a payback period of 3.6 years. These measures will have an emissions savings of 65.1 tonnes/year in 2033 compared to the baseline building's emissions in the same year as presented in Table 9.5.

**Table 9.5: Antigonish Water Treatment Plant Phase 1 Energy Efficiency Measures**

| ECM | CAPEX ($) | GHG Savings (tonne) | CAPEX/ GHG Reduction ($/tonne) | Energy Savings GJ/yr | Cost Savings $/yr | Cost Savings/ GHG Saved ($/tonne $CO_2e$) | Simple Payback (yr) |
|---|---|---|---|---|---|---|---|
| Upgrade Lighting to LED* | $25,020 | 4.9 | $5,534 | 56 | $2,926 | $595 | 9.3 |
| Occupancy Sensors for Lighting Controls | $2,200 | | | | | | |
| Propane Boiler with Outdoor Air Temperature Reset* | $60,000 | 18.7 | $3,565 | 19 | $35,581 | $1,903 | 1.9 |
| Concrete Pad for Propane Tank | $5,000 | | | | | | |
| Infiltration Reduction | $1,650 | | | | | | |
| Add VFD to Recycle Pumps | $50,000 | 31.2 | $1,600 | 355.5 | $17,528 | $561 | 2.9 |
| Repair Louvers for Exhaust Fans | $14,000 | 0.4 | $38,143 | 6.1 | $155 | $422 | 90.3 |
| PV Systems | $52,695 | 8.9 | $3,283 | 0.0 | $2,938 | $330 | 17.9 |
| **ECM Implementation Total** | **$210,565** | **64.1** | **$3,283** | **436.6** | **$59,129** | **$922** | **3.6** |

### 9.3.4 Phase 2 Measurement and Analysis

No additional measures were considered for implementation in this facility in Phase 2.

# 10 Energy and GHG Reduction Pathway for Eight Buildings

## 10.1 Energy Rates & Emission Intensity Factors

The scope of this study is to present a pathway for the TOA to reduce cumulative carbon emissions by 50% by 2033, Phase 1, and by 80% by 2043, Phase 2. The study is comprised of eight buildings, which are listed in no particular order in Table 10.1, as well as their baseline energy usage. The baseline energy usage was determined using the January/December 2022 year. This year was selected for the baseline as it was determined that this would more accurately depict each facility's regular operations and energy usage after the COVID-19 pandemic.

**Table 10.1: Baseline Energy Consumption January/December 2022 for each of the Eight Facilities**

| Facility | Electricity Consumption (kWh) | Heating Oil Consumption (L) | Propane Consumption (L) |
|---|---|---|---|
| Antigonish Arena | 532,800 | 36,775 | 4,310 |
| Columbus Field Washrooms | 7,111 | 0 | 0 |
| Antigonish Fire Hall | 14,685 | 12,925 | 0 |
| Antigonish Town and County Library | 202,490 | 0 | 0 |
| Antigonish Public Works/Electric Utility | 74,927 | 17,777 | 0 |
| Antigonish WWTP | 1,553,220 | 0 | 0 |
| Antigonish Town Hall | 55,040 | 17,411 | 0 |
| Antigonish WTP | 269,444 | 43,694 | 0 |

All electricity is provided by the Antigonish Electric Utility with the exception of the Antigonish Water Treatment Plant, which uses NSPI, and the Antigonish Town and County library which has a solar array with an estimated production of 3,690 kWh per year.

The annual carbon emissions for each building and the natural decarbonization of the facilities as both electric grid's emission intensities reduce over time are presented in Figure 10.1.

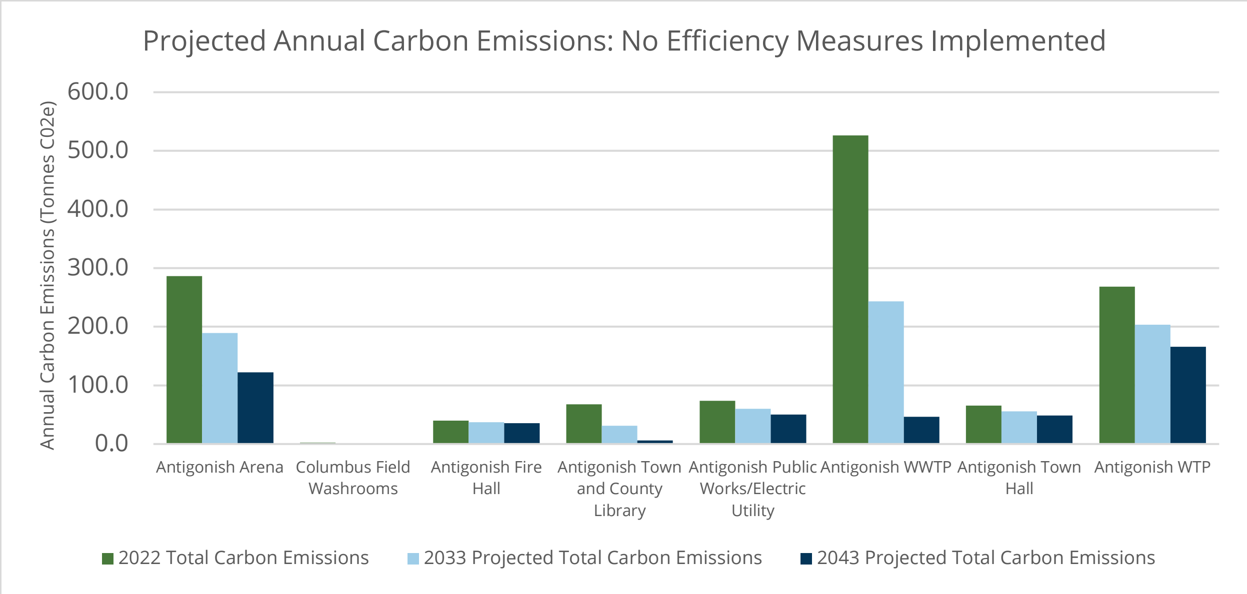


**Figure 10.1: Baseline and Projected Annual Carbon Emissions for each of the Eight Facilities**

A breakdown of the percentage of the total carbon emissions each building contributes to the overall total emissions and a projection of how percentages will change over time is presented in Figure 10.2.

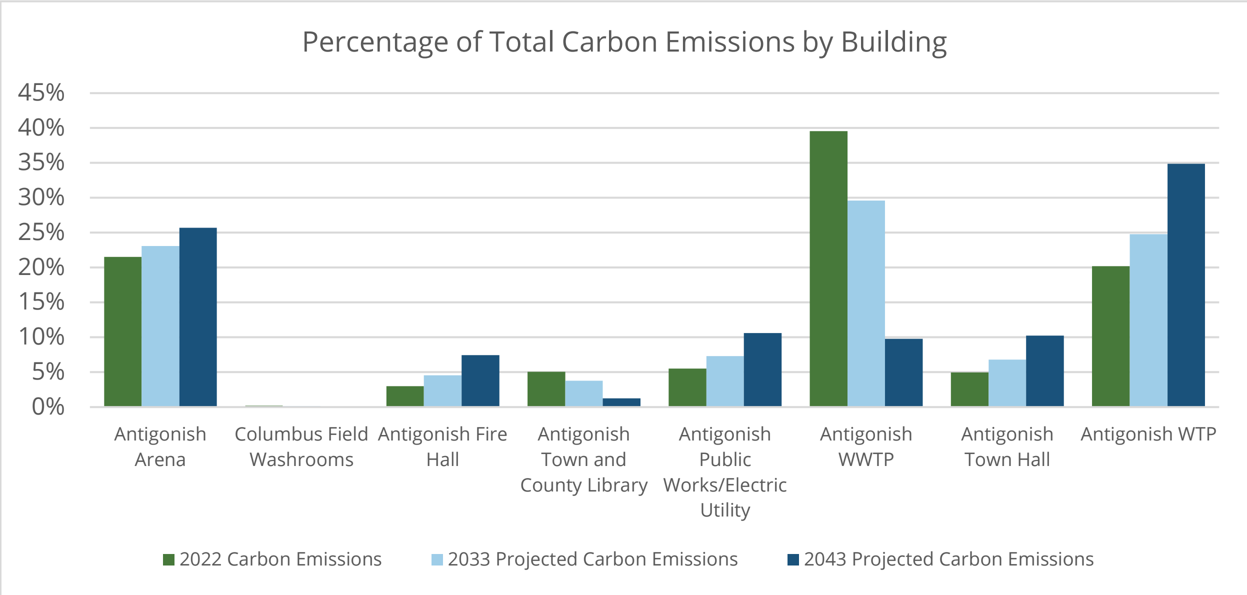


**Figure 10.2: Baseline and Projected Percentage of Total Carbon Emissions for each of the Eight Facilities**

The total baseline carbon emissions for the Town of Antigonish, for the facilities included in this study, as well as how they decrease by the end of Phase 1 and Phase 2 are presented in Table 10.2.

**Table 10.2: Total Emissions by Source for all Eight Buildings**

| Energy Source | 2022 Energy Usage (GJ) | 2022 Emissions (tonnes) | 2033 Projected Emissions (tonnes) | 2043 Projected Emissions |
|---|---|---|---|---|
| Antigonish Electric | 8771.7 | 825.3 | 381.3 | 73.1 |
| NSPI | 970.0 | 150.1 | 85.3 | 47.4 |
| PV System | 13.3 | 0.17 | 0.17 | 0.17 |
| Heating Oil | 4951.6 | 348.3 | 348.3 | 348.3 |
| Propane | 109.7 | 6.6 | 6.6 | 6.6 |
| **Total** | **14,816.3** | **1,330.5** | **821.4** | **475.6** |

The total baseline energy consumption, January-December 2022, is 14,816.3 GJ annually and results in carbon emissions of 1330.5 tonnes per year based on 2022 emissions factors. The carbon emission intensity of the electric grid and fossil fuels are projected to decrease during the lifespan of this study. Table 10.2 shows the projected annual emission without the implementation of any energy conservation measures. Compared to the baseline, emissions are expected to decrease by 38.3% and 64.3% by 2033 and 2043, respectively.

The emission targets for the end of Phases 1 and 2 are a 50% and 80% reduction from 2022 values. This will be an annual emission of 665.3 and 266.1 tonnes $CO_2e$ by 2033 and 2043, respectively. Considering the natural reduction that will occur over this time period, the implementation of energy efficiency measures will need to reduce carbon emissions by 156.3 tonnes in Phase 1 and 209.4 tonnes in Phase 2 to meet emissions targets as shown in Figure 10.3.

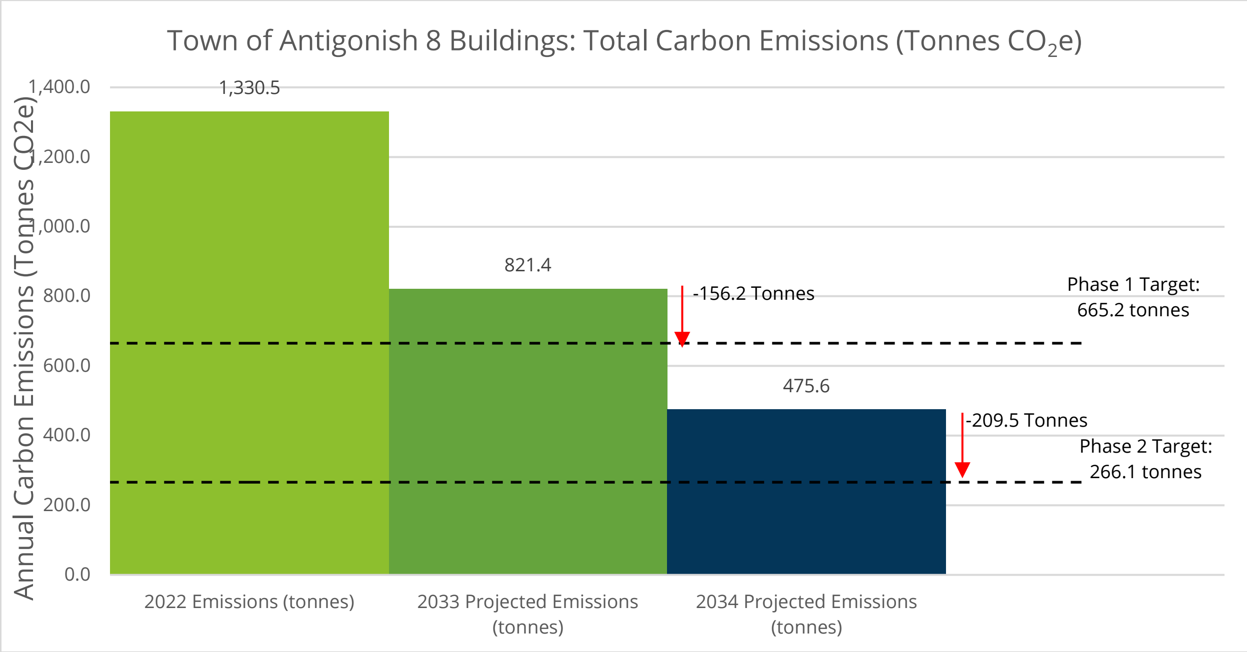


**Figure 10.3: Eight Buildings Total Annual Carbon Emissions compared to Phase 1 and 2 Targets**

The following list includes all the assumptions and variables considered for the technical and financial analysis:

- Cost of Electricity:
  - Antigonish Arena: $0.1258/kWh
  - Columbus Field Washrooms: $0.2667/kWh
  - Antigonish Fire Hall: $0.1745/kWh
  - Antigonish Town and County Library: $0.1467/kWh
  - Antigonish Public Works/Electric Utility: $0.1476/kWh
  - Antigonish WWTP: $0.1268/kWh
  - Antigonish Town Hall: $0.1541/kWh
  - Antigonish WTP: $0.1775/kWh
- Cost of Heating Oil: $1.79/L
- Cost of Propane:
  - Antigonish Arena (Heating): $0.80/L
  - Antigonish Arena (Ice Resurfacer): $0.97/L
  - Antigonish WTP: $0.64/L
- Antigonish Electric GHG Emission Intensity Factor 2022: 0.3387 $CO_2$e kg/kWh[48]
- Antigonish Electric GHG Emission Intensity Factor 2033: 0.1565 $CO_2$e kg/kWh
- Antigonish Electric GHG Emission Intensity Factor 2043: 0.0300 $CO_2$e kg/kWh
- NSPI GHG Emission Intensity Factor 2022: 0.5572 $CO_2$e kg/kWh[48]
- NSPI Electric GHG Emission Intensity Factor 2033: 0.3164 $CO_2$e kg/kWh[48]
- NSPI Electric GHG Emission Intensity Factor 2043: 0.1760 $CO_2$e kg/kWh[48]
- PV Electricity GHG Emission Intensity[49]: 0.046 $CO_2$e kg/kWh
- Heating Oil GHG Emission Intensity Factor: 2.71 $CO_2$e kg/L
- Propane GHG Emission Intensity Factor: 1.52 $CO_2$e kg/L

### 10.1.1 Phase 1 Measurement and Analysis

When considering the implementation of Phase 1 reduction measures, the total emissions for each building are presented in Table 10.3. A cumulative natural reduction of emissions of 508.9 tonnes can be observed, and an additional 211.1 tonnes can be attributed to the addition energy conservation measures implemented in Phase 1. The total annual emissions for all eight buildings are 610.5 tonnes, with an emissions reduction of 54.1% compared to the baseline.

[48] Source: Air Emissions Reporting| Nova Scotia Power (nspower.ca). Retrieved: 2023-04-01
[49] Source: Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics (Fact Sheet), NREL (National Renewable Energy Laboratory). Retrieved 2023-11-20

**Table 10.3: Town of Antigonish Phase 1 Emission Reductions Summary**

| Building | 2022 Baseline Emissions (Tonnes) | Natural Emission Reductions (Tonnes) - No ECMs Implemented | Phase 1 ECM Emissions Reductions (Tonnes) | 2033 Building Emissions After ECMs | Emissions Saved % |
|---|---|---|---|---|---|
| Antigonish Arena | 286.7 | 97.1 | 61.8 | 127.8 | 55.4% |
| Columbus Field Washroom | 2.4 | 1.3 | 0.6 | 0.6 | 77.1% |
| Antigonish Fire Hall | 40.0 | 2.7 | 11.6 | 25.7 | 35.7% |
| Antigonish Library | 67.3 | 36.2 | 8.2 | 22.9 | 66.0% |
| Public Works/ Electric Utility | 73.6 | 13.7 | 27.4 | 32.5 | 55.7% |
| WW Treatment Plant | 526.1 | 283.0 | 3.1 | 240.0 | 54.4% |
| Antigonish Town Hall | 65.8 | 10.0 | 34.3 | 21.5 | 67.4% |
| Water Treatment Plant | 268.5 | 64.9 | 64.1 | 139.5 | 48.0% |
| **Totals** | **1330.5** | **508.9** | **211.1** | **610.5** | **54.1%** |

The total capital cost to implement Phase 1 measures, as well as cost savings is presented in Table 10.4. The total estimated capital cost to implement Phase 1 will be $1,531,686. This will have a cost savings of approximately $142,098 per year. Based on this, Phase 1 will have a simple payback period of 10.8 years.

