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Public Report

To:	Safety and Facilities Services Committee
From:	Adam Grant, Commissioner, Safety and Facilities Services Department
Report Number:	SF-25-07
Date of Report:	February 5, 2025
Date of Meeting:	February 10, 2025
Subject:	Energy Audit Update
Ward:	All Wards
File:	03-05

1.0 Purpose

The purpose of this report is to provide an update on Energy Audits of various City Facilities.

Attachment 1 is the 2024 Annual Energy Audit Program Summary Report delivered by BLDG Sci Advisory Inc.

2.0 Recommendation

That the Safety and Facilities Services Committee recommend to City Council:

That Report SF-24-07 dated February 5, 2025 concerning the Energy Audits of City Facilities be received for information.

3.0 Input From Other Sources

None

4.0 Background

4.1 Corporate Energy Management Plan (C.E.M.P.) 2024-2028

The Corporate Energy Management Plan (C.E.M.P.) 2024-2028, dated May 10, 2023 which was endorsed by Council on May 15, 2023 outlines the City's current status of energy conservation and greenhouse gas (G.H.G.) reduction.

The targets and measures defined in this plan ensure the City of Oshawa is in compliance with Ontario Regulation 25/23 under the Electricity Act 1998, which mandates that municipalities develop and maintain a conservation and demand management plan.

4.2 Oshawa Strategic Plan 2024-2027: Innovate. Belong. Care. Lead.

The Oshawa Strategic Plan (O.S.P.) 2024 – 2027: Innovate. Belong. Care. Lead., endorsed by Council on June 24, 2024 represents Council's shared priorities and long-term vision for Oshawa.

The O.S.P. identifies four (4) priority areas, each supported by specific goals, action items and key performance indicators (K.P.I.) to help measure progress. These priority areas are Innovate, Belong, Care and Lead. Energy Management is aligned with the priority area of Care: Safe and Sustainable Environment. This priority area is reinforced through Section 4 of the goals and actions of Care; reduce the City's carbon footprint and greenhouse gas emissions.

Corporate accountability is outlined in 4.1 which directs that the Corporate Energy Management Plan be advanced, as appropriate.

Metrics within the O.S.P. further outline how the progress of these goals and actions can be measured. Care, Metric 7, quantifies the number of corporate energy audits performed.

4.3 Energy Audit Program Capital Considerations

The C.E.M.P. recommended the development of an ongoing Energy Audit Program to deliver consistent evaluation of energy efficiency opportunities at City facilities.

The 2024 Capital Budget submission included Project 10-0085 in the amount of $150,000 which was subsequently approved as part of the Mayor's 2024 Budget.

Facilities Management Services established and implemented a four (4) year Energy Audit Program that aligns with the Building Condition Audit Program to support and inform capital project recommendations. The energy audits deliver an assessment of energy efficiency for City buildings and mechanical systems. Outcomes from the audit program will identify potential opportunities to reduce consumption in operations, capital replacement and enhance efficiencies of maintenance procedures. These audits include both City-owned facilities and those operated in partnership with other organizations where the City is responsible for energy costs.

Contract C2024-014 Energy Audits was awarded to BLDG Sci Advisory Inc. through the City's established Purchasing By-law, for an initial one-year term with the option to renew for an additional three (3) one-year terms subject to future capital budget approval.

5.0 Analysis

BLDG Sci Advisory Inc. performed energy audits at the following City of Oshawa sites:

- Northview Community Centre (150 Beatrice St. E.)
- Parking Garage (G1) and Bus Terminal (1 Centre St. N.)
- Parks and Animal Services Buildings & Greenhouses (919 Farewell St.)
- Donevan Recreation Complex (171 Harmony Rd. S.)
- Parking Garage (G2) McMillan Parkade (100 King St. W.)
- Airport – Terminal Building (1200 Airport Blvd.)
- Airport – Hanger (481 Aviator Lane)
- Airport – Electrical Building/Canteen/Stores/Museum (1000 Stevenson Rd. N.)
- Howden Rd- Offices and Garage Sand Dome (235 Howden Rd. E.)
- Arts Resource Centre (45 Queen St.)

As outlined in Contract C2024-014, BLDG Sci Advisory Inc. was required to provide two (2) levels of reporting:

1. Site specific energy audit reports for each location; and

2. A non-complex final summary report to highlight the findings and provide recommendations.

5.1 Baseline Analysis

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 211 is the recognized industry approach for conducting and reporting energy audits for commercial and institutional buildings. The standard defines three (3) levels of audits, which can be implemented based on the complexity of the building and the anticipated opportunity for energy reductions. Each level of audit offers increasing levels of detail and includes criteria of the preceding level.

ASHRAE Level 1 - A preliminary assessment involving basic review of energy bills, building systems and operational practices.

ASHRAE Level 2 - A more detailed approach which builds on Level 1 including equipment inventory, energy balance of the facility, detailed energy savings estimates, capital project recommendations, cost estimates and financial analysis of each measure.

ASHRAE Level 3 - An investment grade audit, typically delivered in feasibility and detailed engineering assessments where more expensive capital projects are being considered, and high accuracy is desired.

The City required additional criteria to support the ASHRAE audit levels.

Level 1 audits were conducted by BLDG Sci Advisory Inc. at seven (7) facilities and Level 2 audits were conducted at three (3) facilities. The audits analyzed the current energy performance for each facility, conducted an onsite energy assessment, and produced a list

of energy and water conservation measures as well as capital recommendations complete with relevant opinion of probable costs.

A baseline analysis for each facility was established including:

- Utility analysis
- Baseline year determination
- Energy modelling and calculations establishing breakdown by major end use category
- G.H.G. and cost analysis by fuel type

A summary of the baseline analysis can be found in Table 3-1: Annual Baseline Utility Use by Facility set out in Attachment 1.

5.2 Recommended Measures

The recommendations include proposed future capital projects, considerations for coordination with anticipated capital projects, and increased efficiency opportunities through operations and maintenance actions.

The measures identified can be categorized as follows:

- **Building Envelope** - Insulation upgrades and window replacement opportunities.

- **Heating, Ventilation, and Air Conditioning** - Equipment upgrades and control optimization (demand control ventilation, temperature control set points, etc.).

- **Lighting** - Interior LED upgrades/retrofits, exterior LED upgrades/retrofits, and control optimization (occupancy, dimming, daylighting, etc.).

- **Domestic Hot Water** - Efficiency upgrade or right-sizing units to meet space/occupant needs.

- **Auxiliary Equipment** - Evaluation of opportunities on a case-by-case basis and guided by facility type and operations. These can be related to process upgrades or retrofit opportunities that fall outside of the other categories (such as compressed air leak mitigation or motorized pool cover, etc.).

- **Water Conservation** - Evaluation of toilet, faucet, and shower flush/flow rates to eliminate cases of excessive use.

- **Renewables** - Preliminary estimate of electricity production potential from implementation of solar photovoltaic panels at facilities suited for implementation.

- **Low Cost / No Cost Measures/ Behavioral Opportunities** - Infiltration reduction, re-commissioning, terminal unit maintenance and procurement policy recommendations.

Appendix A contained in Attachment 1 includes a summary of measures investigated for all sites.

5.3 Presentation of Recommendations

The BLDG Sci Advisory Inc. 2024 Annual Energy Audit Program Summary Report (Attachment 1) summarizes the data related to efficacy, financial analysis and estimated G.H.G. reductions of energy recommendations.

The following analysis are included:

- Summary of recommended Energy and Water Conservation Measures
- Summary of Lighting Opportunities
- Shortlisted Energy Conservation Measures
- Solar Photovoltaic Opportunities
- Electrification Measures Evaluated
- Estimated Annual Utility and G.H.G. Savings by Facility
- Energy Utilization Index (E.U.I.) and Cost Utilization Index (C.U.I.) Metrics

While no action is being recommended at this time, the recommendations noted will be investigated for implementation as part of future capital project considerations and collaborative efforts with Facility Operations and Maintenance.

6.0 Financial Implications

There are no financial implications directly related to this report.

7.0 Relationship to the Oshawa Strategic Plan

This report responds to the Oshawa Strategic Plan Priority Area “Care: Safe and Sustainable Environment” with the goal to reduce the City's carbon footprint and greenhouse gas emissions.

Randy Garey, Director,
Facilities Management Services

Adam Grant, Commissioner,
Safety and Facilities Services Department

Annual Energy Audit Program Summary Report

The Corporation of the City of Oshawa

Prepared for:
City of Oshawa
The Corporation of the City of Oshawa
Centre Street South
Oshawa, Ontario
Canada, L1H 3Z7

Prepared by:
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November 8, 2024

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Third-party disclaimer

Contract Client Reference

BLDG-SCI was retained by City of Oshawa to conduct Energy Audit's for The Corporation of the City of Oshawa, located at Centre Street South in Oshawa, Ontario, Canada and operated by City of Oshawa. The contractual relationship exists between BLDG-SCI and the City of Oshawa.

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EXECUTIVE SUMMARY

BLDG-SCI Advisory Inc. (BLDG-SCI) was retained by the City of Oshawa to complete an ASHRAE Energy Audits for **The Corporation of the City of Oshawa** for various sites in Oshawa. A walk-through non-invasive site visit was conducted on July 22nd, 2024 in accordance with the ASHRAE 211-2018 Standard for Commercial Building Energy Audits according to Level I and II.

The ASHRAE Level I audits were conducted at seven (7) facilities and ASHRAE Level II audits were conducted at three (3) facilities. The aim of this study was to analyze the current energy performance of for each Facility, conduct an onsite energy assessment, and produce a list of energy conservation measures and water conservation measures complete with relevant opinion of probable costs for all ten (10) sites.

The total assessment involved a review of 50,809 m2 (530,438 ft2) of total facility area comprising of a mixture of the following department/operations:

- Public Services;
- Public Works;
- Recreation;
- Arts and Culture; and
- Airport.

The site visits revealed the potential for the implementation of energy and water conservation measures which can improve the overall energy efficiency of the City's owned and operated buildings.