**Table 10.4: Town of Antigonish Phase 1 Capital Cost and Simple Payback Summary**

| Building | CAPEX | CAPEX/Phase 1 ECM GHG Reduction ($tonne) | Energy Savings (GJ) | Cost Savings | Simple Payback Period |
|---|---|---|---|---|---|
| Antigonish Arena | $350,125 | $5,665 | 594.6 | $36,929 | 9.5 |
| Columbus Field Washroom | $2,060 | $3,668 | 12.9 | $973 | 2.1 |
| Antigonish Fire Hall | $195,060 | $16,820 | 132.4 | $6,147 | 31.7 |
| Antigonish Library | $8,000 | $991 | 185.7 | $5,867 | 1.4 |
| Public Works/Electric Utility | $227,822 | $8,329 | 218.0 | $12,363 | 18.4 |
| WW Treatment Plant | $213,780 | $69,445 | 70.8 | $2,530 | 84.5 |
| Antigonish Town Hall | $331,610 | $9,655 | 357.0 | $18,159 | 18.3 |
| Water Treatment Plant | $210,565 | $3,283 | 436.6 | $59,129 | 3.6 |
| **Totals** | **$7,240** | **2008.0** | **$142,098** | **10.8** | **$7,240** |

### 10.1.2 Phase 2 Measurement and Analysis

When considering the implementation of Phase 2 reduction measures, the total emissions savings for each building are presented in Table 10.5. A cumulative natural reduction of emissions of 854.9 tonnes can be observed, and an additional 280.5 tonnes can be attributed to the addition energy conservation measures implemented in Phase 1. Phase 2 efficiency measures result in an additional savings of 4.0 tonnes. The total annual emissions for all eight buildings are 191.1 tonnes with an emissions reduction of 85.6% compared to the baseline.

Without the additional implementation of phase 2 measures, it is expected that the target emission reduction of 80% would be met. However, considering that the estimated emission intensity factors for 2033 and 2043 are based on the ability of utilities and fossil fuel emission reductions to meet emissions targets it is recommended that these measures be implemented regardless. Additionally, the measures recommended for phase 2 are the upgrade of existing equipment that will be at the end of its useful service life during this time period, it is recommend these should be upgraded to more efficient versions when replaced.

**Table 10.5: Town of Antigonish Phase 2 Emission Reductions Summary**

| Building | 2022 Baseline Emissions (Tonnes) | Natural Emission Reductions (Tonnes) – No ECMs Implemented | Phase 1 ECM Emissions Reductions (Tonnes) | Phase 2 ECM Emissions Reductions (Tonnes) | 2043 Building Emissions After ECMs | Emissions Saved % |
|---|---|---|---|---|---|---|
| Antigonish Arena | 286.7 | 164.5 | 87.3 | 3.8 | 31.1 | 89.2% |
| Columbus Field Washrooms | 2.4 | 2.2 | 0.1 | 0.01 | 0.1 | 96.1% |
| Antigonish Fire Hall | 40.0 | 4.5 | 14.6 | 0.0 | 20.8 | 47.9% |
| Antigonish Library | 67.4 | 61.4 | 1.5 | 0.0 | 4.4 | 93.4% |
| Public Works/ Electric Utility | 73.6 | 23.1 | 43.1 | 0.2 | 7.2 | 90.2% |
| WW Treatment Plant | 526.1 | 479.5 | 0.6 | 0.0 | 46.0 | 91.3% |
| Antigonish Town Hall | 65.8 | 17.0 | 46.4 | 0.0 | 2.4 | 96.3% |
| Water Treatment Plant | 268.5 | 102.7 | 86.9 | 0.0 | 79.0 | 70.6% |
| **Totals** | **1330.5** | **854.9** | **280.5** | **4.0** | **191.1** | **85.6%** |

The total capital cost and cost savings for each building are presented in Table 10.6. The total estimated capital cost to implement Phase 2 will be $243,500. This will have a cost savings of approximately $2,245/year. Based on this, Phase 2 will have a simple payback period of 108.5 years.

**Table 10.6: Town of Antigonish Phase 2 Capital Cost and Simple Payback Summary**

| Building | CAPEX | CAPEX/Phase 2 ECM GHG Reduction ($/tonne) | Energy Savings (GJ) | Cost Savings | Simple Payback Period |
|---|---|---|---|---|---|
| Antigonish Arena | $190,000 | $49,906 | 29.8 | $1,254 | 152 |
| Columbus Field Washroom | $6,000 | $547,945 | 1.3 | $97 | $62 |
| Antigonish Fire Hall | $34,500 | $936,980 | 2.1 | 102.4 | 336.8 |
| Antigonish Library | $0 | $0 | 0.0 | 0.0 | 0.0 |
| Public Works/ Electric Utility | $13,000 | $80,846 | 19.3 | 791.1 | 16.4 |
| WW Treatment Plant | $0 | $0 | 0.0 | 0.0 | 0.0 |
| Antigonish Town Hall | $0 | $0 | 0.0 | 0.0 | 0.0 |
| Water Treatment Plant | $0 | $0 | 0.0 | 0.0 | 0.0 |
| **Totals** | **$243,500** | **$60,636** | **52.5** | **2245** | **108.5** |

# 11 Life Cycle Cost Assessment

The life cycle cost analysis (LCCA) includes annual O&M costs and replacement costs for major building components and equipment over a 30-year assessment horizon. The analysis parameters considered in the LCCA development are presented below:

- LCCA Term (Years): 30 Years
- Debt (%): 100%
- Equity (%): 0%
- Loan Term (Years): 30 Years
- Loan Amortization Every Month: 1
- Interest Rate: 4.5%
- Discount Rate: 3.75%
- Inflation Rate (Operation and Maintenance Cost): 2.0%
- Construction Cost Inflation: 3.5%
- Antigonish Electric Utility Inflation 4.1%
- NSPI Electric Utility Inflation 4.1%
- Heating Oil Inflation 10.9%
- Propane Inflation 10.9%
- Carbon Tax**:** $50/ton in 2022, increased by $15/ton/yr until 2030. Then, assuming $300/ton in 2050. Lineal increased is assumed.
- Cost of Electricity:
  - Antigonish Arena: $0.1258/kWh
  - Columbus Field Washrooms: $0.2667/kWh
  - Antigonish Fire Hall: $0.1745/kWh
  - Antigonish Town and County Library: $0.1467/kWh
  - Antigonish Public Works/Electric Utility: $0.1476/kWh
  - Antigonish WWTP: $0.1268/kWh
  - Antigonish Town Hall: $0.1541/kWh
  - Antigonish WTP: $0.1775/kWh
  - NSPI Electricity PV: $0.10521/kWh
- Cost of Heating Oil: $1.79/L
- Cost of Propane:
  - Antigonish Arena (Heating): $0.8/L
  - Antigonish Arena (Ice Resurfacer): $0.97/L
  - Antigonish WTP: $0.64

- Antigonish Electric GHG Emission Intensity Factor 2022: 0.3387 $CO_2e$ kg/kWh[50]
- Antigonish Electric GHG Emission Intensity Factor 2033: 0.1565 $CO_2e$ kg/kWh
- Antigonish Electric GHG Emission Intensity Factor 2043: 0.0300 $CO_2e$ kg/kWh
- NSPI GHG Emission Intensity Factor 2022: 0.5572 $CO_2e$ kg/kWh[50]
- NSPI GHG Emission Intensity Factor 2033: 0.3164 $CO_2e$ kg/kWh[50]
- NSPI GHG Emission Intensity Factor 2043: 0.1760 $CO_2e$ kg/kWh
- PV Electricity GHG Emission Intensity[51]: 0.040 $CO_2e$ kg/kWh
- Heating Oil GHG Emission Intensity Factor: 2.71 $CO_2e$ kg/L[52]
- Propane GHG Emission Intensity Factor: 1.52 $CO_2e$ kg/L[52]

A list of the equipment that was considered in the LCCA, as well as its estimated lifespan and replacement costs can be found in Appendix C. The estimated implementation timeline for the efficiency measures listed for Phase 1 and Phase 2 is also presented in Appendix A. This timeline is an estimate and corresponds to when the majority of equipment reaches its end of life. If the equipment fails earlier than expected it is recommended that the implementation of the measure occurs prior to the estimated schedule.

The 30-year LCCA for each of the facilities, as well as the total of all eight buildings included in this study is presented in Table 11.1.

**Table 11.1: 30-Year LCCA for each of the Eight Facilities**

| Building | Baseline (W/O Energy Efficiency Measures) | With Energy Efficiency Measures |
|---|---|---|
| Antigonish Arena | $9,670,125 | $4,221,784 |
| Columbus Field Washrooms | $69,765 | $37,918 |
| Antigonish Fire Hall | $2,471,512 | $1,903,751 |
| Antigonish Town and County Library | $984,459 | $778,060 |
| Antigonish Public Works/Electric Utility | $5,348,272 | $3,103,804 |
| Antigonish Wastewater Treatment Plant | $6,644,684 | $6,688,173 |
| Antigonish Town Hall | $3,778,343 | $1,352,517 |
| Antigonish Water Treatment Plant | $9,408,296 | $5,306,300 |
| **Totals for the Eight Facilities** | **$38,375,455** | **$23,392,306** |

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[50] Source: Air Emissions Reporting | Nova Scotia Power (nspower.ca). Retrieved: 2023-04-01
[51] Source: Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics (Fact Sheet), NREL (National Renewable Energy Laboratory). Retrieved 2023-11-20
[52] Source: Emission Factors for Greenhouse Gas Inventories (epa.gov). Retrieved: 2023-04-01

With the exception of the library and the WTP, the remainder of the facilities show a lower LCC over a 30-year-period, compared to the same building without the implementation of EEMs. Also, for the group of eight buildings with EEMs, the LCC is lower than the baseline LCC. This indicates that the implementation of the recommended EEM/phases will result in a lower operational cost over a 30-year-period.

Differences in the life cycle cost assessments between the baseline and proposed facilities are higher in buildings where switching from to a lower carbon emitting energy source was recommended. This is due to a combination of the inflation rate for fossil fuels being higher than that of electricity, as well as the increase in the carbon tax on building emissions over time.

# 12 Closing

The opinion of probable costs for this study is presented on the basis of experience, qualifications, and best judgement. It has been prepared in accordance with acceptable principles and practices. Sudden market trends, non-competitive bidding situations, unforeseen labour and material adjustments, and the like, are beyond the control of our professional cost estimators. As such, we cannot warrant or guarantee that actual costs and/or savings will not significantly vary from the opinion provided in the preceding sections.

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Reviewed by:
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Senior Project Manager, Energy Services

# APPENDIX A

## Energy Modelling Reports

### Table 1. Annual Costs

| Component | Antigonish Arena: Baseline Building ($) | Antigonish Arena:Pathway ECMs ($) |
|---|---|---|
| Air System Fans | 793 | 793 |
| Cooling | 30,255 | 30,245 |
| Heating | 69,983 | 41,241 |
| Pumps | 19,007 | 19,005 |
| Heat Rejection Fans | 1,560 | 1,560 |
| **HVAC Sub-Total** | **121,597** | **92,843** |
| Lights | 8,992 | 5,099 |
| Electric Equipment | 3,389 | 3,389 |
| Misc. Electric | 165 | 165 |
| Misc. Fuel Use | 0 | 0 |
| **Non-HVAC Sub-Total** | **12,547** | **8,654** |
| **Grand Total** | **134,143** | **101,497** |

### Table 2. Annual Cost per Unit Floor Area

| Component | Antigonish Arena: Baseline Building ($/sqft) | Antigonish Arena:Pathway ECMs ($/sqft) |
|---|---|---|
| Air System Fans | 0.015 | 0.015 |
| Cooling | 0.553 | 0.552 |
| Heating | 1.278 | 0.753 |
| Pumps | 0.347 | 0.347 |
| Heat Rejection Fans | 0.029 | 0.029 |
| **HVAC Sub-Total** | **2.221** | **1.696** |
| Lights | 0.164 | 0.093 |
| Electric Equipment | 0.062 | 0.062 |
| Misc. Electric | 0.003 | 0.003 |
| Misc. Fuel Use | 0.000 | 0.000 |
| **Non-HVAC Sub-Total** | **0.229** | **0.158** |
| **Grand Total** | **2.450** | **1.854** |
| Gross Floor Area (sqft) | 54753.7 | 54753.7 |
| Modeled Floor Area (sqft) | 54753.7 | 54753.7 |

Note: Values in this table are calculated using the Gross Floor Area.

**Table 3. Component Cost as a Percentage of Total Cost**

| Component | Antigonish Arena: Baseline Building (%) | Antigonish Arena:Pathway ECMs (%) |
|---|---|---|
| Air System Fans | 0.6 | 0.8 |
| Cooling | 22.6 | 29.8 |
| Heating | 52.2 | 40.6 |
| Pumps | 14.2 | 18.7 |
| Heat Rejection Fans | 1.2 | 1.5 |
| **HVAC Sub-Total** | **90.6** | **91.5** |
| Lights | 6.7 | 5.0 |
| Electric Equipment | 2.5 | 3.3 |
| Misc. Electric | 0.1 | 0.2 |
| Misc. Fuel Use | 0.0 | 0.0 |
| **Non-HVAC Sub-Total** | **9.4** | **8.5** |
| **Grand Total** | **100.0** | **100.0** |

**Table 1. Annual Costs**

| Component | Antigonish Arena: Baseline Building ($) | Antigonish Arena:Pathway ECMs ($) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 54,324 | 91,217 |
| Natural Gas | 0 | 0 |
| Fuel Oil | 65,504 | 0 |
| Propane | 1,768 | 1,627 |
| Remote HW | 0 | 0 |
| Remote Steam | 0 | 0 |
| Remote CW | 0 | 0 |
| **HVAC Sub-Total** | **121,596** | **92,844** |
| **Non-HVAC Components** | | |
| Electric | 12,547 | 8,654 |
| Natural Gas | 0 | 0 |
| Fuel Oil | 0 | 0 |
| Propane | 0 | 0 |
| Remote HW | 0 | 0 |
| Remote Steam | 0 | 0 |
| **Non-HVAC Sub-Total** | **12,547** | **8,654** |
| **Grand Total** | **134,143** | **101,498** |

### Table 2. Annual Energy Consumption

| Component | Antigonish Arena: Baseline Building | Antigonish Arena:Pathway ECMs |
|---|---|---|
| **HVAC Components** | | |
| Electric (kWh) | 431,825 | 725,097 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (*) | 36,595 | 0 |
| Propane (L) | 1,668 | 1,535 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| Remote CW (na) | 0 | 0 |
| | | |
| **Non-HVAC Components** | | |
| Electric (kWh) | 99,736 | 68,791 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (*) | 0 | 0 |
| Propane (L) | 0 | 0 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| | | |
| **Totals** | | |
| Electric (kWh) | 531,561 | 793,889 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (*) | 36,595 | 0 |
| Propane (L) | 1,668 | 1,535 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| Remote CW (na) | 0 | 0 |

(*) Energy Units differ among Buildings.

### Table 3. Annual Emissions

| Component | Antigonish Arena: Baseline Building | Antigonish Arena:Pathway ECMs |
|---|---|---|
| CO2 Equivalent (lb) | 0 | 0 |

**Table 4. Annual Cost per Unit Floor Area**

| Component | Antigonish Arena: Baseline Building ($/sqft) | Antigonish Arena:Pathway ECMs ($/sqft) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 0.992 | 1.666 |
| Natural Gas | 0.000 | 0.000 |
| Fuel Oil | 1.196 | 0.000 |
| Propane | 0.032 | 0.030 |
| Remote HW | 0.000 | 0.000 |
| Remote Steam | 0.000 | 0.000 |
| Remote CW | 0.000 | 0.000 |
| **HVAC Sub-Total** | **2.221** | **1.696** |
| **Non-HVAC Components** | | |
| Electric | 0.229 | 0.158 |
| Natural Gas | 0.000 | 0.000 |
| Fuel Oil | 0.000 | 0.000 |
| Propane | 0.000 | 0.000 |
| Remote HW | 0.000 | 0.000 |
| Remote Steam | 0.000 | 0.000 |
| **Non-HVAC Sub-Total** | **0.229** | **0.158** |
| **Grand Total** | **2.450** | **1.854** |
| Gross Floor Area (sqft) | 54753.7 | 54753.7 |
| Modeled Floor Area (sqft) | 54753.7 | 54753.7 |

Note: Values in this table are calculated using the Gross Floor Area.