The portfolio of buildings was individually assessed based on 2019-2023 utility data analysis, the data provided was further analysed for selecting the best representative ideal baseline year for Electricity (kWh/yr) and Natural Gas Use (m^3/yr) usages for each individual building.

BLDG Sci completed the review of all sites and have summarized the general energy conservation opportunities requiring either no capital cost or very low capital cost investments were identified and included that are common for majority of sites:

- **Infiltration Reduction -** Improving building air tightness is often the first step in energy conservation and energy management. The installation or replacement of worn or broken weather stripping, window caulking, and foam sealants can contribute towards reducing air infiltration around doors, windows, piping, cracks, and plumbing penetrations. It is recommended to employ an infiltration reduction program to identify, tag, record and fix sources of air leaks and new leaks as they develop on a regular basis.

- **Re-commissioning** – Ensure equipment control setting match current building space needs and occupancy schedule.

- **Terminal Unit Maintenance** – Terminal units include baseboard heaters, forced air heaters, fan heaters, unit heaters, and split systems. Routine maintenance is recommended to keep radiator fins free of debris (dirt, dust, hair, etc.) buildup. The enclosure cover can be removed and any visible debris inside the unit cleaned using a vacuum, soft brush or even a steam pressure cleaner. If any of the fins are bent or damaged they should be straightened using a pair of needle-nose pliers, metal scrapper or putty knife.

- **Procurement Policy -** Implementing a green procurement policy to guide the sourcing of goods and services will promote factoring in environmental credentials such as energy use along with other aspects such as price, performance, and quality. Purchasing efficient products reduces energy costs without compromising quality.

BLDG Sci's opinion of Probable Costs were estimated through a combination of:

- RSMeans cost estimating resources for the construction industry;
- Project costs from similar projects completed in the past; and
- Vendor and/or contractor quotes or budget pricing.

Opinion of Probable Costs are a class D level cost estimate and detailed design efforts are always recommended before proceeding with implementation. Energy savings were estimated using energy savings calculations by comparing the existing state (base case) energy consumption to a proposed state (post implementation of energy conservation measures) energy consumption. The base case was modified to reflect the proposed changes, either through new controls strategies, new equipment, new building envelope, etc. Energy savings for certain measures (specified in the energy/water conservation measure section) had prescriptive savings and were calculated using spreadsheets (for example LEED v4 Environment and Efficiency calculator for water consumption end use breakdown) with savings applied to the baseline electricity/gas consumption.

A review of the existing energy consumption profile for all facilities was reviewed closely and revealed the following report summary for feasible energy and water conservation measures that were reviewed along with estimated costs, savings, and simple payback. The report summary presents the estimated energy savings and greenhouse gas reductions from implementing the recommended measures in this annual report. These measures are chosen to provide practical opportunities for the respective sites to improve energy performance and achieve cost savings in an economical way. The primary goal is to identify a series of energy savings opportunities which are constructable, have an attractive simple payback, and present a path forward for project initiatives. Other considerations include green-house gas reduction potential and improving occupant comfort. The summary table below provides the estimated potential annual savings of the aggregated recommended energy and water conservation measures from each of the building's respective energy audit reports.

Table E-1-1: Summary of Recommended Energy and Water Conservation Measures

Building Name	ASHRAE Level	Estimated Annual Savings									
		Natural Gas	Propane	Electricity	Demand	Water	Total Cost Savings	GHG Reduction		Energy	
		m^3	L	kWh	kW	m3	$	Tonnes CO2e	%	GJ	%
Donevan Recreation Complex	Level II	12,190		155,180	20.4	2,030	29,140	27.9	9.6%	1,013	11.6%
Parks & Animal Services	Level II	19,890		75,460	50.1	0	13,390	40.3	19.8%	1,012	21.8%
Airport - Terminal Building	Level II	25,030		71,800	8.0	150	18,930	50.4	45.7%	1,191	39.2%
Northview Community Centre	Level I	19,550	0	132,550	96.7	530	25,440	41.5	55.5%	1,205	46.5%
G1 Parking Garage & Bus Terminal	Level I	1,600	0	97,800	22.5	0	12,600	5.8	16.6%	412	19.6%
Airport - South Field Buildings	Level I	4,180	0	89,090	65.0	30	15,260	10.6	21.5%	476	37.4%
Arts Resource Centre	Level I	5,880	0	11,870	20.2	150	4,550	11.7	35.7%	262	28.5%
Parking Garage - McMillan Parkade (G2)	Level I	0	0	29,950	1.5	0	4,190	0.8	12.1%	108	12.1%
Howden Public Works Depot	Level I	0	1,860	18,170	14.0	0	3,540	3.4	10.0%	113	14.9%
Airport - Hanger	Level I	160	0	9,210	3.4	0	1,410	0.6	15.3%	39	28.2%
Total		**88,480**	**1,860**	**691,080**	**301.9**	**2,890**	**128,450**	**193.0**	**22.9%**	**5,831**	**23.2%**
Total (level I)	Level I	31,370	1,860	388,640	223	710	66,990	74.4	31.5%	2,615	30.1%
Total (level II)	Level II	57,110	0	302,440	79	2,180	61,460	118.6	19.6%	3,216	19.6%

Notes:

1. Potential annual savings in table E-1-1 for each building name are based on the individual report consolidating all the ECMs and WCMs.
2. Refer to individual building reports for ECM and WCM breakdown, details, etc.

ACRONYMS AND ABBREVIATIONS

A/C	air conditioner
ACH	air changes per hour
AFUE	average fuel utilization efficiency
ASHRAE	American Society of Heating, Refrigeration, and Air-Condition Engineers
BAS	building automation system
BTU	British thermal unit
BTU/hr	BTU per hour
°C	degree Celsius
CFM	cubic feet per minute
CAV	constant air volume
CDD	cooling degree days
CO_2	carbon dioxide
CO_2e	greenhouse gas carbon dioxide equivalence
COP	coefficient of performance
DCW	domestic cold water
DHW	domestic hot water
DX	direct expansion
EER	energy efficiency ratio
°F	degree Fahrenheit
FCU	fan coil unit
ft^2	square feet
ft^3	cubic feet
HCFC	hydrochlorofluorocarbon
HFC	hydrofluorocarbon
HID	high intensity discharge
HRAI	Heating, Refrigeration and Air Conditioning Institute of Canada
HST	harmonized sales tax
HVAC	heating, ventilation, and air conditioning
IESNA	Illuminating Engineering Society of North America
IESO	Independent Electricity System Operator
IGU	insulated glazing unit
IR	Infrared
kVA	kilovolt-ampere
kW	kilo-watt
kWh	kilowatt hour

L	litres
LED	light emitting diode
m^2	square meters
m^3	cubic meters
MBH	million BTU per hour
N/A	not applicable
NBC	National Building Code of Canada
NG	natural gas
O&M	operation and maintenance
OEM	original equipment manufacturer
RT	refrigeration tons
RTU	roof top unit
R-Value	thermal resistance measure in $(hr \cdot ft^{2} \cdot °F)/BTU$
SP	simple payback
U-Value	Thermal transmittance measured in $BTU/(hr \cdot ft^{2} \cdot °F)$
USG	United States gallon
UV	ultraviolet
VAV	variable air volume
VFD	variable frequency drive
VSD	variable-speed drive
W	Watt
WCM	water conservation measure
U-Value	Thermal transmittance measured in $BTU/(hr \cdot ft^{2} \cdot °F)$

GLOSSARY

The definition should be considered during the review of this **ASHRAE Energy Audit Summary**:

Building Automation System (BAS)	A distributed control system that is a computerized, intelligent network of electronic devices designed to monitor and control the mechanical, electronics, and lighting systems in a building. BAS core functionality keeps the building climate within a specified range, provides lighting based on an occupancy schedule, and monitors system performance and device failures and provides email and/or text notifications to building engineering/maintenance staff. The BAS functionality reduces building energy and maintenance costs when compared to a non-controlled building. A building controlled by a BAS is often referred to as an intelligent building.
Constant Air Volume (CAV)	A type of air distribution system where the temperature of air is varied while the volume of air delivered is held constant depending on the heating or cooling needs of each space.
Opinion of Probable Cost Alternate Term: **Capital Cost**	Opinions of Probable Costs identified in this report include costs including the following phases of work: design, equipment and materials, construction/ installation, project management, construction administration, and commissioning.
Contingency	A reserve amount (typically 15%) in Canadian Dollars which is incorporated into the Opinion of Probable Cost to cover potential events, uncertainties, or time delays not specifically accounted for in the cost estimate.
Cooling Degree Days (CDD)	Cooling Degree Days is a measure of how hot a location was over a period, relative to a base temperature. The base temperature is 18.0°C and the period is one year. If the daily average temperature exceeds the base temperature, the number of cooling degree-days for that day is the difference between the two temperatures. However, if the daily average is equal to or less than the base temperature, the number of cooling degree-days for that day is zero.
Direct Expansion (DX)	A type of cooling system where the refrigerant is prepared to absorb heat from a space by passing through an expansion valve.
Domestic Hot Water (DHW)	Hot water provided for potable uses, such as handwashing or laundry.
Energy Conservation Measure (ECM)	Any type of project conducted, or technology implemented, to reduce the consumption of energy in a building. These can come in a variety of forms: water, electricity and gas being the main three for industrial and commercial enterprises. The aim of an ECM should be to achieve a saving, reducing the amount of energy used by a particular process, technology or Facility.
Energy Utilization Index (EUI)	Energy Utilization Index is a normalized comparison of the energy performance of a Facility where the normalizing factor is floor area. The units for the EUI are kBTU/ft^2 or GJ/m^2.