**Table 5. Component Cost as a Percentage of Total Cost**

| Component | Antigonish Arena: Baseline Building (%) | Antigonish Arena:Pathway ECMs (%) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 40.5 | 89.9 |
| Natural Gas | 0.0 | 0.0 |
| Fuel Oil | 48.8 | 0.0 |
| Propane | 1.3 | 1.6 |
| Remote HW | 0.0 | 0.0 |
| Remote Steam | 0.0 | 0.0 |
| Remote CW | 0.0 | 0.0 |
| **HVAC Sub-Total** | **90.6** | **91.5** |
| **Non-HVAC Components** | | |
| Electric | 9.4 | 8.5 |
| Natural Gas | 0.0 | 0.0 |
| Fuel Oil | 0.0 | 0.0 |
| Propane | 0.0 | 0.0 |
| Remote HW | 0.0 | 0.0 |
| Remote Steam | 0.0 | 0.0 |
| **Non-HVAC Sub-Total** | **9.4** | **8.5** |
| **Grand Total** | **100.0** | **100.0** |

# Annual Cost Summary

Project: Antigonish- Columbus Field Washrooms 02/02/2024

Prepared by: CBCL Limited 4:08 PM

**Table 1. Annual Costs**

| Component | Columbus Field Washrooms Baseline ($) | Columbus Field Washrooms ECM Heat Off ($) |
|---|---|---|
| Air System Fans | 0 | 0 |
| Cooling | 0 | 0 |
| Heating | 2,294 | 940 |
| Pumps | 0 | 0 |
| Heat Rejection Fans | 0 | 0 |
| **HVAC Sub-Total** | **2,294** | **940** |
| Lights | 486 | 486 |
| Electric Equipment | 52 | 52 |
| Misc. Electric | 0 | 0 |
| Misc. Fuel Use | 0 | 0 |
| **Non-HVAC Sub-Total** | **538** | **538** |
| **Grand Total** | **2,832** | **1,478** |

**Table 2. Annual Cost per Unit Floor Area**

| Component | Columbus Field Washrooms Baseline ($/sqft) | Columbus Field Washrooms ECM Heat Off ($/sqft) |
|---|---|---|
| Air System Fans | 0.000 | 0.000 |
| Cooling | 0.000 | 0.000 |
| Heating | 1.896 | 0.777 |
| Pumps | 0.000 | 0.000 |
| Heat Rejection Fans | 0.000 | 0.000 |
| **HVAC Sub-Total** | **1.896** | **0.777** |
| Lights | 0.402 | 0.402 |
| Electric Equipment | 0.043 | 0.043 |
| Misc. Electric | 0.000 | 0.000 |
| Misc. Fuel Use | 0.000 | 0.000 |
| **Non-HVAC Sub-Total** | **0.445** | **0.445** |
| **Grand Total** | **2.341** | **1.221** |
| Gross Floor Area (sqft) | 1209.7 | 1209.7 |
| Modeled Floor Area (sqft) | 1209.7 | 1209.7 |

Note: Values in this table are calculated using the Gross Floor Area.

**Table 3. Component Cost as a Percentage of Total Cost**

| Component | Columbus Field Washrooms Baseline (%) | Columbus Field Washrooms ECM Heat Off (%) |
|---|---|---|
| Air System Fans | 0.0 | 0.0 |
| Cooling | 0.0 | 0.0 |
| Heating | 81.0 | 63.6 |
| Pumps | 0.0 | 0.0 |
| Heat Rejection Fans | 0.0 | 0.0 |
| **HVAC Sub-Total** | **81.0** | **63.6** |
| Lights | 17.2 | 32.9 |
| Electric Equipment | 1.8 | 3.5 |
| Misc. Electric | 0.0 | 0.0 |
| Misc. Fuel Use | 0.0 | 0.0 |
| **Non-HVAC Sub-Total** | **19.0** | **36.4** |
| **Grand Total** | **100.0** | **100.0** |

**Table 1. Annual Costs**

| Component | Columbus Field Washrooms Baseline ($) | Columbus Field Washrooms ECM Heat Off ($) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 2,294 | 940 |
| Natural Gas | 0 | 0 |
| Fuel Oil | 0 | 0 |
| Propane | 0 | 0 |
| Remote HW | 0 | 0 |
| Remote Steam | 0 | 0 |
| Remote CW | 0 | 0 |
| **HVAC Sub-Total** | **2,294** | **940** |
| **Non-HVAC Components** | | |
| Electric | 538 | 538 |
| Natural Gas | 0 | 0 |
| Fuel Oil | 0 | 0 |
| Propane | 0 | 0 |
| Remote HW | 0 | 0 |
| Remote Steam | 0 | 0 |
| **Non-HVAC Sub-Total** | **538** | **538** |
| **Grand Total** | **2,832** | **1,478** |

**Table 2. Annual Energy Consumption**

| Component | Columbus Field Washrooms Baseline | Columbus Field Washrooms ECM Heat Off |
|---|---|---|
| **HVAC Components** | | |
| Electric (kWh) | 8,600 | 3,523 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (na) | 0 | 0 |
| Propane (na) | 0 | 0 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| Remote CW (na) | 0 | 0 |
| | | |
| **Non-HVAC Components** | | |
| Electric (kWh) | 2,018 | 2,018 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (na) | 0 | 0 |
| Propane (na) | 0 | 0 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| | | |
| **Totals** | | |
| Electric (kWh) | 10,618 | 5,540 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (na) | 0 | 0 |
| Propane (na) | 0 | 0 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| Remote CW (na) | 0 | 0 |

**Table 3. Annual Emissions**

| Component | Columbus Field Washrooms Baseline | Columbus Field Washrooms ECM Heat Off |
|---|---|---|
| CO2 Equivalent (lb) | 17,731 | 9,252 |

### Table 4. Annual Cost per Unit Floor Area

| Component | Columbus Field Washrooms Baseline ($/sqft) | Columbus Field Washrooms ECM Heat Off ($/sqft) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 1.896 | 0.777 |
| Natural Gas | 0.000 | 0.000 |
| Fuel Oil | 0.000 | 0.000 |
| Propane | 0.000 | 0.000 |
| Remote HW | 0.000 | 0.000 |
| Remote Steam | 0.000 | 0.000 |
| Remote CW | 0.000 | 0.000 |
| **HVAC Sub-Total** | **1.896** | **0.777** |
| **Non-HVAC Components** | | |
| Electric | 0.445 | 0.445 |
| Natural Gas | 0.000 | 0.000 |
| Fuel Oil | 0.000 | 0.000 |
| Propane | 0.000 | 0.000 |
| Remote HW | 0.000 | 0.000 |
| Remote Steam | 0.000 | 0.000 |
| **Non-HVAC Sub-Total** | **0.445** | **0.445** |
| **Grand Total** | **2.341** | **1.221** |
| Gross Floor Area (sqft) | 1209.7 | 1209.7 |
| Modeled Floor Area (sqft) | 1209.7 | 1209.7 |

Note: Values in this table are calculated using the Gross Floor Area.

### Table 5. Component Cost as a Percentage of Total Cost

| Component | Columbus Field Washrooms Baseline (%) | Columbus Field Washrooms ECM Heat Off (%) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 81.0 | 63.6 |
| Natural Gas | 0.0 | 0.0 |
| Fuel Oil | 0.0 | 0.0 |
| Propane | 0.0 | 0.0 |
| Remote HW | 0.0 | 0.0 |
| Remote Steam | 0.0 | 0.0 |
| Remote CW | 0.0 | 0.0 |
| **HVAC Sub-Total** | **81.0** | **63.6** |
| **Non-HVAC Components** | | |
| Electric | 19.0 | 36.4 |
| Natural Gas | 0.0 | 0.0 |
| Fuel Oil | 0.0 | 0.0 |
| Propane | 0.0 | 0.0 |
| Remote HW | 0.0 | 0.0 |
| Remote Steam | 0.0 | 0.0 |
| **Non-HVAC Sub-Total** | **19.0** | **36.4** |
| **Grand Total** | **100.0** | **100.0** |

# Annual Cost Summary

Project: Antigonish Fire Hall Model-Calibrated 02/02/2024
Prepared by: CBCL Limited 1:52 PM

### Table 1. Annual Costs

| Component | Antigonish Firehall Baseline Model ($) | Antigonish Firehall-Phase 1 ECMs ($) | Antigonish Firehall-Phase 2 ECMs ($) |
|---|---|---|---|
| Air System Fans | 332 | 491 | 490 |
| Cooling | 0 | 140 | 141 |
| Heating | 22,453 | 16,822 | 16,719 |
| Pumps | 623 | 602 | 602 |
| Heat Rejection Fans | 0 | 0 | 0 |
| **HVAC Sub-Total** | **23,408** | **18,055** | **17,953** |
| Lights | 713 | 255 | 255 |
| Electric Equipment | 378 | 378 | 378 |
| Misc. Electric | 459 | 459 | 459 |
| Misc. Fuel Use | 0 | 0 | 0 |
| **Non-HVAC Sub-Total** | **1,550** | **1,091** | **1,091** |
| **Grand Total** | **24,957** | **19,146** | **19,044** |

### Table 2. Annual Cost per Unit Floor Area

| Component | Antigonish Firehall Baseline Model ($/sqft) | Antigonish Firehall-Phase 1 ECMs ($/sqft) | Antigonish Firehall-Phase 2 ECMs ($/sqft) |
|---|---|---|---|
| Air System Fans | 0.042 | 0.062 | 0.062 |
| Cooling | 0.000 | 0.018 | 0.018 |
| Heating | 2.826 | 2.117 | 2.104 |
| Pumps | 0.079 | 0.076 | 0.076 |
| Heat Rejection Fans | 0.000 | 0.000 | 0.000 |
| **HVAC Sub-Total** | **2.946** | **2.273** | **2.260** |
| Lights | 0.090 | 0.032 | 0.032 |
| Electric Equipment | 0.048 | 0.048 | 0.048 |
| Misc. Electric | 0.058 | 0.058 | 0.058 |
| Misc. Fuel Use | 0.000 | 0.000 | 0.000 |
| **Non-HVAC Sub-Total** | **0.195** | **0.137** | **0.137** |
| **Grand Total** | **3.141** | **2.410** | **2.397** |
| Gross Floor Area (sqft) | 7944.8 | 7944.8 | 7944.8 |
| Modeled Floor Area (sqft) | 7944.8 | 7944.8 | 7944.8 |

Note: Values in this table are calculated using the Gross Floor Area.

**Table 3. Component Cost as a Percentage of Total Cost**

| Component | Antigonish Firehall Baseline Model (%) | Antigonish Firehall-Phase 1 ECMs (%) | Antigonish Firehall-Phase 2 ECMs (%) |
|---|---|---|---|
| Air System Fans | 1.3 | 2.6 | 2.6 |
| Cooling | 0.0 | 0.7 | 0.7 |
| Heating | 90.0 | 87.9 | 87.8 |
| Pumps | 2.5 | 3.1 | 3.2 |
| Heat Rejection Fans | 0.0 | 0.0 | 0.0 |
| **HVAC Sub-Total** | **93.8** | **94.3** | **94.3** |
| Lights | 2.9 | 1.3 | 1.3 |
| Electric Equipment | 1.5 | 2.0 | 2.0 |
| Misc. Electric | 1.8 | 2.4 | 2.4 |
| Misc. Fuel Use | 0.0 | 0.0 | 0.0 |
| **Non-HVAC Sub-Total** | **6.2** | **5.7** | **5.7** |
| **Grand Total** | **100.0** | **100.0** | **100.0** |

**Table 1. Annual Costs**

| Component | Antigonish Firehall Baseline Model ($) | Antigonish Firehall-Phase 1 ECMs ($) | Antigonish Firehall-Phase 2 ECMs ($) |
|---|---|---|---|
| **HVAC Components** | | | |
| Electric | 955 | 5,703 | 5,615 |
| Natural Gas | 0 | 0 | 0 |
| Fuel Oil | 22,453 | 12,352 | 12,338 |
| Propane | 0 | 0 | 0 |
| Remote HW | 0 | 0 | 0 |
| Remote Steam | 0 | 0 | 0 |
| Remote CW | 0 | 0 | 0 |
| **HVAC Sub-Total** | **23,408** | **18,055** | **17,953** |
| **Non-HVAC Components** | | | |
| Electric | 1,550 | 1,091 | 1,091 |
| Natural Gas | 0 | 0 | 0 |
| Fuel Oil | 0 | 0 | 0 |
| Propane | 0 | 0 | 0 |
| Remote HW | 0 | 0 | 0 |
| Remote Steam | 0 | 0 | 0 |
| **Non-HVAC Sub-Total** | **1,550** | **1,091** | **1,091** |
| **Grand Total** | **24,957** | **19,146** | **19,044** |

**Table 2. Annual Energy Consumption**

| Component | Antigonish Firehall Baseline Model | Antigonish Firehall-Phase 1 ECMs | Antigonish Firehall-Phase 2 ECMs |
|---|---|---|---|
| **HVAC Components** | | | |
| Electric (kWh) | 5,474 | 32,681 | 32,176 |
| Natural Gas (na) | 0 | 0 | 0 |
| Fuel Oil (Litre) | 12,543 | 6,901 | 6,893 |
| Propane (na) | 0 | 0 | 0 |
| Remote HW (na) | 0 | 0 | 0 |
| Remote Steam (na) | 0 | 0 | 0 |
| Remote CW (na) | 0 | 0 | 0 |
| | | | |
| **Non-HVAC Components** | | | |
| Electric (kWh) | 8,880 | 6,255 | 6,255 |
| Natural Gas (na) | 0 | 0 | 0 |
| Fuel Oil (Litre) | 0 | 0 | 0 |
| Propane (na) | 0 | 0 | 0 |
| Remote HW (na) | 0 | 0 | 0 |
| Remote Steam (na) | 0 | 0 | 0 |
| | | | |
| **Totals** | | | |
| Electric (kWh) | 14,354 | 38,935 | 38,430 |
| Natural Gas (na) | 0 | 0 | 0 |
| Fuel Oil (Litre) | 12,543 | 6,901 | 6,893 |
| Propane (na) | 0 | 0 | 0 |
| Remote HW (na) | 0 | 0 | 0 |
| Remote Steam (na) | 0 | 0 | 0 |
| Remote CW (na) | 0 | 0 | 0 |

**Table 3. Annual Emissions**

| Component | Antigonish Firehall Baseline Model | Antigonish Firehall-Phase 1 ECMs | Antigonish Firehall-Phase 2 ECMs |
|---|---|---|---|
| CO2 Equivalent (lb) | 0 | 0 | 0 |

**Table 4. Annual Cost per Unit Floor Area**

| Component | Antigonish Firehall Baseline Model ($/sqft) | Antigonish Firehall-Phase 1 ECMs ($/sqft) | Antigonish Firehall-Phase 2 ECMs ($/sqft) |
|---|---|---|---|
| **HVAC Components** | | | |
| Electric | 0.120 | 0.718 | 0.707 |
| Natural Gas | 0.000 | 0.000 | 0.000 |
| Fuel Oil | 2.826 | 1.555 | 1.553 |
| Propane | 0.000 | 0.000 | 0.000 |
| Remote HW | 0.000 | 0.000 | 0.000 |
| Remote Steam | 0.000 | 0.000 | 0.000 |
| Remote CW | 0.000 | 0.000 | 0.000 |
| **HVAC Sub-Total** | **2.946** | **2.273** | **2.260** |
| **Non-HVAC Components** | | | |
| Electric | 0.195 | 0.137 | 0.137 |
| Natural Gas | 0.000 | 0.000 | 0.000 |
| Fuel Oil | 0.000 | 0.000 | 0.000 |
| Propane | 0.000 | 0.000 | 0.000 |
| Remote HW | 0.000 | 0.000 | 0.000 |
| Remote Steam | 0.000 | 0.000 | 0.000 |
| **Non-HVAC Sub-Total** | **0.195** | **0.137** | **0.137** |
| **Grand Total** | **3.141** | **2.410** | **2.397** |
| Gross Floor Area (sqft) | 7944.8 | 7944.8 | 7944.8 |
| Modeled Floor Area (sqft) | 7944.8 | 7944.8 | 7944.8 |

Note: Values in this table are calculated using the Gross Floor Area.

**Table 5. Component Cost as a Percentage of Total Cost**

| Component | Antigonish Firehall Baseline Model (%) | Antigonish Firehall-Phase 1 ECMs (%) | Antigonish Firehall-Phase 2 ECMs (%) |
|---|---|---|---|
| **HVAC Components** | | | |
| Electric | 3.8 | 29.8 | 29.5 |
| Natural Gas | 0.0 | 0.0 | 0.0 |
| Fuel Oil | 90.0 | 64.5 | 64.8 |
| Propane | 0.0 | 0.0 | 0.0 |
| Remote HW | 0.0 | 0.0 | 0.0 |
| Remote Steam | 0.0 | 0.0 | 0.0 |
| Remote CW | 0.0 | 0.0 | 0.0 |
| **HVAC Sub-Total** | **93.8** | **94.3** | **94.3** |
| **Non-HVAC Components** | | | |
| Electric | 6.2 | 5.7 | 5.7 |
| Natural Gas | 0.0 | 0.0 | 0.0 |
| Fuel Oil | 0.0 | 0.0 | 0.0 |
| Propane | 0.0 | 0.0 | 0.0 |
| Remote HW | 0.0 | 0.0 | 0.0 |
| Remote Steam | 0.0 | 0.0 | 0.0 |
| **Non-HVAC Sub-Total** | **6.2** | **5.7** | **5.7** |
| **Grand Total** | **100.0** | **100.0** | **100.0** |

# Annual Cost Summary

Project: 237554.00 - Antigonish - Library
Prepared by: CBCL Limited

02/02/2024
1:53 PM

### Table 1. Annual Costs

| Component | Antigonish Library- Baseline ($) | Antigonish Library- NTSB ($) |
|---|---|---|
| Air System Fans | 2,919 | 1,151 |
| Cooling | 1,483 | 1,267 |
| Heating | 9,290 | 6,301 |
| Pumps | 2,269 | 1,881 |
| Heat Rejection Fans | 0 | 0 |
| **HVAC Sub-Total** | **15,960** | **10,600** |
| Lights | 6,400 | 6,400 |
| Electric Equipment | 1,774 | 1,774 |
| Misc. Electric | 0 | 0 |
| Misc. Fuel Use | 0 | 0 |
| **Non-HVAC Sub-Total** | **8,174** | **8,174** |
| **Grand Total** | **24,134** | **18,774** |

### Table 2. Annual Cost per Unit Floor Area

| Component | Antigonish Library- Baseline ($/sqft) | Antigonish Library- NTSB ($/sqft) |
|---|---|---|
| Air System Fans | 0.092 | 0.036 |
| Cooling | 0.047 | 0.040 |
| Heating | 0.293 | 0.199 |
| Pumps | 0.072 | 0.059 |
| Heat Rejection Fans | 0.000 | 0.000 |
| **HVAC Sub-Total** | **0.504** | **0.334** |
| Lights | 0.202 | 0.202 |
| Electric Equipment | 0.056 | 0.056 |
| Misc. Electric | 0.000 | 0.000 |
| Misc. Fuel Use | 0.000 | 0.000 |
| **Non-HVAC Sub-Total** | **0.258** | **0.258** |
| **Grand Total** | **0.761** | **0.592** |
| Gross Floor Area (sqft) | 31702.8 | 31702.8 |
| Modeled Floor Area (sqft) | 31702.8 | 31702.8 |

Note: Values in this table are calculated using the Gross Floor Area.

### Table 3. Component Cost as a Percentage of Total Cost

| Component | Antigonish Library- Baseline (%) | Antigonish Library- NTSB (%) |
|---|---|---|
| Air System Fans | 12.1 | 6.1 |
| Cooling | 6.1 | 6.7 |
| Heating | 38.5 | 33.6 |
| Pumps | 9.4 | 10.0 |
| Heat Rejection Fans | 0.0 | 0.0 |
| **HVAC Sub-Total** | **66.1** | **56.5** |
| Lights | 26.5 | 34.1 |
| Electric Equipment | 7.3 | 9.4 |
| Misc. Electric | 0.0 | 0.0 |
| Misc. Fuel Use | 0.0 | 0.0 |
| **Non-HVAC Sub-Total** | **33.9** | **43.5** |
| **Grand Total** | **100.0** | **100.0** |

**Table 1. Annual Costs**

| Component | Antigonish Library- Baseline ($) | Antigonish Library- NTSB ($) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 15,961 | 10,600 |
| Natural Gas | 0 | 0 |
| Fuel Oil | 0 | 0 |
| Propane | 0 | 0 |
| Remote HW | 0 | 0 |
| Remote Steam | 0 | 0 |
| Remote CW | 0 | 0 |
| **HVAC Sub-Total** | **15,961** | **10,600** |
| **Non-HVAC Components** | | |
| Electric | 8,174 | 8,174 |
| Natural Gas | 0 | 0 |
| Fuel Oil | 0 | 0 |
| Propane | 0 | 0 |
| Remote HW | 0 | 0 |
| Remote Steam | 0 | 0 |
| **Non-HVAC Sub-Total** | **8,174** | **8,174** |
| **Grand Total** | **24,135** | **18,774** |

**Table 2. Annual Energy Consumption**

| Component | Antigonish Library- Baseline | Antigonish Library- NTSB |
|---|---|---|
| **HVAC Components** | | |
| Electric (kWh) | 108,801 | 72,259 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (na) | 0 | 0 |
| Propane (na) | 0 | 0 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| Remote CW (na) | 0 | 0 |
| | | |
| **Non-HVAC Components** | | |
| Electric (kWh) | 55,720 | 55,720 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (na) | 0 | 0 |
| Propane (na) | 0 | 0 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| | | |
| **Totals** | | |
| Electric (kWh) | 164,520 | 127,979 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (na) | 0 | 0 |
| Propane (na) | 0 | 0 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| Remote CW (na) | 0 | 0 |

**Table 3. Annual Emissions**

| Component | Antigonish Library- Baseline | Antigonish Library- NTSB |
|---|---|---|
| CO2 Equivalent (lb) | 0 | 0 |

**Table 4. Annual Cost per Unit Floor Area**

| Component | Antigonish Library- Baseline ($/sqft) | Antigonish Library- NTSB ($/sqft) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 0.504 | 0.334 |
| Natural Gas | 0.000 | 0.000 |
| Fuel Oil | 0.000 | 0.000 |
| Propane | 0.000 | 0.000 |
| Remote HW | 0.000 | 0.000 |
| Remote Steam | 0.000 | 0.000 |
| Remote CW | 0.000 | 0.000 |
| **HVAC Sub-Total** | **0.504** | **0.334** |
| **Non-HVAC Components** | | |
| Electric | 0.258 | 0.258 |
| Natural Gas | 0.000 | 0.000 |
| Fuel Oil | 0.000 | 0.000 |
| Propane | 0.000 | 0.000 |
| Remote HW | 0.000 | 0.000 |
| Remote Steam | 0.000 | 0.000 |
| **Non-HVAC Sub-Total** | **0.258** | **0.258** |
| **Grand Total** | **0.761** | **0.592** |
| Gross Floor Area (sqft) | 31702.8 | 31702.8 |
| Modeled Floor Area (sqft) | 31702.8 | 31702.8 |

Note: Values in this table are calculated using the Gross Floor Area.

**Table 5. Component Cost as a Percentage of Total Cost**

| Component | Antigonish Library- Baseline (%) | Antigonish Library- NTSB (%) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 66.1 | 56.5 |
| Natural Gas | 0.0 | 0.0 |
| Fuel Oil | 0.0 | 0.0 |
| Propane | 0.0 | 0.0 |
| Remote HW | 0.0 | 0.0 |
| Remote Steam | 0.0 | 0.0 |
| Remote CW | 0.0 | 0.0 |
| **HVAC Sub-Total** | **66.1** | **56.5** |
| **Non-HVAC Components** | | |
| Electric | 33.9 | 43.5 |
| Natural Gas | 0.0 | 0.0 |
| Fuel Oil | 0.0 | 0.0 |
| Propane | 0.0 | 0.0 |
| Remote HW | 0.0 | 0.0 |
| Remote Steam | 0.0 | 0.0 |
| **Non-HVAC Sub-Total** | **33.9** | **43.5** |
| **Grand Total** | **100.0** | **100.0** |

# Annual Cost Summary

Project: Public Works Electric Utility Energy Model-Calibrated | 02/02/2024
Prepared by: CBCL Limited | 1:54 PM

**Table 1. Annual Costs**

| Component | 0. Public Works/Electric Utility Baseline Model ($) | 1. Phase 1 ECMs Public Works/Electric Utility Model ($) | 2. Phase 2 ECMs Public Works/Electric Utility Model ($) |
|---|---|---|---|
| Air System Fans | 2,076 | 926 | 899 |
| Cooling | 0 | 6 | 7 |
| Heating | 34,258 | 22,879 | 22,114 |
| Pumps | 0 | 0 | 0 |
| Heat Rejection Fans | 0 | 0 | 0 |
| **HVAC Sub-Total** | **36,334** | **23,812** | **23,021** |
| Lights | 1,333 | 1,267 | 1,267 |
| Electric Equipment | 3,702 | 3,702 | 3,702 |
| Misc. Electric | 905 | 905 | 905 |
| Misc. Fuel Use | 0 | 0 | 0 |
| **Non-HVAC Sub-Total** | **5,940** | **5,875** | **5,875** |
| **Grand Total** | **42,274** | **29,686** | **28,895** |

**Table 2. Annual Cost per Unit Floor Area**

| Component | 0. Public Works/Electric Utility Baseline Model ($/sqft) | 1. Phase 1 ECMs Public Works/Electric Utility Model ($/sqft) | 2. Phase 2 ECMs Public Works/Electric Utility Model ($/sqft) |
|---|---|---|---|
| Air System Fans | 0.126 | 0.056 | 0.055 |
| Cooling | 0.000 | 0.000 | 0.000 |
| Heating | 2.081 | 1.390 | 1.343 |
| Pumps | 0.000 | 0.000 | 0.000 |
| Heat Rejection Fans | 0.000 | 0.000 | 0.000 |
| **HVAC Sub-Total** | **2.207** | **1.446** | **1.398** |
| Lights | 0.081 | 0.077 | 0.077 |
| Electric Equipment | 0.225 | 0.225 | 0.225 |
| Misc. Electric | 0.055 | 0.055 | 0.055 |
| Misc. Fuel Use | 0.000 | 0.000 | 0.000 |
| **Non-HVAC Sub-Total** | **0.361** | **0.357** | **0.357** |
| **Grand Total** | **2.568** | **1.803** | **1.755** |
| Gross Floor Area (sqft) | 16464.6 | 16464.6 | 16464.6 |
| Modeled Floor Area (sqft) | 16464.6 | 16464.6 | 16464.6 |

Note: Values in this table are calculated using the Gross Floor Area.

**Table 3. Component Cost as a Percentage of Total Cost**

| Component | 0. Public Works/Electric Utility Baseline Model (%) | 1. Phase 1 ECMs Public Works/Electric Utility Model (%) | 2. Phase 2 ECMs Public Works/Electric Utility Model (%) |
|---|---|---|---|
| Air System Fans | 4.9 | 3.1 | 3.1 |
| Cooling | 0.0 | 0.0 | 0.0 |
| Heating | 81.0 | 77.1 | 76.5 |
| Pumps | 0.0 | 0.0 | 0.0 |
| Heat Rejection Fans | 0.0 | 0.0 | 0.0 |
| **HVAC Sub-Total** | **85.9** | **80.2** | **79.7** |
| Lights | 3.2 | 4.3 | 4.4 |
| Electric Equipment | 8.8 | 12.5 | 12.8 |
| Misc. Electric | 2.1 | 3.0 | 3.1 |
| Misc. Fuel Use | 0.0 | 0.0 | 0.0 |
| **Non-HVAC Sub-Total** | **14.1** | **19.8** | **20.3** |
| **Grand Total** | **100.0** | **100.0** | **100.0** |

**Table 1. Annual Costs**

| Component | 0. Public Works/Electric Utility Baseline Model ($) | 1. Phase 1 ECMs Public Works/Electric Utility Model ($) | 2. Phase 2 ECMs Public Works/Electric Utility Model ($) |
|---|---|---|---|
| **HVAC Components** | | | |
| Electric | 5,420 | 23,812 | 23,021 |
| Natural Gas | 0 | 0 | 0 |
| Fuel Oil | 30,914 | 0 | 0 |
| Propane | 0 | 0 | 0 |
| Remote HW | 0 | 0 | 0 |
| Remote Steam | 0 | 0 | 0 |
| Remote CW | 0 | 0 | 0 |
| **HVAC Sub-Total** | **36,334** | **23,812** | **23,021** |
| **Non-HVAC Components** | | | |
| Electric | 5,940 | 5,874 | 5,874 |
| Natural Gas | 0 | 0 | 0 |
| Fuel Oil | 0 | 0 | 0 |
| Propane | 0 | 0 | 0 |
| Remote HW | 0 | 0 | 0 |
| Remote Steam | 0 | 0 | 0 |
| **Non-HVAC Sub-Total** | **5,940** | **5,874** | **5,874** |
| **Grand Total** | **42,274** | **29,686** | **28,895** |

**Table 2. Annual Energy Consumption**

| Component | 0. Public Works/Electric Utility Baseline Model | 1. Phase 1 ECMs Public Works/Electric Utility Model | 2. Phase 2 ECMs Public Works/Electric Utility Model |
|---|---|---|---|
| **HVAC Components** | | | |
| Electric (kWh) | 36,722 | 161,326 | 155,966 |
| Natural Gas (na) | 0 | 0 | 0 |
| Fuel Oil (*) | 17,271 | 0 | 0 |
| Propane (na) | 0 | 0 | 0 |
| Remote HW (na) | 0 | 0 | 0 |
| Remote Steam (na) | 0 | 0 | 0 |
| Remote CW (na) | 0 | 0 | 0 |
| | | | |
| **Non-HVAC Components** | | | |
| Electric (kWh) | 40,243 | 39,800 | 39,800 |
| Natural Gas (na) | 0 | 0 | 0 |
| Fuel Oil (*) | 0 | 0 | 0 |
| Propane (na) | 0 | 0 | 0 |
| Remote HW (na) | 0 | 0 | 0 |
| Remote Steam (na) | 0 | 0 | 0 |
| | | | |
| **Totals** | | | |
| Electric (kWh) | 76,965 | 201,126 | 195,766 |
| Natural Gas (na) | 0 | 0 | 0 |
| Fuel Oil (*) | 17,271 | 0 | 0 |
| Propane (na) | 0 | 0 | 0 |
| Remote HW (na) | 0 | 0 | 0 |
| Remote Steam (na) | 0 | 0 | 0 |
| Remote CW (na) | 0 | 0 | 0 |

(*) Energy Units differ among Buildings.

**Table 3. Annual Emissions**

| Component | 0. Public Works/Electric Utility Baseline Model | 1. Phase 1 ECMs Public Works/Electric Utility Model | 2. Phase 2 ECMs Public Works/Electric Utility Model |
|---|---|---|---|
| $CO_2$ Equivalent (lb) | 0 | 0 | 0 |

**Table 4. Annual Cost per Unit Floor Area**

| Component | 0. Public Works/Electric Utility Baseline Model ($/sqft) | 1. Phase 1 ECMs Public Works/Electric Utility Model ($/sqft) | 2. Phase 2 ECMs Public Works/Electric Utility Model ($/sqft) |
|---|---|---|---|
| **HVAC Components** | | | |
| Electric | 0.329 | 1.446 | 1.398 |
| Natural Gas | 0.000 | 0.000 | 0.000 |
| Fuel Oil | 1.878 | 0.000 | 0.000 |
| Propane | 0.000 | 0.000 | 0.000 |
| Remote HW | 0.000 | 0.000 | 0.000 |
| Remote Steam | 0.000 | 0.000 | 0.000 |
| Remote CW | 0.000 | 0.000 | 0.000 |
| **HVAC Sub-Total** | **2.207** | **1.446** | **1.398** |
| **Non-HVAC Components** | | | |
| Electric | 0.361 | 0.357 | 0.357 |
| Natural Gas | 0.000 | 0.000 | 0.000 |
| Fuel Oil | 0.000 | 0.000 | 0.000 |
| Propane | 0.000 | 0.000 | 0.000 |
| Remote HW | 0.000 | 0.000 | 0.000 |
| Remote Steam | 0.000 | 0.000 | 0.000 |
| **Non-HVAC Sub-Total** | **0.361** | **0.357** | **0.357** |
| **Grand Total** | **2.568** | **1.803** | **1.755** |
| Gross Floor Area (sqft) | 16464.6 | 16464.6 | 16464.6 |
| Modeled Floor Area (sqft) | 16464.6 | 16464.6 | 16464.6 |

Note: Values in this table are calculated using the Gross Floor Area.

**Table 5. Component Cost as a Percentage of Total Cost**

| Component | 0. Public Works/Electric Utility Baseline Model (%) | 1. Phase 1 ECMs Public Works/Electric Utility Model (%) | 2. Phase 2 ECMs Public Works/Electric Utility Model (%) |
|---|---|---|---|
| **HVAC Components** | | | |
| Electric | 12.8 | 80.2 | 79.7 |
| Natural Gas | 0.0 | 0.0 | 0.0 |
| Fuel Oil | 73.1 | 0.0 | 0.0 |
| Propane | 0.0 | 0.0 | 0.0 |
| Remote HW | 0.0 | 0.0 | 0.0 |
| Remote Steam | 0.0 | 0.0 | 0.0 |
| Remote CW | 0.0 | 0.0 | 0.0 |
| **HVAC Sub-Total** | **85.9** | **80.2** | **79.7** |
| **Non-HVAC Components** | | | |
| Electric | 14.1 | 19.8 | 20.3 |
| Natural Gas | 0.0 | 0.0 | 0.0 |
| Fuel Oil | 0.0 | 0.0 | 0.0 |
| Propane | 0.0 | 0.0 | 0.0 |
| Remote HW | 0.0 | 0.0 | 0.0 |
| Remote Steam | 0.0 | 0.0 | 0.0 |
| **Non-HVAC Sub-Total** | **14.1** | **19.8** | **20.3** |
| **Grand Total** | **100.0** | **100.0** | **100.0** |

# Annual Cost Summary

Project: Antigonish WWTP | 02/02/2024
Prepared by: CBCL Limited | 1:55 PM

**Table 1. Annual Costs**

| Component | Antigonish WWTP-Lab Area ($) | Antigonish WWTP-Lab Area NTSB ($) |
|---|---|---|
| Air System Fans | 0 | 0 |
| Cooling | 0 | 0 |
| Heating | 4,737 | 4,722 |
| Pumps | 0 | 0 |
| Heat Rejection Fans | 0 | 0 |
| **HVAC Sub-Total** | **4,737** | **4,722** |
| Lights | 32 | 32 |
| Electric Equipment | 1 | 1 |
| Misc. Electric | 0 | 0 |
| Misc. Fuel Use | 0 | 0 |
| **Non-HVAC Sub-Total** | **34** | **34** |
| **Grand Total** | **4,771** | **4,756** |

**Table 2. Annual Cost per Unit Floor Area**

| Component | Antigonish WWTP-Lab Area ($/sqft) | Antigonish WWTP-Lab Area NTSB ($/sqft) |
|---|---|---|
| Air System Fans | 0.000 | 0.000 |
| Cooling | 0.000 | 0.000 |
| Heating | 4.381 | 4.368 |
| Pumps | 0.000 | 0.000 |
| Heat Rejection Fans | 0.000 | 0.000 |
| **HVAC Sub-Total** | **4.381** | **4.368** |
| Lights | 0.030 | 0.030 |
| Electric Equipment | 0.001 | 0.001 |
| Misc. Electric | 0.000 | 0.000 |
| Misc. Fuel Use | 0.000 | 0.000 |
| **Non-HVAC Sub-Total** | **0.031** | **0.031** |
| **Grand Total** | **4.412** | **4.399** |
| Gross Floor Area (sqft) | 1081.2 | 1081.2 |
| Modeled Floor Area (sqft) | 1081.2 | 1081.2 |

Note: Values in this table are calculated using the Gross Floor Area.