Greenhouse Gas (GHG)	Greenhouse Gases (GHGs) are primarily comprised of Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Sulfur Hexafluoride (SF_6), Perfluorocarbons (PFCs), and Hydrofluorocarbons (HFCs).
Greenhouse Gas Carbon Dioxide Equivalence (CO2e)	GHGs are typically measured in terms of kilograms or tonnes of carbon dioxide equivalent (CO_2e). Since different GHGs exhibit differences in the amount of global warming they can potentially cause, this allows emissions of different GHGs to be combined into a common unit of measure.
Heating, Ventilation, and Air-conditioning (HVAC)	This term collectively refers to the process of conditioning air for use in a built environment for the comfort of occupants.
Heating Degree Days (HDD)	Heating Degree Days is a measure of how cold a location was over a period, relative to a base temperature. The base temperature is 18.0°C and the period is one year. If the daily average temperature is below the base temperature, the number of heating degree-days for that day is the difference between the two temperatures. However, if the daily average temperature is equal to or higher than the base temperature, the number of heating degree-days for that day is zero.
Incremental Cost	Incremental cost is typically used when a component is approaching the end of its useful life and must be replaced. The replacement can consider a like-to-like replacement, or replacement with a higher efficiency alternative. Incremental cost is the difference in the cost of a base case measure compared to the cost of a higher energy efficiency alternative.
Independent Electricity System Operator (IESO)	An independent, non-profit crown corporation responsible for the real-time procurement of electric power in the province of Ontario. The IESO merged with the Ontario Power Authority (OPA) on January 1, 2015; the OPA was the former administrator of the SaveOnEnergy program.
Light Emitting Diode (LED)	An LED lamp passes electrical current through a diode designed to produce visible light. This is a relatively new technology that exhibits exceptional colour rendering and very low energy use.
Low Cost/No Cost Measures	Low cost/no cost measures are defined as measures that can be implemented within the Operations and Maintenance (O&M) budget. Low cost/no cost measures typically include such initiatives as: schedule adjustment, set-point adjustment, and fluid flow-rate adjustment.
Net Present Value (NPV)	Net Present Value (NPV) is a standard method for the financial appraisal of long-term projects. Used for capital budgeting, and widely throughout economics, it measures the excess or shortfall of cash flows, in present value (PV) terms, once financing charges are met. It is also called net present worth (NPW).
Office of Energy Efficiency (OEE)	The Office of Energy Efficiency (OEE) is Canada's centre of excellence for energy, efficiency and alternative fuels information. The OEE is mandated to strengthen and expand Canada's commitment to energy efficiency in order to help address the Government of Canada's policy objectives.

Original Equipment Manufacturer (OEM)	OEM is a company whose equipment, goods, or products are used in the products of other companies who sell the finished products to users.
Outdoor Air (OA)	The ambient air outside of a building.
Outdoor Air Temperature (OAT)	The temperature of the ambient air outside of a building.
Simple Payback (SP)	Simple payback is the ratio of capital investment cost to the energy cost savings. It indicates how long a capital investment pays back. SP = (Capital Cost) / (Energy Cost Savings)
Unit Heater (UH)	A type of terminal unit typically equipped with a fan and either an electric heater, hydronic heating coils, or a natural gas burner to provide space heating.
Variable Air Volume (VAV)	A type of air distribution system where the temperature of air is held constant while the volume of air delivered is varied depending on the heating or cooling needs of each space.
Variable Frequency Drive (VFD)	A type of adjustable-speed drive used in electro-mechanical drive systems to control AC motor speed and torque by varying motor input frequency and voltage.
Water Conservation Measure (WCM)	Any type of project conducted, or technology implemented, to reduce the consumption of water in a building. The aim of a WCM should be to achieve savings, reducing the amount of water used by a particular process, technology, or Facility.
Water Utilization Index	Water Utilization Index is a normalized comparison of the water performance of a Facility where the normalizing factor is floor area. The units for the WUI are m^3/m^2 or ft^3/ft^2.

1.0 INTRODUCTION

BLDG-SCI Advisory Inc. (BLDG-SCI) was retained by the City of Oshawa to execute consulting services for an Energy Audit Program for various municipal facilities owned and operated by the City of Oshawa.

The energy audit program is intended to cover sixty (60) facilities over a four (4) year period. This report covers year one (2024) and a total of ten (10) buildings.

The energy assessments consisted of walk-through audits, discussions with building operators, utility analysis, and identification of Energy Conservation Measures (ECMs) and Water Conservation Measures (WCMs), including no-cost/low-cost opportunities. The site visits associated with this project were conducted between June 18th and July 22nd 2024 by BLDG-SCI Engineering Manager, Nathan Sokolowski, P.Eng., CEM.

1.1 PURPOSE

The purpose of this report is to highlight findings and top recommendations for the ten (10) facilities audited in year one (2024). A summary of estimated energy and water savings will be provided, along with pathways for significant greenhouse gas reductions. The potential improvement in building performance metrics relative to the baseline year will be captured to illustrate the positive business case from implementation of recommended measures. A subsection will be dedicated to consolidated lighting opportunities portfolio wide as requested by the City of Oshawa.

1.2 BACKGROUND

1.2.1 Client Information

The following table summarizes key client information related to this assignment.

Table 1-1: Key Client Information Summary

Client	City of Oshawa
Point of Contact	Kevin Wong
Title	Energy Management Coordinator
Contact Information	Phone: 905-436-3311 ext. 2030 Email: kwong@oshawa.ca

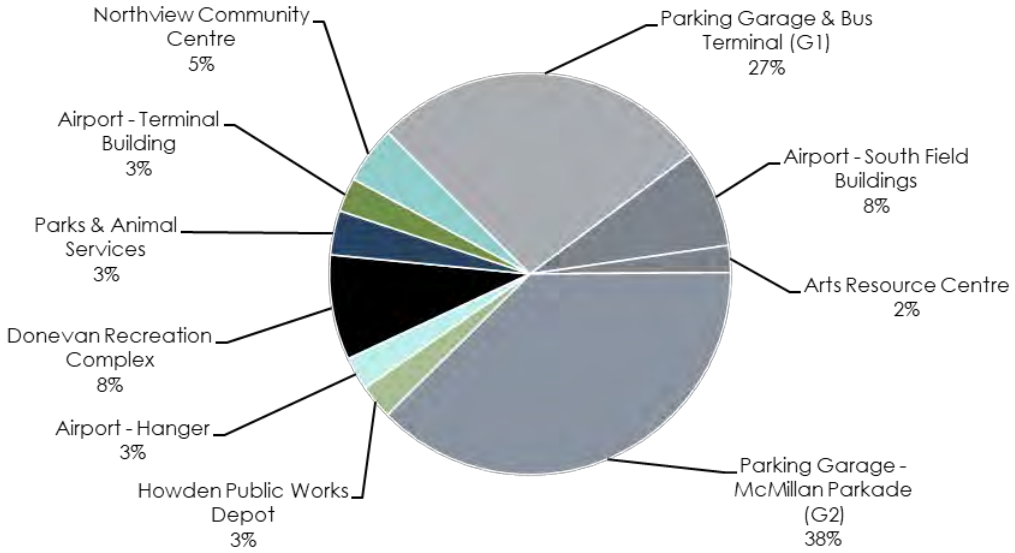
1.3 PORTFOLIO DESCRIPTION

Table 1-2 provides general facility details for the assessed buildings. The total audited area was 50,809 m2 (530,438 ft2). ASHRAE Level I and Level II energy audits were conducted at seven (7) and three (3) facilities, respectively. The audited buildings were a mixture of the following departments/operations:

- Airport
- Public Services
- Public Works
- Recreation
- Arts and Culture

Table 1-2: Facility Details

Site #	Building Name	ASHRAE Level	Location	Vintage	Gross Floor Area (m^2)	Gross Floor Area (ft^2)	Description
29	Donevan Recreation Complex	Level II	171 Harmony Road South	1975	4,174	44,929	Athletic Centre with one ice rink swimming pool (2 floors)
26	Parks & Animal Services	Level II	919 Farewell Street	1961	1,764	18,988	Animal facility, storage, greenhouse (1 floor)
46	Airport - Terminal Building	Level II	1200 Airport Blvd	1997	1,347	14,499	Offices (2 floors)
2	Northview Community Centre	Level I	150 Beatrice Street East	1989	2,282	24,563	Community Centre (1 floor)
21	Parking Garage & Bus Terminal (G1)	Level I	1 Centre Street North	1974	13,471	145,001	Multi-level parking spaces (4 floors)
48	Airport - South Field Buildings	Level I	1000 Stevenson Road North	1940	3,896	41,936	Storage, museum, canteen, FEC (1 floor)
58	Arts Resource Centre	Level I	45 Queen Street	1952	1,068	11,496	Gallery (2 floors)
45	Parking Garage - McMillan Parkade (G2)	Level I	100 King Street West	1982	18,581	200,004	Multi-level parking spaces (5 floors)
57	Howden Public Works Depot	Level I	235 Howden Road East	1991	1,381	14,865	Offices & garage (2 floors)
47	Airport - Hanger	Level I	481 Aviator Lane	1997	2,845	14,157	Hanger (1 floor)



Gross Floor Area Breakdown by Building

2.0 ASSESSMENT METHODOLOGY

The energy audit process begins with a Request For Information (RFI). BLDG-SCI communicates with key project stakeholders to determine basic facility characteristics and makes a request for available as-built drawings, historic utility bills, and details on recent upgrades/renovations that may have occurred at the facility.

Site visits are then carried out at each site. The qualified energy auditor(s) conducts a walk-through survey of the facility to become familiar with its construction, building systems, equipment schedules, operation characteristics, and maintenance needs. The auditor(s) is accompanied by a knowledgeable building operator or maintenance staff member to discuss opportunities for operational optimization as well as any persistent issues affecting building performance or occupant behaviour.

Information collected from the RFI and site assessment is then analyzed to establish an energy baseline. This is comprised of the following steps detailed below.

Step 1 – Utility Analysis

- Determine how much energy a facility is consuming.
- Determine portions/percentage of energy attributed to each utility stream (electricity, natural gas, and propane).
- Analyze historical utility data to identify trends and irregularities.
- Establish building performance metrics such as Energy Utilization Index (EUI) and Cost Utilization Index (CUI).