**Table 3. Component Cost as a Percentage of Total Cost**

| Component | Antigonish WWTP-Lab Area (%) | Antigonish WWTP-Lab Area NTSB (%) |
|---|---|---|
| Air System Fans | 0.0 | 0.0 |
| Cooling | 0.0 | 0.0 |
| Heating | 99.3 | 99.3 |
| Pumps | 0.0 | 0.0 |
| Heat Rejection Fans | 0.0 | 0.0 |
| **HVAC Sub-Total** | **99.3** | **99.3** |
| Lights | 0.7 | 0.7 |
| Electric Equipment | 0.0 | 0.0 |
| Misc. Electric | 0.0 | 0.0 |
| Misc. Fuel Use | 0.0 | 0.0 |
| **Non-HVAC Sub-Total** | **0.7** | **0.7** |
| **Grand Total** | **100.0** | **100.0** |

**Table 1. Annual Costs**

| Component | Antigonish WWTP-Lab Area ($) | Antigonish WWTP-Lab Area NTSB ($) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 4,737 | 4,722 |
| Natural Gas | 0 | 0 |
| Fuel Oil | 0 | 0 |
| Propane | 0 | 0 |
| Remote HW | 0 | 0 |
| Remote Steam | 0 | 0 |
| Remote CW | 0 | 0 |
| **HVAC Sub-Total** | **4,737** | **4,722** |
| **Non-HVAC Components** | | |
| Electric | 34 | 34 |
| Natural Gas | 0 | 0 |
| Fuel Oil | 0 | 0 |
| Propane | 0 | 0 |
| Remote HW | 0 | 0 |
| Remote Steam | 0 | 0 |
| **Non-HVAC Sub-Total** | **34** | **34** |
| **Grand Total** | **4,771** | **4,756** |

**Table 2. Annual Energy Consumption**

| Component | Antigonish WWTP-Lab Area | Antigonish WWTP-Lab Area NTSB |
|---|---|---|
| **HVAC Components** | | |
| Electric (kWh) | 37,356 | 37,242 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (na) | 0 | 0 |
| Propane (na) | 0 | 0 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| Remote CW (na) | 0 | 0 |
| | | |
| **Non-HVAC Components** | | |
| Electric (kWh) | 267 | 267 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (na) | 0 | 0 |
| Propane (na) | 0 | 0 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| | | |
| **Totals** | | |
| Electric (kWh) | 37,622 | 37,508 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (na) | 0 | 0 |
| Propane (na) | 0 | 0 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| Remote CW (na) | 0 | 0 |

**Table 3. Annual Emissions**

| Component | Antigonish WWTP-Lab Area | Antigonish WWTP-Lab Area NTSB |
|---|---|---|
| CO2 Equivalent (lb) | 0 | 0 |

**Table 4. Annual Cost per Unit Floor Area**

| Component | Antigonish WWTP-Lab Area ($/sqft) | Antigonish WWTP-Lab Area NTSB ($/sqft) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 4.381 | 4.368 |
| Natural Gas | 0.000 | 0.000 |
| Fuel Oil | 0.000 | 0.000 |
| Propane | 0.000 | 0.000 |
| Remote HW | 0.000 | 0.000 |
| Remote Steam | 0.000 | 0.000 |
| Remote CW | 0.000 | 0.000 |
| **HVAC Sub-Total** | **4.381** | **4.368** |
| **Non-HVAC Components** | | |
| Electric | 0.031 | 0.031 |
| Natural Gas | 0.000 | 0.000 |
| Fuel Oil | 0.000 | 0.000 |
| Propane | 0.000 | 0.000 |
| Remote HW | 0.000 | 0.000 |
| Remote Steam | 0.000 | 0.000 |
| **Non-HVAC Sub-Total** | **0.031** | **0.031** |
| **Grand Total** | **4.412** | **4.399** |
| Gross Floor Area (sqft) | 1081.2 | 1081.2 |
| Modeled Floor Area (sqft) | 1081.2 | 1081.2 |

Note: Values in this table are calculated using the Gross Floor Area.

**Table 5. Component Cost as a Percentage of Total Cost**

| Component | Antigonish WWTP-Lab Area (%) | Antigonish WWTP-Lab Area NTSB (%) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 99.3 | 99.3 |
| Natural Gas | 0.0 | 0.0 |
| Fuel Oil | 0.0 | 0.0 |
| Propane | 0.0 | 0.0 |
| Remote HW | 0.0 | 0.0 |
| Remote Steam | 0.0 | 0.0 |
| Remote CW | 0.0 | 0.0 |
| **HVAC Sub-Total** | **99.3** | **99.3** |
| **Non-HVAC Components** | | |
| Electric | 0.7 | 0.7 |
| Natural Gas | 0.0 | 0.0 |
| Fuel Oil | 0.0 | 0.0 |
| Propane | 0.0 | 0.0 |
| Remote HW | 0.0 | 0.0 |
| Remote Steam | 0.0 | 0.0 |
| **Non-HVAC Sub-Total** | **0.7** | **0.7** |
| **Grand Total** | **100.0** | **100.0** |

# Annual Cost Summary

Project: 237554.00 - Antigonish - Town Hall - Calibrated	02/02/2024
Prepared by: CBCL Limited	1:56 PM

**Table 1. Annual Costs**

| Component | Antigonish Town Hall-Baseline ($) | Antigonish-Town Hall- Phase 1 ECMs ($) |
|---|---|---|
| Air System Fans | 0 | 0 |
| Cooling | 837 | 787 |
| Heating | 32,713 | 16,876 |
| Pumps | 657 | 504 |
| Heat Rejection Fans | 0 | 0 |
| **HVAC Sub-Total** | **34,207** | **18,168** |
| Lights | 3,603 | 2,090 |
| Electric Equipment | 2,761 | 2,760 |
| Misc. Electric | 135 | 135 |
| Misc. Fuel Use | 0 | 0 |
| **Non-HVAC Sub-Total** | **6,499** | **4,986** |
| **Grand Total** | **40,706** | **23,153** |

**Table 2. Annual Cost per Unit Floor Area**

| Component | Antigonish Town Hall-Baseline ($/sqft) | Antigonish-Town Hall- Phase 1 ECMs ($/sqft) |
|---|---|---|
| Air System Fans | 0.000 | 0.000 |
| Cooling | 0.058 | 0.055 |
| Heating | 2.270 | 1.171 |
| Pumps | 0.046 | 0.035 |
| Heat Rejection Fans | 0.000 | 0.000 |
| **HVAC Sub-Total** | **2.374** | **1.261** |
| Lights | 0.250 | 0.145 |
| Electric Equipment | 0.192 | 0.192 |
| Misc. Electric | 0.009 | 0.009 |
| Misc. Fuel Use | 0.000 | 0.000 |
| **Non-HVAC Sub-Total** | **0.451** | **0.346** |
| **Grand Total** | **2.825** | **1.607** |
| Gross Floor Area (sqft) | 14408.6 | 14408.6 |
| Modeled Floor Area (sqft) | 14408.6 | 14408.6 |

Note: Values in this table are calculated using the Gross Floor Area.

**Table 3. Component Cost as a Percentage of Total Cost**

| Component | Antigonish Town Hall-Baseline (%) | Antigonish-Town Hall- Phase 1 ECMs (%) |
|---|---|---|
| Air System Fans | 0.0 | 0.0 |
| Cooling | 2.1 | 3.4 |
| Heating | 80.4 | 72.9 |
| Pumps | 1.6 | 2.2 |
| Heat Rejection Fans | 0.0 | 0.0 |
| **HVAC Sub-Total** | **84.0** | **78.5** |
| Lights | 8.9 | 9.0 |
| Electric Equipment | 6.8 | 11.9 |
| Misc. Electric | 0.3 | 0.6 |
| Misc. Fuel Use | 0.0 | 0.0 |
| **Non-HVAC Sub-Total** | **16.0** | **21.5** |
| **Grand Total** | **100.0** | **100.0** |

**Table 1. Annual Costs**

| Component | Antigonish Town Hall-Baseline ($) | Antigonish-Town Hall- Phase 1 ECMs ($) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 2,273 | 18,168 |
| Natural Gas | 0 | 0 |
| Fuel Oil | 31,934 | 0 |
| Propane | 0 | 0 |
| Remote HW | 0 | 0 |
| Remote Steam | 0 | 0 |
| Remote CW | 0 | 0 |
| **HVAC Sub-Total** | **34,207** | **18,168** |
| **Non-HVAC Components** | | |
| Electric | 6,498 | 4,986 |
| Natural Gas | 0 | 0 |
| Fuel Oil | 0 | 0 |
| Propane | 0 | 0 |
| Remote HW | 0 | 0 |
| Remote Steam | 0 | 0 |
| **Non-HVAC Sub-Total** | **6,498** | **4,986** |
| **Grand Total** | **40,706** | **23,153** |

### Table 2. Annual Energy Consumption

| Component | Antigonish Town Hall-Baseline | Antigonish-Town Hall- Phase 1 ECMs |
|---|---|---|
| **HVAC Components** | | |
| Electric (kWh) | 14,747 | 117,887 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (*) | 17,915 | 0 |
| Propane (na) | 0 | 0 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| Remote CW (na) | 0 | 0 |
| | | |
| **Non-HVAC Components** | | |
| Electric (kWh) | 42,162 | 32,349 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (*) | 0 | 0 |
| Propane (na) | 0 | 0 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| | | |
| **Totals** | | |
| Electric (kWh) | 56,909 | 150,236 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (*) | 17,915 | 0 |
| Propane (na) | 0 | 0 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| Remote CW (na) | 0 | 0 |

(*) Energy Units differ among Buildings.

### Table 3. Annual Emissions

| Component | Antigonish Town Hall-Baseline | Antigonish-Town Hall- Phase 1 ECMs |
|---|---|---|
| CO2 Equivalent (lb) | 0 | 0 |

**Table 4. Annual Cost per Unit Floor Area**

| Component | Antigonish Town Hall-Baseline ($/sqft) | Antigonish-Town Hall- Phase 1 ECMs ($/sqft) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 0.158 | 1.261 |
| Natural Gas | 0.000 | 0.000 |
| Fuel Oil | 2.216 | 0.000 |
| Propane | 0.000 | 0.000 |
| Remote HW | 0.000 | 0.000 |
| Remote Steam | 0.000 | 0.000 |
| Remote CW | 0.000 | 0.000 |
| **HVAC Sub-Total** | **2.374** | **1.261** |
| **Non-HVAC Components** | | |
| Electric | 0.451 | 0.346 |
| Natural Gas | 0.000 | 0.000 |
| Fuel Oil | 0.000 | 0.000 |
| Propane | 0.000 | 0.000 |
| Remote HW | 0.000 | 0.000 |
| Remote Steam | 0.000 | 0.000 |
| **Non-HVAC Sub-Total** | **0.451** | **0.346** |
| **Grand Total** | **2.825** | **1.607** |
| Gross Floor Area (sqft) | 14408.6 | 14408.6 |
| Modeled Floor Area (sqft) | 14408.6 | 14408.6 |

Note: Values in this table are calculated using the Gross Floor Area.

**Table 5. Component Cost as a Percentage of Total Cost**

| Component | Antigonish Town Hall-Baseline (%) | Antigonish-Town Hall- Phase 1 ECMs (%) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 5.6 | 78.5 |
| Natural Gas | 0.0 | 0.0 |
| Fuel Oil | 78.5 | 0.0 |
| Propane | 0.0 | 0.0 |
| Remote HW | 0.0 | 0.0 |
| Remote Steam | 0.0 | 0.0 |
| Remote CW | 0.0 | 0.0 |
| **HVAC Sub-Total** | **84.0** | **78.5** |
| **Non-HVAC Components** | | |
| Electric | 16.0 | 21.5 |
| Natural Gas | 0.0 | 0.0 |
| Fuel Oil | 0.0 | 0.0 |
| Propane | 0.0 | 0.0 |
| Remote HW | 0.0 | 0.0 |
| Remote Steam | 0.0 | 0.0 |
| **Non-HVAC Sub-Total** | **16.0** | **21.5** |
| **Grand Total** | **100.0** | **100.0** |

# Annual Cost Summary

Project: Antigonish WTP — 02/02/2024
Prepared by: CBCL Limited — 2:00 PM

**Table 1. Annual Costs**

| Component | 0.Antigonish WTP Baseline Building ($) | 1 Antigonish WTP ECM Propane Boiler ($) |
|---|---|---|
| Air System Fans | 712 | 701 |
| Cooling | 33 | 33 |
| Heating | 76,678 | 40,934 |
| Pumps | 1,323 | 1,297 |
| Heat Rejection Fans | 0 | 0 |
| **HVAC Sub-Total** | **78,746** | **42,965** |
| Lights | 3,974 | 3,974 |
| Electric Equipment | 764 | 764 |
| Misc. Electric | 0 | 0 |
| Misc. Fuel Use | 0 | 0 |
| **Non-HVAC Sub-Total** | **4,738** | **4,738** |
| **Grand Total** | **83,484** | **47,703** |

**Table 2. Annual Cost per Unit Floor Area**

| Component | 0.Antigonish WTP Baseline Building ($/sqft) | 1 Antigonish WTP ECM Propane Boiler ($/sqft) |
|---|---|---|
| Air System Fans | 0.073 | 0.072 |
| Cooling | 0.003 | 0.003 |
| Heating | 7.855 | 4.194 |
| Pumps | 0.136 | 0.133 |
| Heat Rejection Fans | 0.000 | 0.000 |
| **HVAC Sub-Total** | **8.067** | **4.402** |
| Lights | 0.407 | 0.407 |
| Electric Equipment | 0.078 | 0.078 |
| Misc. Electric | 0.000 | 0.000 |
| Misc. Fuel Use | 0.000 | 0.000 |
| **Non-HVAC Sub-Total** | **0.485** | **0.485** |
| **Grand Total** | **8.553** | **4.887** |
| Gross Floor Area (sqft) | 9761.2 | 9761.2 |
| Modeled Floor Area (sqft) | 9761.2 | 9761.2 |

Note: Values in this table are calculated using the Gross Floor Area.

**Table 3. Component Cost as a Percentage of Total Cost**

| Component | 0.Antigonish WTP Baseline Building (%) | 1 Antigonish WTP ECM Propane Boiler (%) |
|---|---|---|
| Air System Fans | 0.9 | 1.5 |
| Cooling | 0.0 | 0.1 |
| Heating | 91.8 | 85.8 |
| Pumps | 1.6 | 2.7 |
| Heat Rejection Fans | 0.0 | 0.0 |
| **HVAC Sub-Total** | **94.3** | **90.1** |
| Lights | 4.8 | 8.3 |
| Electric Equipment | 0.9 | 1.6 |
| Misc. Electric | 0.0 | 0.0 |
| Misc. Fuel Use | 0.0 | 0.0 |
| **Non-HVAC Sub-Total** | **5.7** | **9.9** |
| **Grand Total** | **100.0** | **100.0** |

**Table 1. Annual Costs**

| Component | 0.Antigonish WTP Baseline Building ($) | 1 Antigonish WTP ECM Propane Boiler ($) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 2,068 | 2,031 |
| Natural Gas | 0 | 0 |
| Fuel Oil | 76,678 | 0 |
| Propane | 0 | 40,934 |
| Remote HW | 0 | 0 |
| Remote Steam | 0 | 0 |
| Remote CW | 0 | 0 |
| **HVAC Sub-Total** | **78,746** | **42,965** |
| **Non-HVAC Components** | | |
| Electric | 4,738 | 4,738 |
| Natural Gas | 0 | 0 |
| Fuel Oil | 0 | 0 |
| Propane | 0 | 0 |
| Remote HW | 0 | 0 |
| Remote Steam | 0 | 0 |
| **Non-HVAC Sub-Total** | **4,738** | **4,738** |
| **Grand Total** | **83,484** | **47,703** |

**Table 2. Annual Energy Consumption**

| Component | 0.Antigonish WTP Baseline Building | 1 Antigonish WTP ECM Propane Boiler |
|---|---|---|
| **HVAC Components** | | |
| Electric (kWh) | 11,650 | 11,444 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (*) | 42,837 | 0 |
| Propane (*) | 0 | 63,959 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| Remote CW (na) | 0 | 0 |
| | | |
| **Non-HVAC Components** | | |
| Electric (kWh) | 26,690 | 26,690 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (*) | 0 | 0 |
| Propane (*) | 0 | 0 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| | | |
| **Totals** | | |
| Electric (kWh) | 38,341 | 38,134 |
| Natural Gas (na) | 0 | 0 |
| Fuel Oil (*) | 42,837 | 0 |
| Propane (*) | 0 | 63,959 |
| Remote HW (na) | 0 | 0 |
| Remote Steam (na) | 0 | 0 |
| Remote CW (na) | 0 | 0 |

(*) Energy Units differ among Buildings.

**Table 3. Annual Emissions**

| Component | 0.Antigonish WTP Baseline Building | 1 Antigonish WTP ECM Propane Boiler |
|---|---|---|
| CO2 Equivalent (lb) | 0 | 0 |

**Table 4. Annual Cost per Unit Floor Area**

| Component | 0.Antigonish WTP Baseline Building ($/sqft) | 1 Antigonish WTP ECM Propane Boiler ($/sqft) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 0.212 | 0.208 |
| Natural Gas | 0.000 | 0.000 |
| Fuel Oil | 7.855 | 0.000 |
| Propane | 0.000 | 4.194 |
| Remote HW | 0.000 | 0.000 |
| Remote Steam | 0.000 | 0.000 |
| Remote CW | 0.000 | 0.000 |
| **HVAC Sub-Total** | **8.067** | **4.402** |
| **Non-HVAC Components** | | |
| Electric | 0.485 | 0.485 |
| Natural Gas | 0.000 | 0.000 |
| Fuel Oil | 0.000 | 0.000 |
| Propane | 0.000 | 0.000 |
| Remote HW | 0.000 | 0.000 |
| Remote Steam | 0.000 | 0.000 |
| **Non-HVAC Sub-Total** | **0.485** | **0.485** |
| **Grand Total** | **8.553** | **4.887** |
| Gross Floor Area (sqft) | 9761.2 | 9761.2 |
| Modeled Floor Area (sqft) | 9761.2 | 9761.2 |

Note: Values in this table are calculated using the Gross Floor Area.

**Table 5. Component Cost as a Percentage of Total Cost**

| Component | 0.Antigonish WTP Baseline Building (%) | 1 Antigonish WTP ECM Propane Boiler (%) |
|---|---|---|
| **HVAC Components** | | |
| Electric | 2.5 | 4.3 |
| Natural Gas | 0.0 | 0.0 |
| Fuel Oil | 91.8 | 0.0 |
| Propane | 0.0 | 85.8 |
| Remote HW | 0.0 | 0.0 |
| Remote Steam | 0.0 | 0.0 |
| Remote CW | 0.0 | 0.0 |
| **HVAC Sub-Total** | **94.3** | **90.1** |
| **Non-HVAC Components** | | |
| Electric | 5.7 | 9.9 |
| Natural Gas | 0.0 | 0.0 |
| Fuel Oil | 0.0 | 0.0 |
| Propane | 0.0 | 0.0 |
| Remote HW | 0.0 | 0.0 |
| Remote Steam | 0.0 | 0.0 |
| **Non-HVAC Sub-Total** | **5.7** | **9.9** |
| **Grand Total** | **100.0** | **100.0** |

# APPENDIX B

## LED Lighting Inventory

# 1 Antigonish Arena

**Table 1.1: Spaces Considered for LED Upgrades**

| Space | Fixture Qty | Fixture Type | Lamp Type | Existing Wattage /Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| **First Floor** | | | | | |
| **001 - Exterior** | 3 | Floodlight | HID | 100 | 25 W |
| **002 - Entrance Corridor** | 16 | 2ft x 2ft Recessed Panel | 2ft T12 | 80 | 27 W |
| | 2 | 1ft x 4ft Recessed Panel | T12 Fl | 80 | 19 W |
| **003 – Women's Washroom** | 1 | 4ft wall mount linear above sink | T12 Fl | 40 | 35 W |
| | 1 | 4ft prismatic lens Wrap ceiling Surface Mount | T12 Fl | 80 | 24 W |
| **004 – Men's Washroom** | 1 | Circular Ceiling Surface | Incandescent | 40 | 19 W |
| | 1 | 4ft wall mount linear above sink | T12 Fl | 40 | 35 W |
| | 2 | 4ft prismatic lens Wrap ceiling Surface Mount | T12 Fl | 80 | 27 W |
| **005 - Locker Corridor** | 9 | 1ft x 4ft Recessed Panel | Fluorescent | 80 | 19 W |
| **Trophy Case** | 2 | 4ft Ceiling strip | T12 Fl | 40 | 35 W |
| **006 - Locker Room 5** | 4 | 4ft prismatic lens Wrap ceiling Surface Mount | T12 Fl | 80 | 27 W |
| | 6 | 1ft x 4ft Recessed Panel | Fluorescent | 80 | 19 W |
| **007 - Janitor Closet** | 1 | Edison Base (Bare bulb socket) | Incandescent | 180 | 35 W |
| **008 - Skate Sharpening** | 1 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 80 | 35 W |
| **009 - Spare Room** | 6 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 80 | 27 W |

| Space | Fixture Qty | Fixture Type | Lamp Type | Existing Wattage /Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| 010 - Entrance Corridor | 1 | 1ft x 4ft Recessed Panel | T12 Fl | 40 | 35 W |
| 011 - Canteen | 3 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 80 | 35 W |
| | 4 | 4ft Linear Fixture Surface Mount | Fluorescent | 86 | 19 W |
| | 1 | Edison Base (Bare bulb socket) | Incandescent | 0 | 35 W |
| 012 - Locker Room | 4 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 80 | 27 W |
| | 6 | 1ft x 4ft Recessed Panel | Fluorescent | 80 | 35 W |
| 014 - Exterior Mech Room | 2 | Edison Base (Bare bulb socket) | Incandescent | 60 | 35 W |
| 017 - Mech Room | 5 | 4ft Linear Fixture Surface Mount - Industrial | Fluorescent | 80 | 35 W |
| 018 - "Exit Only" Doors Alcove | 1 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 80 | 35 W |
| 019 - Electrical Closet | 1 | Edison Base (Bare bulb socket) | Incandescent | 60 | 35 W |
| 020 - Corridor | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 80 | 35 W |
| 021 - Storage Closet | 1 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 80 | 51 W |
| 022 - Locker Room | 2 | 2 x 4ft Recessed | Fluorescent | 160 | 35 W |
| | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 80 | 37 W |
| 023 - Corridor | 6 | 8" Recessed Potlight | Triple Twin CFL | 42 | 35 W |
| 024 - Hospitality Room | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 80 | 35 W |
| 025 - Spectating Room | 1 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 80 | 35 W |

| Space | Fixture Qty | Fixture Type | Lamp Type | Existing Wattage /Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| 026 - Boardroom | 4 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 80 | 35 W |
| 027 - Electrical Closet | 1 | Edison Base (Bare bulb socket) | Incandescent | 60 | 25 W |
| Rink Seating | 20 | Edison Base (Metal reflector pendant) | Incandescent | 100 | 27 W |

**Table 1.2: Spaces Considered for Occupancy Sensors**

| Space |
|---|
| 114 - Reception |
| 121 - WC |
| 117 - Locker Room |
| 100 - Locker Room |
| 208 - Standing Room |
| 205 - Hospitality |
| 201 - Radio |
| 113 - Office |
| 110 - Locker Room |
| 116 - Locker Room |
| 122 - WC |
| 109 - Locker Room |

# 2 Columbus Field Washrooms

**Table 2.1: Spaces Considered for LED Upgrades**

| Space | Fixture Qty | Lamp Type | Existing Wattage/ Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|
| **Men's Washroom** | 4 | Fluorescent | 64 | 25 |
| **Women's Washroom** | 4 | Fluorescent | 64 | 25 |

**Table 2.2: Spaces Considered for Occupancy Sensors**

| Space |
|---|
| Men's Washroom |
| Women's Washroom |

# 3 Antigonish Fire Hall

**Table 3.1: Spaces Considered for LED Upgrades**

| Space | Fixture Qty | Fixture Type | Lamp Type | Existing Wattage /Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| **First Floor** | | | | | |
| 001 - Truck Bay | 26 | Industrial Fixture Ceiling Mount | Fluorescent | 100 | 59 W |
| 002 - Entrance | 2 | 2ft x 4ft Recessed Troffer | Fluorescent | 128 | 51 W |
| 003 - Stair | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 64 | 19 W |
| 004 - Dispatch | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 64 | 35 W |
| 005 - Mechanical Room | 1 | 4ft chain mount strip | Fluorescent | 64 | 30 W |
| | 1 | Light Bulb | Fluorescent | 60 | 30 W |
| 006 - Storage | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 64 | 35 W |
| 007 - Washroom | 1 | Vanity Fixture | Fluorescent | 400 | 22 W |
| 008 - Activity Room | 6 | 2ft x 4ft Recessed Troffer | Fluorescent | 96 | 51 W |
| | 6 | Decorative wall sconce | Fluorescent | 100 | 7 W |
| 009 - Kitchen | 1 | Enclosed surface mount round (est. 2 edison base) | Fluorescent | 120 | 35 W |
| 010 - Entrance | 1 | 2ft x 2ft Recessed Troffer | Fluorescent | 40 | 25 W |
| **Second Floor** | | | | | |
| 011 - Rec Room | 15 | 2ft x 4ft Recessed Troffer | Fluorescent | 96 | 25 W |
| | 6 | Track Lighting | Incandescent | 60 | 8 W |
| 013 - Washroom | 1 | Linear Vanity Light | Fluorescent | 20 | 22 W |

| Space | Fixture Qty | Fixture Type | Lamp Type | Existing Wattage /Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| 014 - Weight Room | 3 | 2ft x 4ft Recessed Troffer | Fluorescent | 96 | 51 W |
| | 1 | 4ft strip (no lamp, not in use) | Fluorescent | 32 | 25 W |
| 017 - Fire Chief | 2 | 2ft x 4ft Recessed Troffer | Fluorescent | 128 | 51 W |
| Exterior | | | | | |
| 020 - Exterior | 3 | Exterior Wall Pack | Fluorescent | 200 | 35 W |

**Table 3.2: Spaces Considered for Occupancy Sensors**

| Space |
|---|
| Activity Room |
| Fire Chief's Office |
| Kitchen |
| Washroom: Truck Bay |
| Washrooms: Second Floor |
| Fire Apartment |
| Fire Apartment Washroom |
| Activity Room |

# 4 Antigonish Public Works/Electric Utility

**Table 4.1: Spaces Considered for LED Upgrades**

| Space | Fixture Qty | Fixture Type | Existing Lamp type | Existing Wattage /Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| 001 - Exterior | 7 | Wall Pack | HID | 100 | 35W |
| 003 - Sign Room | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 64 | 35 W |
| 006 - Catwalk | 3 | 4ft Linear Fixture Surface Mount | Fluorescent | 64 | 35 W |

**Table 4.2: Spaces Considered for Occupancy Sensors**

| Space |
|---|
| Electric Utility: Kitchen |
| Electric Utility: Washroom |
| Electric Utility: Office |
| Public Works Washroom |
| Public Works: Bills Office |
| Public Works: Break room |

# 5 Antigonish Wastewater Treatment Plant

**Table 5.1: Spaces Considered for LED Upgrades**

| Space | Fixture Qty | Existing Lamp type | Existing Wattage/ Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|
| **Pumping Station** | | | | |
| **Exterior** | 1 | HID | 100 | 18 |
| **Filter Building** | | | | |
| **Chemical Room** | 4 | Fluorescent | 64 | 48 |
| **Blower Room** | 4 | Fluorescent | 64 | 27 |
| **Lab/Office** | 4 | Fluorescent | 64 | 17 |
| | 1 | Under counter Fluorescent Bulb | 34 | 16 |
| | 1 | Under counter Fluorescent Bulb | 40 | 16 |
| **Washroom** | 1 | Fluorescent | 64 | 32.5 |
| | 1 | Fluorescent | 32 | 32.5 |
| **Hallway** | 1 | Fluorescent | 64 | 32.5 |

**Table 5.2: Spaces Considered for Occupancy Sensors**

| Space |
|---|
| Chemical Room |
| Blower Room |
| Lab/Office |
| Washroom |
| Hallway |

# 6 Antigonish Town Hall

**Table 6.1: Spaces Considered for LED Upgrades**

| Space | Fixture Qty | Fixture Type | Lamp type | Existing Wattage/ Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| **First Floor** | | | | | |
| 004 – Men's Washroom | 1 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 005 - Ladies Washroom | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 006 - Main Staircase | 3 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 007 - Storage | 1 | 2ft x 4ft Recessed Troffer | Fluorescent | 112 | 35 W |
| 010 - Reception | 6 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 010 - Work Area | 2 | 4ft x 4ft Fixture Surface Mount | Fluorescent | 224 | 34 W |
| | 15 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 012 - Kitchen | 3 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 013 - Deputy Clerks Office | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 014 - Office Supplies | 3 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 015 - Storage | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 016 - Mayors Office | 4 | 2ft x 4ft Recessed Troffer | Fluorescent | 112 | 35 W |

| Space | Fixture Qty | Fixture Type | Lamp type | Existing Wattage/ Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| **017 - Former Library** | 34 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **Second Floor** | | | | | |
| **019 - Second Floor Stair Landing** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **023 - Engineering Dept** | 8 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **024 - Director of Engineering and Public Works** | 4 | 2ft x 4ft Recessed Troffer | Fluorescent | 56 | 25 W |
| **025 - Lab** | 4 | 2ft x 4ft Recessed Troffer | Fluorescent | 56 | 25 W |
| **026 - Vault** | 4 | 2ft x 4ft Recessed Troffer | Fluorescent | 56 | 25 W |
| **027 - Conference Room** | 4 | 2ft x 4ft Recessed Troffer | Fluorescent | 84 | 25 W |
| **028 - Stair** | 1 | Suspended fixture | Fluorescent | 56 | |
| **029 - Building Inspector** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **Third Floor** | | | | | |
| **030 - Summer Rec** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **031 - Corridor** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **032 - Washroom** | 1 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **033 - Highland Society** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **034 - Clock Tower** | 6 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |

| Space | Fixture Qty | Fixture Type | Lamp type | Existing Wattage/ Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| 036 - Fire Inspector/ Safety Officer | 2 | 2ft x 4ft Recessed Troffer | Fluorescent | 112 | 25 W |
| 037 - Closet | 1 | Bare socket (Edison base) | CFL screw base | 13 | 25 W |
| 038 - Closet | 1 | Bare socket (Edison base) | CFL screw base | 13 | 25 W |
| **Basement** | | | | | |
| Basement | 16 | Bare socket (Edison base) | LED screw bulb | 9 | 25 W |
| | 1 | Bare socket (Edison base) | CFL screw base | 13 | 25 W |
| | 7 | 4ft strip | Fluorescent | 56 | 35 W |

**Table 6.2: Spaces Considered for Occupancy Sensors**

| Space |
|---|
| 200 - Office |
| 201 - Office |
| 308 - Office |
| 122 - Rec. Offices |
| 116 - Office |
| 118 - Office |
| 120 - Wc |
| 302 - Office |
| 303 - Kitchen |
| 304 - Wc |
| 301 - Office |
| 207 - Wc |
| 307 - Office |
| 210 - Lab |
| 106 - Office |
| 112 - Office |
| 107 - Wc |
| 110 - Kitchen |
| 108 - Wc |
| 204 - Office |
| 113 - Office |

# 7 Antigonish Water Treatment Plant

**Table 7.1: Spaces Considered for LED Upgrades**

| Space | Fixture Qty | Fixture Type | Existing Lamp Type | Existing Wattage/ Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| 101 Tankage Room | 13 | Circular High Bay | HPS | 250 | 100 |
| | 8 | 4ft Vaportight Fixture Suspended | Fluorescent | 64 | 45 |
| 102 Corridor | 5 | 2x2 Recessed Troffer | U bulb | 64 | 16 |
| 103 Soda Ash | 2 | 4ft Vaportight Fixture Suspended | Fluorescent | 64 | 45 |
| 104 Mechanical Room | 2 | 4ft Vaportight Fixture Suspended | Fluorescent | 64 | 45 |
| 105 Electrical Room | 4 | Wraparound | Fluorescent | 64 | 30 |
| 106 Office | 4 | 2x4 Recessed Troffer | Fluorescent | 64 | 16 |
| 107 Lab | 4 | 2x4 Recessed Troffer | Fluorescent | 64 | 16 |
| 108 W/C | 1 | Linear Fixture | Fluorescent | 32 | 27 |
| 109 Shower | 1 | Downlight | LED Potlight | 30 | 8.5 |
| | 1 | Downlight (Shower Proof) | Fluorescent | 32 | 100 |
| 110 Chemical Feed Room | 5 | 4ft Vaportight Fixture Suspended | Fluorescent | 64 | 45 |

| Space | Fixture Qty | Fixture Type | Existing Lamp Type | Existing Wattage/ Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| **111 Lunch Room** | 6 | Downlight | LED Potlight | 30 | 8.5 |
| | 2 | 2x4 Recessed Troffer | Fluorescent | 64 | 16 |
| **112 Chlorine Storage** | 2 | 4ft Vaportight Fixture Suspended | Fluorescent | 64 | 45 |
| **Tank Room(Caustic and Alum)** | 6 | 4ft Vaportight Fixture Suspended | Fluorescent | 64 | 45 |
| **Basement** | 17 | 4ft Vaportight Fixture Suspended | Fluorescent | 64 | 45 |