Step 2 – Baseline Year Determination

- Determine a baseline year to establish a reference point in which energy savings can be compared.
- Conduct linear regression analysis (R-squared analysis) for each utility stream
    - Measure the degree of correlation between utility consumption (electricity and natural gas) and outdoor temperature via Heating Degree Days (HDDs) and Cooling Degree Days (CDDs).
    - If a moderate to strong correlation was found, the linear regression between the utility consumption and the annual HDDs/CDDs in a comparative year was used to identify the reporting period baseline use.
    - If a weak correlation was found, the provided utility data, omitting irregular years, was averaged to identify the baseline year.

Step 3 – Breakdown by Major End Use

- Breakdown the annual energy consumption at each respective facility into the following major end use categories. Note some facilities will have additional categories as required (for example, 'Refrigeration Plant' in buildings with ice rinks)
    - **Space Heating** – This includes all space heating provided heating systems to maintain space temperatures in the Facility;
    - **Space Cooling** – This includes energy consumed by air conditioning equipment;

- **Domestic Hot Water** – All Domestic Hot Water (DHW) used in building;
- **Air System Fans** – All fan systems (HVAC, exhaust, supply, etc.) serving the building;
- **Lighting** – All interior and exterior lighting; and
- **Auxiliary Equipment** – Energy consumed by plug loads (for example kitchen appliances, vending machines, computers, televisions, etc.).

- Generally, the breakdown is determined with two (2) strategies
  - Strategy 1 – Energy Modelling
    - The building simulation program Hourly Analysis Program (HAP) version 6.1 (Energy Plus) is used to simulate building energy consumption. The program uses typical weather data along with input from the user of the building's HVAC equipment, building occupancy schedule, envelope materials, plug loads, and process loads to simulate energy use.
    - The architectural features for the baseline model are gathered from the Facility drawings provided which included Facility dimensions, wall construction, roof construction, window dimensions and building orientation.
    - The Facility's internal gains are entered in the baseline model using occupancy counts and estimating electrical appliances such as computers; the ASHRAE Fundamentals 2021 Handbook was used as a guide for estimating the loads from this equipment.
    - To determine the Facility's lighting load consumption, lighting counts were taken whilst on site.
    - The Facility's HVAC components were generated in the model using a combination of provided drawings, manufacturer specifications and equipment nameplates. In addition, the building operator's description of the Facility's HVAC sequences of operations (BAS where applicable) was also considered in the model.
    - To ensure that the baseline model was operating similar to the existing building, the Facility's baseline consumption based on the utility billing data was compared to the building simulation's energy consumption outputs. This comparison was done both analytically by comparison to total consumption and visually by comparing monthly trends to expected consumption.
  - Strategy 2 – Engineering Calculations
    - The estimation of the energy consumption by major end-use is made based on the listing of identified equipment on site, relevant nameplate information, the estimated run hours, and any diversity in use that can be foreseen.

The baseline year, end use breakdown, and interviews with facility staff serve as a basis for identification of energy and water conservation opportunities. Energy and water conservation measures are discussed in detail within section 4.0. The following section will summarize the simulated baseline year on a site level as well as a portfolio level.

3.0 BASELINE YEAR SUMMARY

Table 3-1 presents the baseline year for each facility. Electrical and natural gas energy consumption values have been converted to common units of energy (gigajoules - GJ) to be able to compare the total amount of energy from each source at each Facility. The table is sorted based on energy (GJ) use with the largest users top down.

Note water consumption (m^3) is omitted from the table however it's cost is reflected in the total. Also note the propane consumption (L) and cost for Howden Public Works Depot is not shown in the table, but its energy (GJ) and utility expense ($) are included in total.

Table 3-1: Annual Baseline Utility Use by Facility

Building Name	ASHRAE Level	Electricity					Natural Gas				Total		
		Use		Demand	GHG Emissions	Cost	Use		GHG Emissions	Cost	Use	GHG Emissions	Cost
		kWh	GJ	kW	Tonnes CO2e	$	m^3	GJ	Tonnes CO2e	$	GJ	Tonnes CO2e	$
Donevan Recreation Complex	Level II	1,009,791	3,635	265	28.3	137,954	136,511	5,084	263.8	32,142	8,719	292.1	201,121
Parks & Animal Services	Level II	238,986	860	55	6.7	27,926	101,868	3,794	196.8	23,530	4,654	203.5	58,523
Airport - Terminal Building	Level II	298,464	1,074	66	8.4	40,997	52,675	1,962	101.8	11,503	3,036	110.1	61,483
Northview Community Centre	Level I	376,261	1,355	81	10.5	53,202	33,264	1,239	64.3	8,316	2,593	74.8	67,326
G1 Parking Garage & Bus Terminal	Level I	464,175	1,671	179	13.0	57,015	11,462	427	22.1	3,935	2,098	35.1	62,836
Airport - South Field Buildings	Level I	107,219	386	-	3.0	16,079	23,844	888	46.1	10,037	1,274	49.1	27,026
Arts Resource Centre	Level I	94,371	340	37	2.6	11,833	15,575	580	30.1	4,294	920	32.7	20,010
Parking Garage - McMillan Parkade (G2)	Level I	247,942	893	111	6.9	34,648	N/A	N/A	N/A	N/A	893	6.9	35,243
Howden Public Works Depot	Level I	63,356	228	22	1.8	7,908	N/A	N/A	N/A	N/A	759	34.0	22,187
Airport - Hanger	Level I	22,043	79	9	0.6	3,287	1,600	60	3.1	400	139	3.7	9,252
Total		**2,922,607**	**10,521**	**824**	**81.8**	**390,850**	**376,799**	**14,033**	**728.1**	**94,157**	**25,086**	**842.2**	**565,008**
Total (level I)	Level I	1,375,367	4,951	438	39	183,972	85,745	3,193	166	26,982	8,676	236	243,881
Total (level II)	Level II	1,547,240	5,570	386	43	206,878	291,054	10,840	562	67,175	16,410	606	321,127

The baseline energy (GJ) consumption breakdown by facility is illustrated in Figure 3-1. The largest consumers are the facilities which level II audits were conducted at.

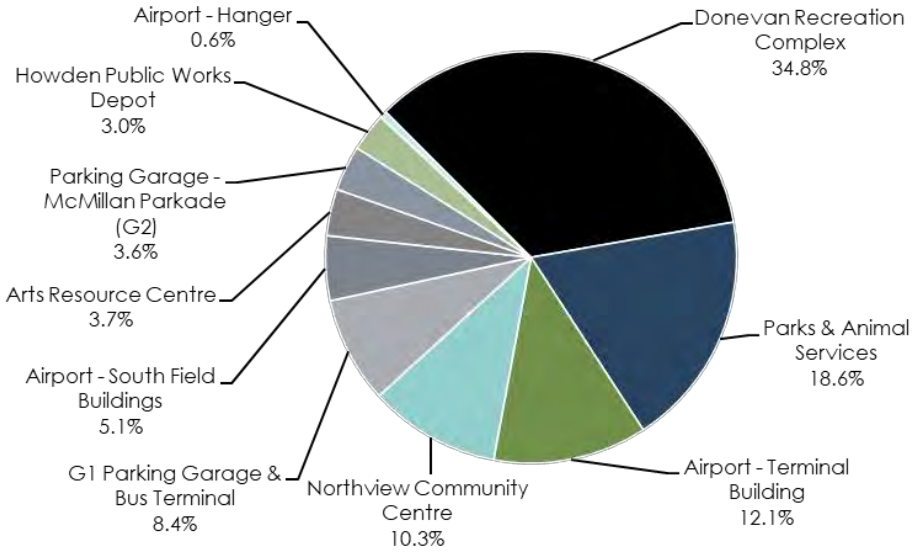


Figure 3-1: Energy Consumption (GJ) Breakdown by Facility

The breakdown of Greenhouse Gas (GHG) emission by facility, as determined from the baseline year, is illustrated in Figure 3-2. The largest emitters are the facilities which level II audits were conducted at.

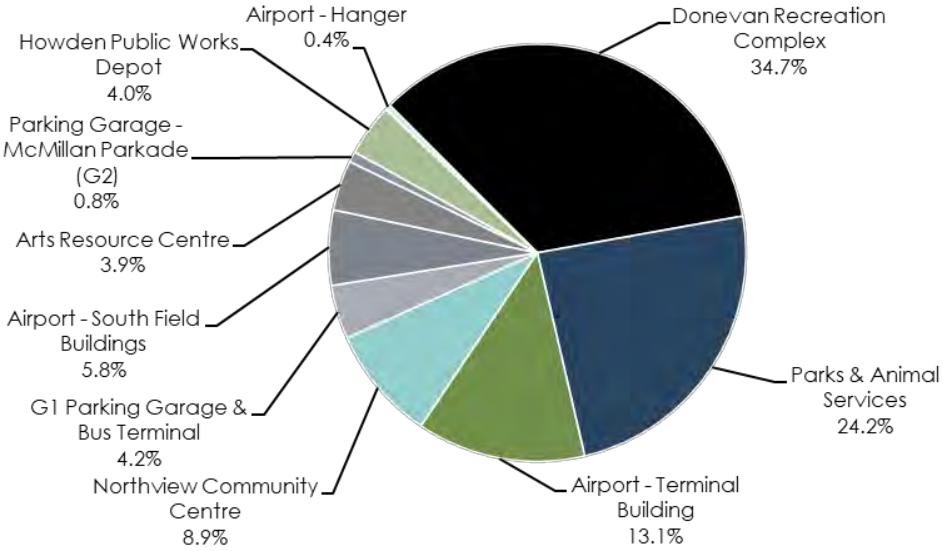


Figure 3-2: GHG Emission (Tonnes CO_2e) Breakdown by Facility

3.1 ANNUAL ENERGY CONSUMPTION BREAKDOWN BY FUEL TYPE

Annual energy consumption breakdown by type was generated from the summation of baseline years for each facility. Electrical, natural gas, and propane energy consumption figures have been converted to common units of energy (gigajoules) to be able to compare the total amount of energy from each source for the portfolio of buildings in year one (phase 1). The following figures show the fuel type breakdown by both consumption and cost.

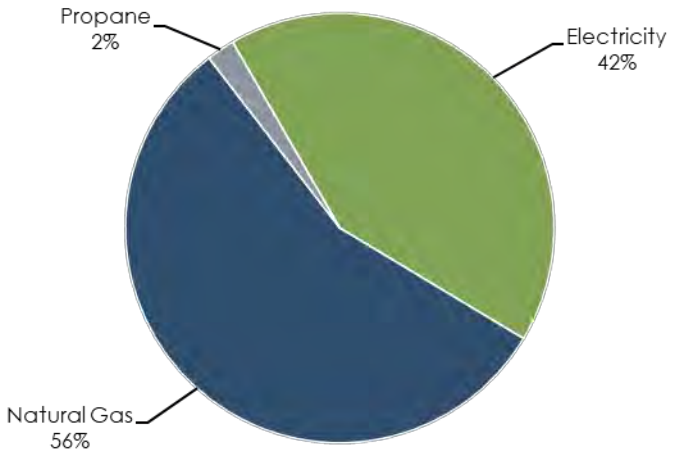


Figure 3-3: Energy Consumption (GJ) Breakdown by Fuel Type

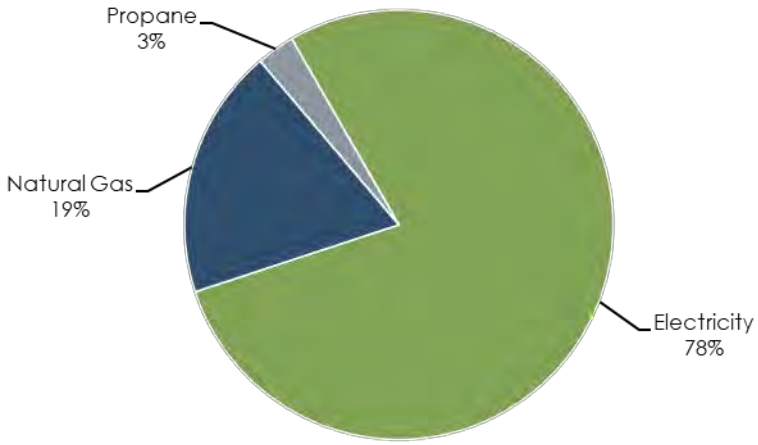


Figure 3-4: Annual Cost Breakdown by Fuel Type

It is observed that natural gas represents the majority of energy consumption in the portfolio but electricity represents the majority of energy costs. This is caused by the price difference between natural gas and electricity in Ontario.

Table 3-2: Annual Energy Consumption and Cost Breakdown by Type

Fuel Type	Energy Consumption	Percentage of Total Consumption	Cost	Percentage of Total Cost
	GJ	%	$	%
Electricity	10,521	42	390,850	78
Natural Gas	14,033	56	94,157	19
Propane	531	2	14,279	3
Total	**25,086**	**100**	**499,286**	**100**

4.0 ENERGY & WATER CONSERVATION OPPORTUNITIES

The goal of each energy assessment is to provide recommendations based on behavioral, operational, Facility, and equipment performance towards how Facilities can be improved through reducing energy and water consumption and overall operating costs. Energy and water conservation measures have been identified for each facility. The measures identified can be categorized as follows:

- **Building Envelope** – Insulation upgrades and window replacement opportunities.
- **Heating, Ventilation, and Air Conditioning –** Equipment upgrades and control optimization (demand control ventilation, temperature control set points, etc.).
- **Lighting –** Interior LED upgrades/retrofits, exterior LED upgrades/retrofits, and control optimization (occupancy, dimming, daylighting, etc.).
- **Domestic Hot Water** – Efficiency upgrade or right-sizing units to meet space/occupant needs.
- **Auxiliary Equipment –** Evaluation of opportunities on a case-by-case basis and guided by facility type and operations. These can be related to process upgrades or retrofit opportunities that fall outside of the other categories (such as compressed air leak mitigation or motorized pool cover, etc.).
- **Water Conservation** – Evaluation of toilet, faucet, and shower flush/flow rates to eliminate cases of excessive use.
- **Renewables -** Preliminary estimate of electricity production potential from implementation of solar photovoltaic panels at facilities suited for implementation.

Based on the site visits, discussions with Facility staff, and review of existing equipment and utility data, low cost and no cost measures were identified for each Facility along with behavioral opportunities for staff to participate in to reduce energy use and operating cost. These include, but are not limited to the following:

- **Infiltration Reduction -** Improving building air tightness is often the first step in energy conservation and energy management. The installation or replacement of worn or broken weather stripping, window caulking, and foam sealants can contribute towards reducing air infiltration around doors, windows, piping, cracks, and plumbing penetrations. It is recommended to employ an infiltration reduction program to identify, tag, record and fix sources of air leaks and new leaks as they develop on a regular basis.
- **Re-commissioning** – Ensure equipment control setting match current building space needs and occupancy schedule.
- **Terminal Unit Maintenance** – Terminal units include baseboard heaters, forced air heaters, fan heaters, unit heaters, and split systems. Routine maintenance is recommended to keep radiator fins free of debris (dirt, dust, hair, etc.) buildup. The enclosure cover can be removed and any visible debris inside the unit cleaned using a vacuum, soft brush or even a steam pressure cleaner. If any of the fins are bent or damaged they should be straightened using a pair of needle-nose pliers, metal scrapper or putty knife.
- **Procurement Policy -** Implementing a green procurement policy to guide the sourcing of goods and services will promote factoring in environmental credentials such as energy use along with other aspects such as price, performance, and quality. Purchasing efficient products reduces energy costs without compromising quality.

A summary of investigated measures for all sites is provided in **Appendix A**.

Table 4-1 presents a site level summary of annual utility savings if each facility implemented the recommended measures identified in their respective audit report. The percentage (%) change column is energy or GHG savings relative to the respective facilities baseline year.

Table 4-1: Estimated Annual Utility and GHG Savings By Facility

Building Name	ASHRAE Level	Estimated Annual Savings									
		Natural Gas	Propane	Electricity	Demand	Water	Cost Savings	GHG Reduction		Energy	
		m^3	L	kWh	kW	m^3	$	Tonnes CO2e	% Change	GJ	% Change
Donevan Recreation Complex	Level II	12,190	-	155,180	20.4	2,030	29,140	27.9	9.6%	1,013	11.6%
Parks & Animal Services	Level II	19,890	-	75,460	50.1	-	13,390	40.3	19.8%	1,012	21.8%
Airport - Terminal Building	Level II	25,030	-	71,800	8.0	150	18,930	50.4	45.7%	1,191	39.2%
Northview Community Centre	Level I	19,550	-	132,550	96.7	530	25,440	41.5	55.5%	1,205	46.5%
G1 Parking Garage & Bus Terminal	Level I	1,600	-	97,800	22.5	-	12,600	5.8	16.6%	412	19.6%
Airport - South Field Buildings	Level I	4,180	-	89,090	65.0	30	15,260	10.6	21.5%	476	37.4%
Arts Resource Centre	Level I	5,880	-	11,870	20.2	150	4,550	11.7	35.7%	262	28.5%
Parking Garage - McMillan Parkade (G2)	Level I	-	-	29,950	1.5	-	4,190	0.8	12.1%	108	12.1%
Howden Public Works Depot	Level I	-	1,860	18,170	14.0	-	3,540	3.4	10.0%	113	14.9%
Airport – Hanger	Level I	160	-	9,210	3.4	-	1,410	0.6	15.3%	39	28.2%
Total		**88,480**	**1,860**	**691,080**	**301.9**	**2,890**	**128,450**	**193.0**	**22.9%**	**5,831**	**23.2%**
Total (level I)	Level I	31,370	1,860	388,640	223	710	66,990	74.4	31.5%	2,615	30.1%
Total (level II)	Level II	57,110	-	302,440	79	2,180	61,460	118.6	19.6%	3,216	19.6%

Table 4-2 presents a summary of annual utility savings for the various lighting measures evaluated in the portfolio of buildings. Net Present Value (NPV) is an indication of the present value of all cash flows, in excess or short fall, measured over the expected useful life of the opportunity. The Internal Rate of Return (IRR) is an indicator of the efficiency of an investment, as opposed to NPV, which indicates value or magnitude. The IRR is the annualized effective compounded return rate which can be earned on the invested capital, i.e., the yield on the investment. The simple payback, NPV, and IRR are calculated without including potential incentive amounts which would be available through SaveOnEnergy prescriptive or custom streams.