**Table 7.2: Spaces Considered for Occupancy Sensors**

| Space |
|---|
| 101 Tankage Room |
| 102 Corridor |
| 103 Soda Ash |
| 102 Corridor |
| 106 Office |
| 107 Lab |
| 108 W/C |
| 109 Shower |
| 110 Chemical Feed Room |
| 111 Lunchroom |
| 106 Office |
| 107 Lab |
| 108 W/C |
| Tank Room(Caustic and Alum) |
| Basement |

| Space | Fixture Qty | Fixture Type | Lamp Type | Existing Wattage/ Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| **First Floor** | | | | | |
| **004 – Men's Washroom** | 1 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **005 - Ladies Washroom** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **006 - Main Staircase** | 3 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **007 - Storage** | 1 | 2ft x 4ft Recessed Troffer | Fluorescent | 112 | 35 W |
| **010 - Reception** | 6 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **010 - Work Area** | 2 | 4ft x 4ft Fixture Surface Mount*** | Fluorescent | 224 | 34 W |
| | 15 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **012 - Kitchen** | 3 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **013 - Deputy Clerks Office** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **014 - Office Supplies** | 3 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **015 - Storage 016 - Mayors Office** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| | 4 | 2ft x 4ft Recessed Troffer | Fluorescent | 112 | 35 W |
| **017 - Former Library** | 34 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **Second Floor** | | | | | |
| **019 - Second Floor Stair Landing** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **023 - Engineering Dept** | 8 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |

| Space | Fixture Qty | Fixture Type | Lamp Type | Existing Wattage/ Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| **024 - Director of Engineering and Public Works** | 4 | 2ft x 4ft Recessed Troffer | Fluorescent | 56 | 25 W |
| **025 - Lab** | 4 | 2ft x 4ft Recessed Troffer | Fluorescent | 56 | 25 W |
| **026 - Vault** | 4 | 2ft x 4ft Recessed Troffer | Fluorescent | 56 | 25 W |
| **027 - Conference Room** | 4 | 2ft x 4ft Recessed Troffer | Fluorescent | 84 | 25 W |
| **028 - Stair** | 1 | Suspended fixture | Fluorescent | 56 | |
| **029 - Building Inspector** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **Third Floor** | | | | | |
| **030 - Summer Rec** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **031 - Corridor** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **032 - Washroom** | 1 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **033 - Highland Society** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **034 - Clock Tower** | 6 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **036 - Fire Inspector/ Safety Officer** | 2 | 2ft x 4ft Recessed Troffer | Fluorescent | 112 | 25 W |
| **037 - Closet** | 1 | Bare socket (edison base) | CFL screw base | 13 | 25 W |
| **038 - Closet** | 1 | Bare socket (edison base) | CFL screw base | 13 | 25 W |
| **Basement** | | | | | |
| **Basement** | 16 | Bare socket (edison base) | LED screw bulb | 9 | 25 W |
| | 1 | Bare socket (edison base) | CFL screw base | 13 | 25 W |

| Space | Fixture Qty | Fixture Type | Lamp Type | Existing Wattage/ Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| | 7 | 4ft strip | Fluorescent | 56 | 35 W |

| Space | Fixture Qty | Fixture Type | Lamp Type | Existing Wattage/ Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| **First Floor** | | | | | |
| 004 – Men's Washroom | 1 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 005 - Ladies Washroom | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 006 - Main Staircase | 3 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 007 - Storage | 1 | 2ft x 4ft Recessed Troffer | Fluorescent | 112 | 35 W |
| 010 - Reception | 6 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 010 - Work Area | 2 | 4ft x 4ft Fixture Surface Mount*** | Fluorescent | 224 | 34 W |
| | 15 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 012 - Kitchen | 3 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 013 - Deputy Clerks Office | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 014 - Office Supplies | 3 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 015 - Storage | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| 016 - Mayors Office | 4 | 2ft x 4ft Recessed Troffer | Fluorescent | 112 | 35 W |
| 017 - Former Library | 34 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **Second Floor** | | | | | |
| 019 - Second Floor Stair Landing | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |

| Space | Fixture Qty | Fixture Type | Lamp Type | Existing Wattage/ Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| **023 - Engineering Dept** | 8 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **024 - Director of Engineering and Public Works** | 4 | 2ft x 4ft Recessed Troffer | Fluorescent | 56 | 25 W |
| **025 - Lab** | 4 | 2ft x 4ft Recessed Troffer | Fluorescent | 56 | 25 W |
| **026 - Vault** | 4 | 2ft x 4ft Recessed Troffer | Fluorescent | 56 | 25 W |
| **027 - Conference Room** | 4 | 2ft x 4ft Recessed Troffer | Fluorescent | 84 | 25 W |
| **028 - Stair** | 1 | Suspended fixture | Fluorescent | 56 | |
| **029 - Building Inspector** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **Third Floor** | | | | | |
| **030 - Summer Rec** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **031 - Corridor** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **032 - Washroom** | 1 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **033 - Highland Society** | 2 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **034 - Clock Tower** | 6 | 4ft Wrapped Fixture Surface Mount | Fluorescent | 56 | 35 W |
| **036 - Fire Inspector/ Safety Officer** | 2 | 2ft x 4ft Recessed Troffer | Fluorescent | 112 | 25 W |
| **037 - Closet** | 1 | Bare socket (edison base) | CFL screw base | 13 | 25 W |
| **038 - Closet** | 1 | Bare socket (edison base) | CFL screw base | 13 | 25 W |

| Space | Fixture Qty | Fixture Type | Lamp Type | Existing Wattage/ Fixture | Proposed Wattage/ Fixture |
|---|---|---|---|---|---|
| **Basement** | | | | | |
| **Basement** | 16 | Bare socket (edison base) | LED screw bulb | 9 | 25 W |
| | 1 | Bare socket (edison base) | CFL screw base | 13 | 25 W |
| | 7 | 4ft strip | Fluorescent | 56 | 35 W |

# APPENDIX C

## LCCA Major Equipment and Replacement Timeline

**Major Equipment Considered in LCCA Development and Assumed Replacement Timeline**

| Antigonish Arena Baseline Building | | | |
|---|---|---|---|
| **Equipment** | **First Year O&M Cost Estimate ($)** | **Typical Equipment Lifespan** | **First Year Replacement Cost Estimate ($)** |
| 932 MBH Oil Fired Boiler | $3,078.00 | 20 | $43,000 |
| Oil Tank | $533.00 | 15 | $4,500 |
| Fluorescent Lighting | $500.00 | 7 | $20,840 |
| Aluminum Framed Windows | - | 20 | $17,600 |
| Propane Radiant Heaters | $3,270.00 | 15 | $77,000 |
| Manual Light Switches | - | 20 | $1,800 |
| Propane Zamboni | $5,000.00 | 20 | $100,000 |
| **Antigonish Arena Proposed Building** | | | |
| Electric Boiler with Outdoor Air Temperature Reset | $1,650.00 | 25 | $45,000 |
| Electrical Entrance Upgrade | - | - | $110,000 |
| LED Lighting | $250.00 | 10 | $41,680 |
| Occupancy Sensors for Lighting Control | - | 20 | $2,400 |
| Upgrade Aluminum Windows to R-4 | - | 20 | $22,000 |
| Electric Radiant Heaters with Pay Control System | $1,000.00 | 20 | $77,000 |
| Hydronic Heating Loop Pipe Insulation | - | 50 | $75 |
| Repair Exhaust Louvers | - | 40 | $720 |
| Air Compressor Maintenance Program | - | - | $1,000 |
| Cold Water Ice Resurfacing with DHW Heat Recovery | - | 30 | $47,000 |
| Electric Zamboni | $6,000.00 | 20 | $190,000 |

| Columbus Field Washroom Baseline Building | | | |
|---|---|---|---|
| **Equipment** | **First Year O&M Cost Estimate ($)** | **Typical Equipment Lifespan** | **First Year Replacement Cost Estimate ($)** |
| Fluorescent Lighting | $32.00 | 7 | $480 |
| Manual Light Switches | - | 20 | $300 |
| Manual Bathroom Exhaust Switch | - | 20 | $300 |
| Electric DHW Heater Tank | $100.00 | 15 | $3,000 |
| **Columbus Field Washroom Proposed Building** | | | |
| Upgrade to LED Lighting | $16.00 | 10 | $960.00 |
| Implement Occupancy Sensors | - | 20 | $400.00 |
| Install Bathroom Exhaust Switch Timer | - | 20 | $400.00 |
| Turn Off Heat when Building is Closed | - | 100 | - |
| Infiltration Reduction | - | 100 | $300.00 |
| Install Tankless Hot Water Heater | $100.00 | 20 | $3,000.00 |
| Electrical Service Entrance Upgrade | - | 100 | $3,000.00 |

| Antigonish Fire Hall Baseline Building | | | |
|---|---|---|---|
| Equipment | First Year O&M Cost Estimate ($) | Typical Equipment Lifespan | First Year Replacement Cost Estimate ($) |
| Fluorescent Lighting | $328.00 | 7 | $4,105 |
| Manual Light Switches | - | 20 | $1,500 |
| Oil Fired Boiler-430 MBH | $2,815.00 | 20 | $32,000 |
| Oil Tank | $533.00 | 15 | $4,500 |
| Original Aluminum Windows | - | 20 | $17,200 |
| Original Vinyl Windows | - | 20 | $27,600 |
| Bathroom Exhaust Switches | - | 20 | $600 |
| **Antigonish Fire Hall Proposed Building** | | | |
| LED Lighting | $164.00 | 10 | $8,210 |
| Occupancy Sensors | - | 20 | $2,000 |
| Bathroom Exhaust Timers | - | 20 | $800 |
| Oil Fired Boiler-430 MBH | $2,815.00 | 25 | $35,000 |
| Electric Radiant Heaters | $348.00 | 20 | $40,000 |
| Electrical Entrance Upgrade | | 100 | $80,000 |
| Infiltration Reduction | - | 100 | $1,550 |
| Air Source Heat pumps | $3,064.00 | 20 | $37,500 |
| Aluminum Window Upgrade to R4 | - | 20 | $21,500 |
| Air Compressor Maintenance System | - | - | $1,000 |
| Vinyl Window Upgrade to R4 | - | 20 | $34,500 |

| Antigonish Town and County Library Baseline Building | | | |
|---|---|---|---|
| Equipment | First Year O&M Cost Estimate ($) | Typical Equipment Lifespan | First Year Replacement Cost Estimate ($) |
| Building Automation System | - | 20 | $200,000 |
| Antigonish Town and County Library Proposed Building | | | |
| Building Automation System | $1,701 | 20 | $200,000 |
| Nighttime Setback | - | - | - |
| Reactivate Electronic Valve | - | - | $8,000 |

| Antigonish Public Works/Electric Utility Baseline Building | | | |
|---|---|---|---|
| **Equipment** | **First Year O&M Cost Estimate ($)** | **Typical Equipment Lifespan** | **First Year Replacement Cost Estimate ($)** |
| Fluorescent Lighting | $48.00 | 7 | $1,736 |
| Manual Light Switches | - | 20 | $1,200 |
| Oil Fired Furnaces Qty 2 | $3,153.00 | 20 | $22,657 |
| Oil Tank Qty 2 | $1,066.00 | 15 | $9,000 |
| Original Aluminum Windows | - | 20 | $4,600 |
| Original Vinyl Windows | - | 20 | $10,400 |
| **Antigonish Public Works/Electric Utility Proposed Building** | | | |
| LED Lighting | $24.00 | 10 | $3,472 |
| Occupancy Sensors | - | 20 | $1,600 |
| Electric Baseboards & Electric Radiant Heaters | $1,200.00 | 20 | $62,000 |
| Electrical Entrance Upgrade | - | - | $90,000 |
| Original Aluminum Windows Upgrade | - | 20 | $5,750 |
| Infiltration Reduction | - | 100 | $5,000 |
| Air Source Heat Pumps | $3,064.00 | 20 | $20,000 |
| Air Compressor Maintenance Program | - | - | $1,000 |
| Vinyl Window Upgrades | - | 20 | $13,000 |

| Antigonish Wastewater Treatment Plant Baseline Building | | | |
|---|---|---|---|
| **Equipment** | **First Year O&M Cost Estimate ($)** | **Typical Equipment Lifespan** | **First Year Replacement Cost Estimate ($)** |
| Pumping Station Fluorescent Lighting | $4 | 7 | $203 |
| Pumping Station Manual Light Switch | - | 20 | $150 |
| Filter Building: Fluorescent Lighting | $68 | 7 | $1,300 |
| Filter Building: Manual Light Switch | - | 20 | $750 |
| Filter Building: Manual Thermostat | - | 20 | $150 |
| Filter Building: 25HP PD Blower | $3,679 | 30 | $100,000 |
| **Antigonish Wastewater Treatment Plant Proposed Building** | | | |
| Pumping Station LED Lighting | $2 | 10 | $410 |
| Pumping Station : Occupancy Sensor | - | 20 | $200 |
| Pumping Station: Exhaust Louvers | - | 40 | $1,400 |
| Filter Building: LED Lighting | $34 | 10 | $2,600 |
| Filter Building: Occupancy Sensors | - | 20 | $1,000 |
| Filter Building: Programmable Thermostat | - | 20 | $200 |
| Filter Building: Repair Exhaust Louvers | - | 40 | $7,250 |
| Filter Building: Repair Damaged Windows | - | 40 | $720 |
| Filter Building: 25 HP Turbo Blowers | $3,679 | 30 | $200,000 |

| Antigonish Town Hall Baseline Building | | | |
|---|---|---|---|
| Equipment | First Year O&M Cost Estimate ($) | Typical Equipment Lifespan | First Year Replacement Cost Estimate ($) |
| Fluorescent Lighting | $592.00 | 7 | $7,555 |
| Manual Light Switches | - | 20 | $3,450 |
| Oil Fired Boilers Qty 2 | $5,630.00 | 20 | $57,000 |
| Oil Tanks Qty 2 | $1,066.00 | 15 | $9,000 |
| Manual Thermostats | - | 20 | $5,400 |
| Original Windows | - | 20 | $120,000 |
| **Antigonish Town Hall Proposed Building** | | | |
| Electric Boilers with Outdoor Air Temperature Reset | $2,907.14 | 25 | $73,500 |
| Upgrade Electrical Entrance | - | - | $90,000 |
| Upgrade to LED Lighting | $296.00 | 10 | $31,864 |
| Occupancy Sensors | - | 20 | $5,968 |
| Programmable Thermostats with Nighttime Setback | - | 20 | $5,400 |
| Infiltration Reduction | - | 100 | $2,700 |
| Upgrade Existing Windows to R-4 | - | 20 | $150,000 |

| Antigonish Water Treatment Plant Baseline Building | | | |
|---|---|---|---|
| Equipment | First Year O&M Cost Estimate ($) | Typical Equipment Lifespan | First Year Replacement Cost Estimate ($) |
| Fluorescent Lighting | $332 | 7 | $7,555 |
| Manual Light Switches | - | 20 | $3,450 |
| Oil Fired Boiler | $3,453 | 20 | $57,000 |
| Oil Tank | $533 | 15 | $5,968 |
| **Antigonish Water Treatment Plant Proposed Building** | | | |
| Upgrade to LED Lighting | $166.00 | 10 | $25,020 |
| Occupancy Sensors for Lighting Control | - | 20 | $2,200 |
| Upgrade to Propane Fired Boiler | $3,453.00 | 20 | $60,000 |
| Concrete Pad, Vehicle Protection, Line, Trench, etc. | - | 40 | $5,000 |
| Infiltration Reduction | - | 20 | $1,650 |
| Implement VFD to Recycling Pumps | $650.00 | 25 | $50,000 |
| Repair Louvers for Exhaust Fans | - | 40 | $14,000 |
| Install Ground Mounted PV Array | $527.00 | 25 | $52,700 |

| Antigonish Arena: Baseline Building | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | Salvage Value At Year 30 |
| Equipment | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | |
| 932 MBH Oil Fired Boiler | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $56,623 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $112,667 | $0 | $0 | -$101,401 |
| Oil Tank | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $5,926 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $9,928 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$5,295 |
| Fluorescent Lighting | $0 | $21,569 | $0 | $0 | $0 | $0 | $0 | $0 | $27,442 | $0 | $0 | $0 | $0 | $0 | $0 | $34,914 | $0 | $0 | $0 | $0 | $0 | $0 | $44,421 | $0 | $0 | $0 | $0 | $0 | $0 | $56,516 | $0 | -$48,442 |
| Aluminum Framed Windows | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $23,176 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $46,115 | $0 | $0 | -$41,504 |
| Propane Radiant Heaters | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $101,394 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $169,871 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$90,598 |
| Manual Light Switches | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $2,370 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $4,716 | $0 | $0 | -$4,245 |
| Propane Zamboni | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $145,997 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$7,300 |

| Antigonish Arena: Proposed Building | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | Salvage Value At Year 30 |
| Equipment | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | |
| Electric Boiler with Outdoor Air Temperature Reset | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $59,256 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$7,111 |
| Electrical Entrance Upgrade | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $144,849 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| LED Lighting | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $54,885 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $77,420 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $109,209 | $0 | $0 | -$87,367 |
| Occupancy Sensors for Lighting Control | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $3,160 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $6,288 | $0 | $0 | -$5,660 |
| Upgrade Aluminum Windows to R-4 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $28,970 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $57,644 | $0 | $0 | -$51,879 |
| Electric Radiant Heaters with Pay Control System | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $101,394 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $201,753 | $0 | $0 | -$181,578 |
| Hydronic Heating Loop Pipe Insulation | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $99 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$55 |
| Repair Exhaust Louvers | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $948 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$427 |
| Air Compressor Maintenance Program | $1,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Cold Water Ice Resurfacing with DHW Heat Recovery | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $61,890 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$16,504 |
| Electric Zamboni | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $277,394 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$13,870 |

**Columbus Field Washrooms: Baseline Building**

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | Salvage Value At Year 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Equipment | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | |
| **Fluorescent Lighting** | $480 | $0 | $0 | $0 | $0 | $0 | $0 | $611 | $0 | $0 | $0 | $0 | $0 | $0 | $777 | $0 | $0 | $0 | $0 | $0 | $0 | $989 | $0 | $0 | $0 | $0 | $0 | $0 | $1,258 | $0 | $0 | -$898 |
| **Manual Light Switches** | $300 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $597 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$298 |
| **Manual Bathroom Exhaust Switch** | $300 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $597 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$298 |
| **Electric DHW Heater Tank** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $4,232 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $7,090 | $0 | $0 | $0 | $0 | $0 | -$4,726 |