Table 4-2: Lighting Opportunities Summarized

Building Name	Energy Conservation Measure	Opinion of Probable Cost	Electrical Savings		Demand Savings	Total Cost Savings	GHG Reduction	Simple Payback	Measure Life Expectancy	Net Present Value	Internal Rate of Return
		$	kWh	%	kW	$	Tonnes eCO_2	Years	Years	$	%
Donevan Recreation Complex	Interior LED Lighting Upgrades	46,000	51,790	5.1%	11.5	7,080	1.5	6.5	12	29,100	8.9%
Donevan Recreation Complex	Exterior LED Lighting Upgrades	39,000	28,870	2.9%	5.9	3,940	0.8	9.9	10	(3,540)	-1.7%
Parks & Animal Services	Interior LED Lighting Upgrades	13,600	10,380	4.3%	5.6	1,200	0.3	11.3	12	(880)	-1.0%
Parks & Animal Services	Exterior LED Lighting Upgrades	3,400	3,110	1.3%	-	360	0.1	9.4	10	(160)	-0.9%
Airport - Terminal Building	Interior Lighting Retrofit	3,100	6,030	2.0%	1.2	830	0.2	3.7	12	5,700	22.5%
Airport - Terminal Building	Runway Pole Lighting Upgrades	11,700	12,320	4.1%	-	1,700	0.3	6.9	10	3,600	5.4%
Northview Community Centre	Interior LED Lighting Upgrades	18,850	20,660	5.5%	5.4	2,920	0.6	6.5	12	12,100	9.0%
Northview Community Centre	Exterior LED Lighting Retrofit	8,840	4,490	1.2%	-	630	0.1	14.0	10	(3,170)	-7.5%
G1 Parking Garage & Bus Terminal	Interior LED Lighting Upgrades	9,100	12,400	2.7%	4.6	1,500	0.3	6.1	12	6,800	10.3%
G1 Parking Garage & Bus Terminal	Exterior LED Lighting Upgrade	53,400	73,200	15.8%	14.6	9,000	2.0	5.9	10	27,600	8.7%
G1 Parking Garage & Bus Terminal	Lighting Control Opportunities	10,000	28,100	6.1%	11.2	3,400	0.8	2.9	12	26,000	30.3%
Airport - South Field Buildings	Interior LED Lighting Upgrades	8,600	6,830	6.4%	5.0	1,020	0.2	8.4	12	2,200	3.9%
Airport - South Field Buildings	Exterior LED Lighting Upgrades	2,500	1,750	1.6%	-	260	<0.1	9.6	10	(160)	-1.2%
Arts Resource Centre	LED Lighting Upgrades	11,000	9,550	10.1%	3.9	1,200	0.3	9.2	12	1,700	2.4%
Parking Garage - McMillan Parkade (G2)	LED Lighting Upgrades	6,740	4,930	2.0%	1.3	690	0.1	9.8	12	570	1.3%
Parking Garage - McMillan Parkade (G2)	Lighting Control - Parking Garage	20,570	8,600	3.5%	-	1,200	0.2	17.1	10	(9,770)	-10.5%
Parking Garage - McMillan Parkade (G2)	Lighting Control - Stairwell	4,000	5,990	2.4%	-	840	0.2	4.8	10	3,600	14.2%
Parking Garage - McMillan Parkade (G2)	Lighting Control - Administration & Service Areas	1,130	60	<0.1%	-	10	<0.1	113.0	12	(1,020)	N/A
Howden Public Works Depot	Interior LED Lighting Retrofit	1,300	1,240	2.0%	1.0	150	<0.1	8.7	12	290	3.4%
Howden Public Works Depot	Exit Sign Upgrade	300	250	0.4%	-	30	<0.1	10.0	12	20	0.9%
Airport - Hanger	LED Lighting Upgrades	7,125	8,240	37.4%	3.4	1,230	0.2	5.8	12	5,900	11.3%
Total	**Lighting ECMs (Combined)**	**280,255**	**298,790**		**74.6**	**39,190**	**8.4**	**7.2**	**12**	**135,200**	**6.9%**

Table 4-3 highlights nine (9) measures which are worth pursuing based on their NPV and IRR. The projects generally impact space heating or HVAC equipment and will require additional study (design, review, commissioning, etc.) to refine the project merit. Airport – Terminal Building 'Exterior Window Replacement' is an outlier in terms of return on investment, however its potential for significant GHG savings is worth emphasizing.

Table 4-3: Shortlisted Energy Conservation Measures

Building Name	Energy Conservation Measure	Opinion of Probable Cost	Natural Gas Savings		Electrical Savings		Total Cost Savings	GHG Reduction	Simple Payback	Measure Life Expectancy	Net Present Value	Internal Rate of Return
		$	m^3	%	kWh	%	$	Tonnes eCO_2	Years	Years	$	%
Donevan Recreation Complex	Roof Top Unit Upgrades	19,000	1,870	1.4%	40,360	4.0%	5,950	4.7	3.2	20	78,700	28.7%
Donevan Recreation Complex	Motorized Pool Cover	30,000	3,910	2.9%	12,660	1.3%	5,000	7.9	6.0	15	34,400	12.3%
Parks & Animal Services	Boiler Piping Arrangement	48,400	18,500	18.2%	3,670	1.5%	4,700	35.6	10.3	20	28,700	5.3%
Airport - Terminal Building	Exterior Window Replacement	302,700	23,810	45.2%	46,950	15.7%	11,600	47.3	26.1	30	(41,490)	-1.0%
Northview Community Centre	RTU Upgrades with Energy Recovery	52,000	12,500	37.6%	13,600	3.6%	5,050	24.5	10.3	20	30,900	5.3%
Northview Community Centre	RTU Demand Control Ventilation	30,000	7,000	21.0%	7,000	1.9%	2,740	13.7	10.9	20	15,000	4.5%
Airport - South Field Buildings	Condensing Gas Unit Heaters	6,000	1,480	6.2%	970	0.9%	770	2.9	7.8	20	6,600	9.2%
Arts Resource Centre	RTU-1 Demand Control Ventilation	3,300	100	0.6%	3,000	3.2%	400	0.3	8.3	20	3,300	8.3%
Arts Resource Centre	RTU-2 Upgrade with Energy Recovery	15,000	3,900	25.0%	(1,100)	-1.2%	940	7.5	16.0	20	430	0.3%
Total	**Shortlisted ECMs (Combined)**	**506,400**	**73,070**		**127,110**		**37,150**	**144.5**	**13.6**	**20**	**103,400**	**2.0%**

Five (5) out of the ten (10) sites were identified as suitable candidates for the implementation of solar photovoltaic panels. Table 4-4 presents a summary of solar photovoltaic opportunities investigated for phase one (2024). Annual solar PV electricity generation for each site was estimated using the United States National Renewable Energy Laboratory's PVWatts Calculator. The analysis takes into consideration the total roof space available for panel installation and accounts for the presence of roof obstructions such as HVAC units, exhaust fans, gas lines, and plumbing vents. Roof footprints glaringly obvious as unsuitable such as those owing to shading concerns or the presence of HVAC equipment were excluded. The analysis establishes a preliminary estimate of the electricity production potential of solar PV systems at the subject site and a detailed design/investigation into the best performing configuration and layout is always recommended.

There are no incentives available to municipalities at this time to offset the capital costs associated with solar panels implementation. The financial analysis does not account for any increases in electricity market price forecast. Note a positive return on investment hinges at a price point of roughly $0.15/kWh.

Table 4-4: Solar Photovoltaics Opportunities Summarized

Building Name	Energy Conservation Measure	Opinion of Probable Cost	Electrical Savings		Demand Savings	Total Cost Savings	GHG Reduction	Simple Payback	Measure Life Expectancy	Net Present Value	Internal Rate of Return	Electricity Rate
		$	kWh	%	kW	$	Tonnes eCO_2	Years	Years	$	%	$/kWh
Parks & Animal Services	Solar Photovoltaics	154,000	56,900	23.8%	44.0	6,650	1.6	23.2	25	(23,570)	-1.3%	0.117
Northview Community Centre	Solar Photovoltaic	245,000	86,800	23.1%	70.0	12,270	2.4	20.0	25	(4,340)	-0.1%	0.141
Airport - South Field Buildings	Solar Photovoltaics	210,000	76,800	71.6%	60.0	11,520	2.2	18.2	25	15,900	0.6%	0.150
Howden Public Works Depot	Solar Photovoltaic	45,500	16,600	26.2%	13.0	2,070	0.5	22.0	25	(4,900)	-0.9%	0.125
Airport - Hanger	Solar Photovoltaic	20,040	9,870	44.8%	6.0	980	0.3	20.4	25	(820)	-0.3%	0.149
Total	**Solar ECMs (Combined)**	**674,540**	**246,970**		**193.0**	**33,490**	**6.9**	**20.1**	**25**	**(17,680)**	**-0.2%**	

4.1 BUILDING ENERGY PERFORMANCE METRICS

Table 4-5 establishes performance metrics for each audited facility. Table 4-6 indicates the potential improvements in benchmarks if all recommended measures are implemented.

Figure 4-1 and Figure 4-2 provide a graphical illustration of potential improvements to performance metrics.

The Facility Energy Utilization Index (EUI) was calculated by dividing the total annual energy used (all energy utilities in common units) by the Facility Gross Floor Area (GFA).

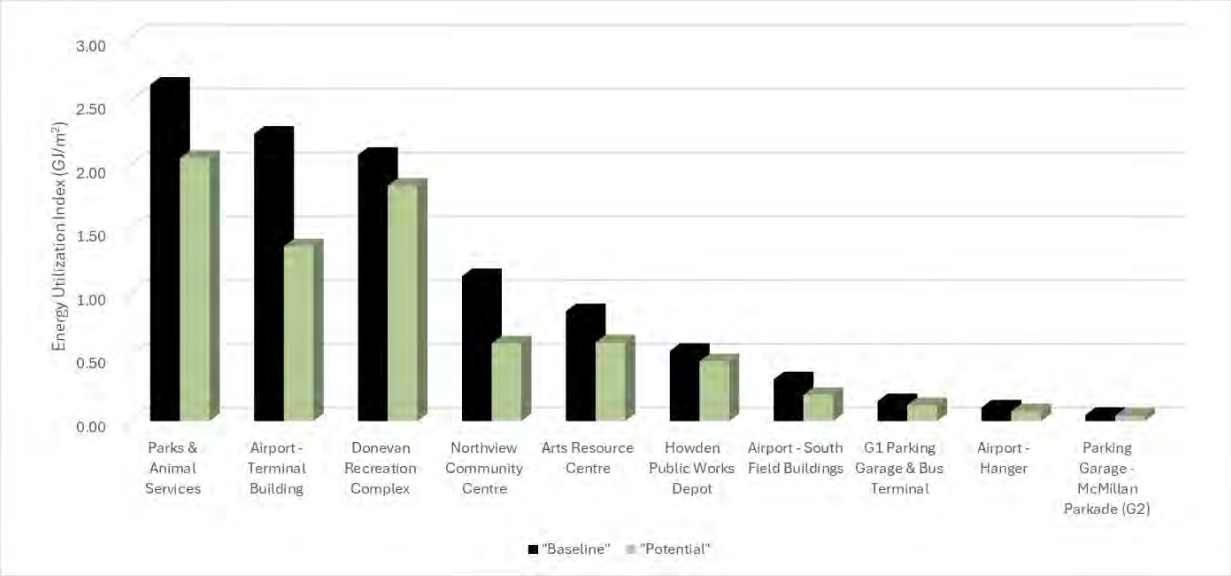


Figure 4-1: Facility EUI Reduction After Implementation of Recommended Measures

The Facility Cost Utilization Index (CUI) was calculated by dividing the total utility cost by the gross floor area.