**Columbus Field Washrooms: Proposed Building**

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | Salvage Value At Year 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Equipment | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | |
| **Upgrade to LED Lighting** | $960 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1,354 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1,910 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $2,695 | -$2,695 |
| **Implement Occupancy Sensors** | $400 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $796 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$398 |
| **Install Bathroom Exhaust Switch Timer** | $400 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $796 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$398 |
| **Turn Off Heat when Building is Closed** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Infiltration Reduction** | $300 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$210 |
| **Install Tankless Hot Water Heater** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $4,232 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $8,420 | -$8,420 |
| **Electrical Service Entrance Upgrade** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $4,232 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| Antigonish Fire Hall: Baseline Building | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | Salvage Value At Year 30 |
| Equipment | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | |
| **Fluorescent Lighting** | $0 | $0 | $4,397 | $0 | $0 | $0 | $0 | $0 | $0 | $5,595 | $0 | $0 | $0 | $0 | $0 | $0 | $7,118 | $0 | $0 | $0 | $0 | $0 | $0 | $9,056 | $0 | $0 | $0 | $0 | $0 | $0 | $11,522 | -$11,522 |
| **Manual Light Switches** | $0 | $0 | $1,607 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $3,197 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$1,918 |
| **Oil Fired Boiler-430 MBH** | $0 | $0 | $34,279 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $68,208 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$40,925 |
| **Oil Tank** | $0 | $0 | $4,821 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $8,076 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$1,077 |
| **Original Aluminum Windows** | $0 | $0 | $18,425 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $36,662 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$21,997 |
| **Original Vinyl Windows** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $46,240 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$11,560 |
| **Bathroom Exhaust Switches** | $0 | $0 | $643 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1,279 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$767 |

| Antigonish Fire Hall: Proposed Building | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | Salvage Value At Year 30 |
| Equipment | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | |
| **LED Lighting** | $0 | $0 | $8,795 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $12,406 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $17,500 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$3,500 |
| **Occupancy Sensors** | $0 | $0 | $2,142 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $4,263 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$2,558 |
| **Bathroom Exhaust Timers** | $0 | $0 | $857 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1,705 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$1,023 |
| **Electric Boiler** | $0 | $0 | $37,493 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $88,605 | $0 | $0 | $0 | -$77,972 |
| **Electric Radiant Heaters** | $0 | $0 | $42,849 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $85,260 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$51,156 |
| **Electrical Entrance Upgrade** | $0 | $0 | $85,698 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Infiltration Reduction** | $0 | $0 | $1,660 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$1,195 |
| **Electric DHW** | $0 | $0 | $40,171 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $79,932 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$47,959 |
| **Aluminum Window Upgrade to R4** | $0 | $0 | $23,031 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $45,827 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$27,496 |
| **Air Compressor Maintenance System** | $1,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Vinyl Window Upgrade to R4** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $57,800 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$14,450 |

| Antigonish Town and County Library: Baseline Building | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | Salvage Value At Year 30 |
| Equipment | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | |
| **Building Automation System** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $272,579 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $542,376 | $0 | -$515,257 |

| Antigonish Town and County Library: Proposed Building | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | Salvage Value At Year 30 |
| Equipment | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | |
| **Building Automation System** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $272,579 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $542,376 | $0 | -$515,257 |
| **Nighttime Setback** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Reactivate Electronic Valve** | $8,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| Antigonish Public Works/Electric Utility: Baseline Building | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | Salvage Value At Year 30 |
| Equipment | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | |
| **Fluorescent Lighting** | $0 | $1,797 | $0 | $0 | $0 | $0 | $0 | $0 | $2,286 | $0 | $0 | $0 | $0 | $0 | $0 | $2,908 | $0 | $0 | $0 | $0 | $0 | $0 | $3,700 | $0 | $0 | $0 | $0 | $0 | $0 | $4,708 | $0 | -$4,035 |
| **Manual Light Switches** | $0 | $1,242 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $2,471 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$1,359 |
| **Oil Fired Furnaces Qty 2** | $0 | $23,450 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $46,660 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$25,663 |
| **Oil Tank Qty 2** | $0 | $9,315 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $15,606 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$1,040 |
| **Original Aluminum Windows** | $0 | $4,761 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $9,473 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$5,210 |
| **Original Vinyl Windows** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $14,670 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $29,191 | $0 | -$29,191 |

| Antigonish Public Works/Electric Utility: Proposed Building | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | Salvage Value At Year 30 |
| Equipment | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | |
| **LED Lighting** | $0 | $3,594 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $5,069 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $7,150 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$715 |
| **Occupancy Sensors** | $0 | $1,656 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $3,295 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$1,812 |
| **Electric Baseboards & Electric Radiant Heaters** | $0 | $64,170 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $127,685 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$70,227 |
| **Electrical Entrance Upgrade** | $0 | $93,150 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Original Aluminum Windows Upgrade** | $0 | $5,951 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $11,842 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$6,513 |
| **Infiltration Reduction** | $0 | $5,175 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$3,674 |
| **Air Source Heat Pumps** | $0 | $20,700 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $34,680 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$2,312 |
| **Air Compressor Maintenance Program** | $0 | $1,035 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Vinyl Window Upgrades** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $18,338 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $36,488 | -$36,488 |

| Antigonish Wastewater Treatment Plant: Baseline Building | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | Salvage Value At Year 30 |
| **Equipment** | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | |
| **Pumping Station Fluorescent Lighting** | $203 | $0 | $0 | $0 | $0 | $0 | $0 | $258 | $0 | $0 | $0 | $0 | $0 | $0 | $328 | $0 | $0 | $0 | $0 | $0 | $0 | $417 | $0 | $0 | $0 | $0 | $0 | $0 | $531 | $0 | $0 | -$379 |
| **Pumping Station Manual Light Switch** | $150 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $298 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$149 |
| **Filter Building: Fluorescent Lighting** | $1,300 | $0 | $0 | $0 | $0 | $0 | $0 | $1,654 | $0 | $0 | $0 | $0 | $0 | $0 | $2,104 | $0 | $0 | $0 | $0 | $0 | $0 | $2,677 | $0 | $0 | $0 | $0 | $0 | $0 | $3,406 | $0 | $0 | -$2,433 |
| **Filter Building: Manual Light Switch** | $750 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1,492 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$746 |
| **Filter Building: Manual Thermostat** | $150 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $298 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$149 |
| **Filter Building: 25HP PD Blower** | $0 | $0 | $0 | $110,872 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$11,087 |

| Antigonish Wastewater Treatment Plant: Proposed Building | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | Salvage Value At Year 30 |
| **Equipment** | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | |
| **Pumping Station LED Lighting** | $410 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $578 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $816 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1,151 | -$1,151 |
| **Pumping Station: Occupancy Sensor** | $200 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $398 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$199 |
| **Pumping Station: Exhaust Louvers** | $1,400 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$350 |
| **Filter Building: LED Lighting** | $2,600 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $3,668 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $5,173 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $7,298 | -$7,298 |
| **Filter Building: Occupancy Sensors** | $1,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1,990 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$995 |
| **Filter Building: Programmable Thermostat** | $200 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $398 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$199 |
| **Filter Building: Repair Exhaust Louvers** | $7,250 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $14,426 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$7,213 |
| **Filter Building: Repair Damaged Windows** | $720 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$180 |
| **Filter Building: 25 HP Turbo Blowers** | $0 | $0 | $0 | $221,744 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$22,174 |

**Antigonish Town Hall: Baseline Building**

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | Salvage Value At Year 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Equipment** | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | |
| **Fluorescent Lighting** | $0 | $7,819 | $0 | $0 | $0 | $0 | $0 | $0 | $9,948 | $0 | $0 | $0 | $0 | $0 | $0 | $12,657 | $0 | $0 | $0 | $0 | $0 | $0 | $16,104 | $0 | $0 | $0 | $0 | $0 | $0 | $20,488 | $0 | -$17,561 |
| **Manual Light Switches** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $4,543 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $9,040 | $0 | $0 | -$8,136 |
| **Oil Fired Boilers Qty 2** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $89,145 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$13,372 |
| **Oil Tanks Qty 2** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $14,076 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $23,582 | $0 | $0 | -$20,437 |
| **Manual Thermostats** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $7,111 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $14,149 | $0 | $0 | -$12,734 |
| **Original Windows** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $158,017 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $314,421 | $0 | $0 | -$282,979 |

**Antigonish Town Hall: Proposed Building**

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | Salvage Value At Year 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Equipment** | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | |
| **Electric Boilers with Outdoor Air Temperature Reset** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $96,785 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$11,614 |
| **Upgrade Electrical Entrance** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $118,513 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Upgrade to LED Lighting** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $19,897 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $28,067 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $39,591 | $0 | $0 | -$31,673 |
| **Occupancy Sensors** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $6,057 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $12,053 | $0 | $0 | -$10,848 |
| **Programmable Thermostats with Nighttime Setback** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $9,481 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $18,865 | $0 | $0 | -$16,979 |
| **Infiltration Reduction** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $3,555 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$2,773 |
| **Upgrade Existing Windows to R-4** | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $197,521 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $393,026 | $0 | $0 | -$353,723 |

| Antigonish Water Treatment Plant: Baseline Building | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | Salvage Value At Year 30 |
| Equipment | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | |
| Fluorescent Lighting | $0 | $0 | $8,093 | $0 | $0 | $0 | $0 | $0 | $0 | $10,297 | $0 | $0 | $0 | $0 | $0 | $0 | $13,100 | $0 | $0 | $0 | $0 | $0 | $0 | $16,667 | $0 | $0 | $0 | $0 | $0 | $0 | $21,205 | -$21,205 |
| Manual Light Switches | $0 | $0 | $3,696 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $7,354 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$4,412 |
| Oil Fired Boiler | $0 | $0 | $61,060 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $121,496 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$72,898 |
| Oil Tank | $0 | $0 | $6,393 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $10,711 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$1,428 |

| Antigonish Water Treatment Plant: Proposed Building | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | Salvage Value At Year 30 |
| Equipment | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | |
| Upgrade to LED Lighting | $0 | $0 | $26,802 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $37,807 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $53,330 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$10,666 |
| Occupancy Sensors for Lighting Control | $0 | $0 | $2,357 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $4,689 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$2,814 |
| Upgrade to Propane Fired Boiler | $0 | $0 | $64,274 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $127,891 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$76,734 |
| Concrete Pad, Vehicle Protection, Line Trench | $0 | $0 | $5,356 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$1,607 |
| Infiltration Reduction | $0 | $0 | $1,768 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $3,517 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$2,110 |
| Implement VFD to Recycling Pumps | $50,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $118,162 | $0 | $0 | $0 | $0 | $0 | -$94,530 |
| Repair Louvers for Exhaust Fans | $0 | $0 | $14,997 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | -$4,499 |
| Install Ground Mounted PV Array | $0 | $0 | $56,454 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $133,414 | $0 | $0 | $0 | -$117,404 |

| Estimated Implementation Timeline | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Building** | **Efficiency Measure** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** | **2034** | **2035** | **2036** | **2037** | **2038** | **2039** | **2040** | **2041** | **2042** |
| **Antigonish Arena** | Electric Boiler with Outdoor Air Temperature Reset | | | | | | | | | $59,256 | | | | | | | | | | |
| | Electrical Entrance Upgrade | | | | | | | | | $144,849 | | | | | | | | | | |
| | LED Lighting | | | | | | | | | $54,885 | | | | | | | | | | |
| | Occupancy Sensors for Lighting Control | | | | | | | | | $3,160 | | | | | | | | | | |
| | Upgrade Aluminum Windows to R-4 | | | | | | | | | $28,970 | | | | | | | | | | |
| | Electric Radiant Heaters with Pay Control System | | | | | | | | | $101,394 | | | | | | | | | | |
| | Hydronic Heating Loop Pipe Insulation | | | | | | | | | $99 | | | | | | | | | | |
| | Repair Exhaust Louvers | | | | | | | | | $948 | | | | | | | | | | |
| | Air Compressor Maintenance Program | $1,000 | | | | | | | | | | | | | | | | | | |
| | Cold Water Ice Resurfacing with DHW Heat Recovery | | | | | | | | | $61,890 | | | | | | | | | | |
| | Electric Zamboni | | | | | | | | | | | | $277,394 | | | | | | | |
| **Columbus Field Washrooms** | Upgrade to LED Lighting | $960 | | | | | | | | | | | | | | | | | | |
| | Implement Occupancy Sensors | $400 | | | | | | | | | | | | | | | | | | |
| | Install Bathroom Exhaust Switch Timer | $400 | | | | | | | | | | | | | | | | | | |
| | Turn Off Heat when Building is Closed | | | | | | | | | | | | | | | | | | | |
| | Infiltration Reduction | $300 | | | | | | | | | | | | | | | | | | |
| | Install Tankless Hot Water Heater | | . | | | | | | | | | $4,232 | | | | | | | | |
| | Electrical Service Entrance Upgrade | | | | | | | | | | | $4,232 | | | | | | | | |
| **Fire Hall** | LED Lighting | | | $8,795 | | | | | | | | | | | | | | | | |
| | Occupancy Sensors | | | $2,142 | | | | | | | | | | | | | | | | |
| | Bathroom Exhaust Timers | | | $857 | | | | | | | | | | | | | | | | |
| | Oil-fired Boiler | | | $37,493 | | | | | | | | | | | | | | | | |
| | Electric Radiant Heaters | | | $42,849 | | | | | | | | | | | | | | | | |
| | Electrical Entrance Upgrade | | | $85,698 | | | | | | | | | | | | | | | | |
| | Infiltration Reduction | | | $1,660 | | | | | | | | | | | | | | | | |
| | Air Source Heat pumps | | | $40,171 | | | | | | | | | | | | | | | | |
| | Aluminum Window Upgrade to R4 | | | $23,031 | | | | | | | | | | | | | | | | |
| | Air Compressor Maintenance System | $1,000 | | | | | | | | | | | | | | | | | | |
| | Vinyl Window Upgrade to R4 | | | | | | | | | | | | | | | | $57,800 | | | |
| **Antigonish Town and County Library** | Building Automation System | | | | | | | | | | | | | | | | | | | |
| | Nighttime Setback | | | | | | | | | | | | | | | | | | | |
| | Reactivate Electronic Valve | $8,000 | | | | | | | | | | | | | | | | | | |
| **Antigonish Public Works/Electric Utility** | LED Lighting | | $3,594 | | | | | | | | | | | | | | | | | |
| | Occupancy Sensors | | $1,656 | | | | | | | | | | | | | | | | | |
| | Electric Baseboards & Electric Radiant Heaters | | $64,170 | | | | | | | | | | | | | | | | | |
| | Electrical Entrance Upgrade | | $93,150 | | | | | | | | | | | | | | | | | |
| | Original Aluminum Windows Upgrade | | $5,951 | | | | | | | | | | | | | | | | | |
| | Infiltration Reduction | | $5,175 | | | | | | | | | | | | | | | | | |
| | Air Source Heat Pumps | | $20,700 | | | | | | | | | | | | | | | | | |
| | Air Compressor Maintenance Program | | | | | | | | | | | | | | | | | | | |
| | Vinyl Window Upgrades | | | | | | | | | | | $18,338 | | | | | | | | |
| **Antigonish Wastewater Treatment Plant** | Pumping Station LED Lighting | $410 | | | | | | | | | | | | | | | | | | |
| | Pumping Station: Occupancy Sensor | $200 | | | | | | | | | | | | | | | | | | |
| | Pumping Station: Exhaust Louvers | $1,400 | | | | | | | | | | | | | | | | | | |
| | Filter Building: LED Lighting | $2,600 | | | | | | | | | | | | | | | | | | |
| | Filter Building: Occupancy Sensors | $1,000 | | | | | | | | | | | | | | | | | | |
| | Filter Building: Programmable Thermostat | $200 | | | | | | | | | | | | | | | | | | |
| | Filter Building: Repair Exhaust Louvers | $7,250 | | | | | | | | | | | | | | | | | | |
| | Filter Building: Repair Damaged Windows | $720 | | | | | | | | | | | | | | | | | | |
| | Filter Building: 25 HP Turbo Blowers | | | | $221,744 | | | | | | | | | | | | | | | |
| **Antigonish Town Hall** | Electric Boilers with Outdoor Air Temperature Reset | | | | | | | | | $96,785 | | | | | | | | | | |
| | Upgrade Electrical Entrance | | | | | | | | | $118,513 | | | | | | | | | | |
| | Upgrade to LED Lighting | | | | | | | | | $19,897 | | | | | | | | | | |
| | Occupancy Sensors | | | | | | | | | $6,057 | | | | | | | | | | |
| | Programmable Thermostats with Nighttime Setback | | | | | | | | | $9,481 | | | | | | | | | | |
| | Infiltration Reduction | | | | | | | | | $3,555 | | | | | | | | | | |
| | Upgrade Existing Windows to R-4 | | | | | | | | | $197,521 | | | | | | | | | | |
| **Antigonish Water Treatment Plant** | Upgrade to LED Lighting | | | $26,802 | | | | | | | | | | | | | | | | |
| | Occupancy Sensors for Lighting Control | | | $2,357 | | | | | | | | | | | | | | | | |
| | Upgrade to Propane Fired Boiler | | | $64,274 | | | | | | | | | | | | | | | | |
| | Concrete Pad, Vehicle Protection, Line Trench | | | $5,356 | | | | | | | | | | | | | | | | |
| | Infiltration Reduction | | | $1,768 | | | | | | | | | | | | | | | | |
| | Implement VFD to Recycling Pumps | $50,000 | | | | | | | | | | | | | | | | | | |
| | Repair Louvers for Exhaust Fans | | | $14,997 | | | | | | | | | | | | | | | | |
| | Install Ground Mounted PV Array | | | $56,454 | | | | | | | | | | | | | | | | |

| | Phase 1 | | | | | | | | | Phase 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 |
| **Total** | $75,840 | $195,431 | $377,746 | $221,744 | $0 | $0 | $0 | $0 | $907,262 | $0 | $26,801 | $218,995 | $0 | $0 | $0 | $57,800 | $0 | $0 | $0 |


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