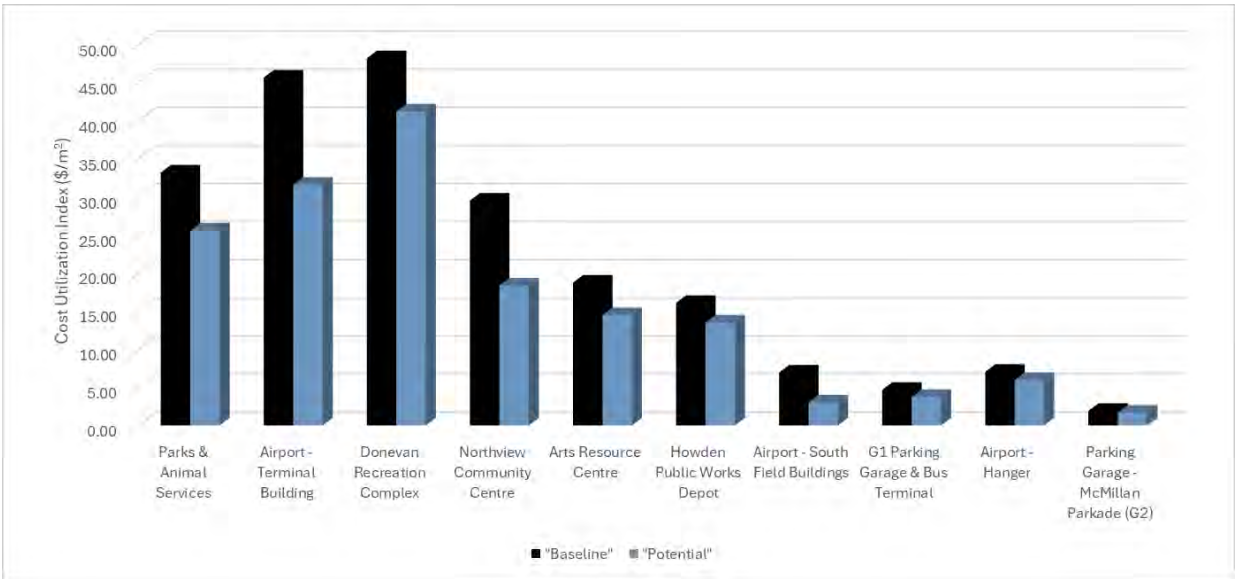


Figure 4-2: Facility CUI Reduction After Implementation of Recommended Measures

Table 4-5: Baseline Year Energy Utilization Index (EUI) and Cost Utilization Index (CUI) Metrics

Name	ASHRAE Level	Energy Utilization Index			Cost Utilization Index				Degree Days		Gross Floor Area	
		GJ/m²	ekWh/ft²	kBtu/ft²	$/m²	$/ft²	$/GJ	$/Tonnes CO2e	HDD	CDD	m²	ft²
Parks & Animal Services	Level II	2.64	68.09	232.41	33.18	3.08	12.6	287.5	3,738	356	1,764	18,988
Airport - Terminal Building	Level II	2.25	58.17	198.56	45.64	4.24	20.2	558.2	3,738	356	1,347	14,499
Donevan Recreation Complex	Level II	2.09	53.91	184.01	48.18	4.48	23.1	688.6	3,738	356	4,174	44,929
Northview Community Centre	Level I	1.14	29.33	100.11	29.50	2.74	26.0	899.9	3,954	367	2,282	24,563
Arts Resource Centre	Level I	0.86	22.23	75.86	18.74	1.74	21.8	611.2	3,738	356	1,068	11,496
Howden Public Works Depot	Level I	0.55	14.19	48.44	16.07	1.49	29.2	652.7	3,738	356	1,381	14,865
Airport - South Field Buildings	Level I	0.33	8.44	28.81	6.94	0.64	21.2	550.7	3,522	345	3,896	41,936
G1 Parking Garage & Bus Terminal	Level I	0.16	4.02	13.72	4.66	0.43	30.0	1,787.9	3,738	356	13,471	145,001
Airport - Hanger	Level I	0.11	2.73	9.31	7.03	0.65	66.6	2,494.5	3,738	356	1,315	14,157
Parking Garage - McMillan Parkade (G2)	Level I	0.05	1.24	4.23	1.90	0.18	39.5	5,076.5	3,738	356	18,581	200,004
Total		**0.51**	**13.14**	**44.84**	**11.47**	**1.07**	**22.5**	**670.9**			**49,279**	**530,438**
Total (level I)	Level I	0.21	5.33	18.20	5.81	0.54	28.1	1,031.6			41,994	452,022
Total (level II)	Level II	2.25	58.13	198.42	44.08	4.10	19.6	530.1			7,285	78,416

Table 4-6: Potential Energy Utilization Index (EUI) and Cost Utilization Index (CUI) Metrics

Name	ASHRAE Level	Energy Utilization Index				Cost Utilization Index				
		GJ/m²	ekWh/ft²	kBtu/ft²	% Change	$/m²	$/ft²	$/GJ	$/Tonnes CO2e	% Change
Parks & Animal Services	Level II	2.06	53.28	181.85	21.8%	25.58	2.38	12.4	276.5	22.9%
Airport - Terminal Building	Level II	1.37	35.36	120.69	39.2%	31.59	2.94	23.1	712.0	30.8%
Donevan Recreation Complex	Level II	1.85	47.65	162.64	11.6%	41.20	3.83	22.3	651.0	14.5%
Northview Community Centre	Level I	0.61	15.70	53.58	46.5%	18.36	1.71	30.2	1,256.9	37.8%
Arts Resource Centre	Level I	0.62	15.90	54.28	28.5%	14.48	1.35	23.5	734.6	22.7%
Howden Public Works Depot	Level I	0.47	12.08	41.24	14.9%	13.50	1.25	28.8	609.3	16.0%
Airport - South Field Buildings	Level I	0.20	5.28	18.03	37.4%	3.02	0.28	14.8	305.6	56.5%
G1 Parking Garage & Bus Terminal	Level I	0.13	3.23	11.03	19.6%	3.73	0.35	29.8	1,713.6	20.1%
Airport - Hanger	Level I	0.08	1.96	6.69	28.2%	5.96	0.55	78.6	2,496.0	15.2%
Parking Garage - McMillan Parkade (G2)	Level I	0.04	1.09	3.72	12.1%	1.67	0.16	39.6	5,087.5	11.9%
Total		**0.39**	**10.08**	**34.42**	**23.2%**	**8.86**	**0.82**	**22.7**	**672.5**	**22.7%**
Total (level I)	Level I	0.14	3.72	12.71	30.1%	4.21	0.39	29.2	1,091.7	27.5%
Total (level II)	Level II	1.81	46.74	159.54	19.6%	35.64	3.31	19.7	533.0	19.1%

5.0 GREENHOUSE GAS REDUCTION OPPORTUNITIES

The pie chart in Figure 5-1 indicates portfolio GHG emissions by utility steam. The breakdown was generated for the summation of baseline years for each facility.

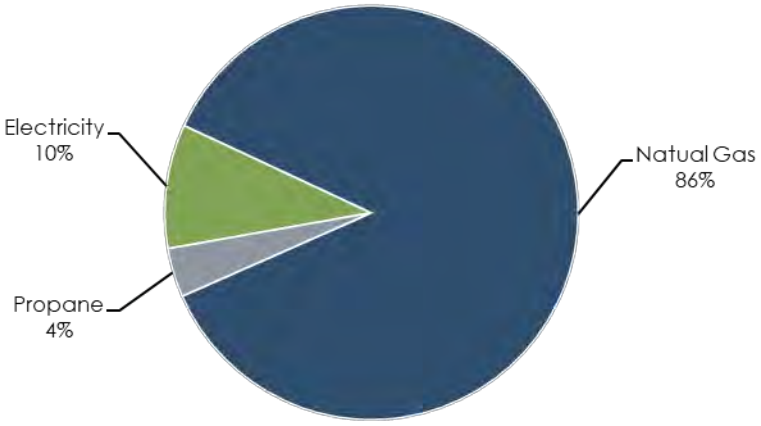


Figure 5-1: Annual GHG Emissions by Fuel Type

It can be observed the largest GHG reductions will be available from measures that concentrate on reducing natural gas use.

Table 5-1: Annual GHG Emission Breakdown by Fuel Type

Fuel Type	GHG Emissions	Equivalent amount of Vehicles on Ontario Roads Annually
	Tonnes CO2e	Vehicles
Electricity	81.8	18
Natural Gas	728.1	158
Propane	32.2	7
Total	**842.2**	**183**

To provide a sense of scale, a comparison is included to the typical passenger vehicle.

1 vehicle on Ontario roads emits the equivalent of 4.6 Tonnes of CO_2

For a sense of scale 4.6 Tonnes of CO_2 is equivalent to

Electricity		Natural Gas		Propane
164,290 kWh equal to ~$21,970	**or**	2,380 m^3 equal to ~$600	**Or**	2,970 L equal to ~$2,040

Table 5-2 indicates the potential GHG savings per utility stream with implementation of all recommended measures.

Table 5-2: Potential GHG Emission Reductions by Fuel Type

Fuel Type	Utility Savings	GHG Emission Reductions		Percentage of Total Emission Reductions	Equivalent Reduction of Vehicles on Ontario Roads Annually
		Tonnes CO2e	%	%	Vehicles
Electricity	691,080 kWh	19.3	24	10	4
Natural Gas	88,480 m^3	170.9	23	89	37
Propane	1,860 L	2.9	9	1	1
Total		**193.0**	**23**	**100**	**42**

Significant greenhouse gas (GHG) emission reductions can be achieved by converting fossil fuel based equipment to electric. Electrification opportunities include the following:

- Roof Top Unit with Air Source Heat Pumps;
- Centrally Ducted Air Source Heat Pumps or Electric Furnaces;
- Electric Boilers;
- Electric Units Heaters;
- Electric Domestic Hot Water Heaters; and
- Electric Zamboni.

These opportunities tend to have poor financial merit due to the price difference between natural gas and electricity in Ontario, however the implementation of all mentioned electrification opportunities has the potential to save approximately 50% of existing portfolio GHG emissions. Table 5-3 provides a preliminary estimate of natural gas and GHG savings, including financials, should facilities implement various electrification measures.

Table 5-3: Electrification Measures Evaluated

Building Name	Energy Conservation Measure	Opinion of Probable Cost	Natural Gas Savings		Electrical Savings		Total Cost Savings	GHG Reduction	Simple Payback	Measure Life Expectancy	Net Present Value	Internal Rate of Return
		$	m^3	%	kWh	%	$	Tonnes eCO_2	Years	Years	$	%
Airport - Terminal Building	Electrification Measures	412,900	52,675	100%	(322,200)	-108.0%	(32,200)	97.6	N/A	20	(941,410)	N/A
Parks & Animal Services	Electrification Measures	456,100	99,760	97.9%	(531,200)	-222.3%	(39,030)	177.9	N/A	20	(1,096,720)	N/A
Donevan Recreation Complex	Roof Top Unit Upgrades - Air Source Heat Pumps	30,000	11,800	8.6%	(38,900)	-3.9%	(2,500)	21.7	N/A	20	(71,030)	N/A
Donevan Recreation Complex	Electric Zamboni	126,000	7,100	100%	(8,000)	-0.8%	1,910	10.8	N/A	20	(94,650)	N/A
Northview Community Centre	Electrification	373,000	32,800	98.6%	(178,100)	-47.3%	(16,980)	58.4	N/A	20	(651,700)	N/A
G1 Parking Garage & Bus Terminal	RTU with Air Source Heat Pump	75,000	10,880	94.9%	(34,500)	-7.4%	(500)	20.1	N/A	20	(83,210)	N/A
Arts Resource Centre	Electrification Measures	290,000	15,520	99.6%	(92,200)	-97.7%	(7,280)	27.4	N/A	20	(409,490)	N/A
Total	**Electrification Measures (Combined)**	**1,763,000**	**230,535**		**(1,205,100)**		**(96,580)**	**413.9**	**N/A**	**20**	**(3,348,210)**	**N/A**

6.0 IMPLEMENTATION SCENARIOS

It is recommended that the measures that are the simplest and have the least interruption to the occupants be implemented first. It is important to consider phasing as a means of implementation in order avoid occupant disruption, levels of expenditure, and time to implement. The following table summarizes the implementation guidelines for each measure, which are high level timeline estimates and can vary considerably.

ECM Type	Design Period	Construction Period	Seasonal Requirements	Occupant Disruption
Infiltration Reduction	1-2 Weeks	1-2 Weeks	None	None
Window Replacement	2-3 Weeks	1-2 Months	Ideally Spring/Fall	High
Roof Insulation (R-40) Retrofit	1-2 Months	2-3 Months	Ideally Summer	High
HVAC System Upgrade	3-4 Months	4-6 Months	Ideally Summer	High
HVAC Control Adjustments (Ex. Temperature Control Set Points, Demand Control Ventilation)	1-2 Weeks	1-2 Weeks	None	Low
Interior LED Retrofit	4-8 weeks	1-2 Months	None	Moderate
Exterior LED Retrofit	1-2 Weeks	1-2 Weeks	None	Low
Low Flow Plumbing Fixtures	1-2 Weeks	2-3 Weeks	None	Moderate

There are also interactive effects to consider between energy conservation measures. Reducing the building thermal and electrical load profiles (from implementing measures that reduce infiltration and heat loss/gain for example) can reduce the required capacity of future HVAC equipment (roof top unit, furnace, HRV, etc.). This will reduce capital costs for the proceeding projects as smaller equipment can potentially be installed.

Low flow plumbing fixtures limit the amount of water drawn from traditional faucets and shower heads and subsequently reduce the amount of energy input due to heating a lower volume of water.

7.0 COMBINED SCENARIOS

A total of ten (10) buildings were investigated and approximately sixty-two (62) measures were recommended. We highlighted a handful of shortlisted measures in section 4.0 however each recommended measure has value in the grand scheme for a pathway to net zero. When individual ECMs are bundled, there will be overlaps between the building systems. There is also value to combined totals which average the good with the 'less attractive' measures to provide a suitable business case as a whole. This is presented in Table 7-1. It is noticed that the NPV of all recommended measures across the portfolio of energy audits becomes more of an attractive financial number, and even more so when leveraging funding available through incentive programs.

Table 7-1: Estimated Annual Utility and GHG Savings By Facility

Name	Estimated Savings			Financial Analysis			Financial Analysis with Incentive			
	Energy	GHG Reduction	Utility Cost Savings	Simple Payback	Net Present Value	Internal Rate of Return	Estimated Incentive	Simple Payback	Net Present Value	Internal Rate of Return
	GJ	Tonnes CO2e	$	Years	$	%	$	Years	$	%
Donevan Recreation Complex	1,013	27.9	29,140	6.8	281,300	11.5%	27,350	5.8	308,700	14.1%
Parks & Animal Services	1,012	40.3	13,390	16.7	(3,220)	-0.1%	6,725	16.2	3,500	0.2%
Airport - Terminal Building	1,191	50.4	18,930	17.4	(17,990)	-0.6%	7,930	16.9	(10,060)	-0.3%
Northview Community Centre	1,205	41.5	25,440	14.6	45,200	1.2%	36,940	13.2	82,100	2.3%
G1 Parking Garage & Bus Terminal	412	5.8	12,600	5.4	138,500	15.5%	11,100	4.5	149,600	19.2%
Airport - South Field Buildings	476	10.6	15,260	16.1	5,500	0.2%	2,090	15.9	7,600	0.3%
Arts Resource Centre	262	11.7	4,550	16.9	(2,120)	-0.3%	8,490	15.0	6,400	0.9%
Parking Garage - McMillan Parkade (G2)	108	0.8	4,190	8.6	32,900	7.8%	5,110	7.3	38,000	10.1%
Howden Public Works Depot	113	3.4	3,540	13.7	9,700	1.9%	160	13.6	9,900	2.0%
Airport - Hanger	39	0.6	1,410	5.9	14,900	14.0%	1,070	5.1	15,900	16.7%
Total	**5,831**	**193.0**	**128,450**	**12.5**	**504,700**	**3.0%**	**106,965**	**11.7**	**611,700**	**3.8%**

APPENDIX A – SUMMARY OF INVESTIGATED MEASURES

Appendix A Summary of Investigated Measures

Building Name	Energy Conservation Measure	Opinion of Probable Cost	Water Savings		Natural Gas Savings		Propane Savings		Electrical Savings		Demand Savings		Total Cost Savings	GHG Reduction	Simple Payback	Measure Life Expectancy	Net Present Value	Internal Rate of Return	Estimated Incentive	Adjusted Net Present Value	Adjusted Internal Rate of Return
		$	m^3	%	m^3	%	L	%	kWh	%	kW	%	$	Tonnes eCO_2	Years	Years	$	%	$	$	%
Airport - Terminal Building	Exterior Window Replacement (Triple Pane)	302,700	-	-	23,810	45.2%	-	-	46,950	15.7%	6.8	6.1%	11,600	47.3	26.1	30	(41,490)	-1.0%	6,000	(35,490)	-0.9%
Airport - Terminal Building	AC-1 Occupancy Schedule Optimization	1,000	-	-	1,200	2.3%	-	-	6,500	2.2%	-	-	1,200	2.5	0.8	20	18,700	115.8%	-	N/A	N/A
Airport - Terminal Building	Interior Lighting Retrofit	3,100	-	-	-	-	-	-	6,030	2.0%	1.2	1.1%	830	0.2	3.7	12	5,700	22.5%	330	6,000	25.7%
Airport - Terminal Building	Runway Pole Lighting Upgrades	11,700	-	-	-	-	-	-	12,320	4.1%	-	-	1,700	0.3	6.9	10	3,600	5.4%	1,600	5,200	8.7%
Airport - Terminal Building	Low Flow Plumbing Fixtures	10,200	150	40%	20	0.0%	-	-	-	-	-	-	3,600	0.04	2.8	20	48,900	32.6%	-	N/A	N/A
Airport - Terminal Building	**Total**	**328,700**	**150**	**40%**	**25,030**	**47.5%**	-	-	**71,800**	**24.1%**	**8.0**	**10.4%**	**18,930**	**50.4**	**17.4**	**20**	**(17,990)**	**-0.6%**	**7,930**	**(10,060)**	**-0.3%**
Airport - Terminal Building	Exterior Window Replacement (Double Pane)	414,900	-	-	17,710	33.6%	-	-	11,110	3.7%	6.8	6.1%	5,400	34.5	N/A	30	(293,300)	N/A	4,400	(288,900)	N/A
Airport - Terminal Building	Electrification Measures	412,900	-	-	52,675	100.0%	-	-	(322,200)	-108.0%	(156.5)	-141.0%	(32,200)	97.6	N/A	20	(941,410)	N/A	27,500	(913,910)	N/A
Airport - Terminal Building	RTU Energy Recovery	35,000	-	-	8,100	15.4%	-	-	13,800	4.6%	(3.5)	-3.2%	3,700	16.0	9.5	20	25,700	6.4%	12,500	38,200	13.3%
Parks & Animal Services	Boiler Piping Arrangement	48,400	-	-	18,500	18.2%	-	-	3,670	1.5%	0.5	0.8%	4,700	35.6	10.3	20	28,700	5.3%	4,625	33,300	6.6%
Parks & Animal Services	Condensing Water Heater – Parks & Animal Services	2,600	-	-	1,390	1.4%	-	-	-	-	-	-	320	2.7	8.1	12	790	4.5%	350	1,100	6.8%
Parks & Animal Services	Point-of-Use Water Heater – Greenhouse	1,000	-	-	-	-	-	-	1,400	0.6%	-	-	160	0.04	6.3	12	700	9.7%	-	N/A	N/A
Parks & Animal Services	Interior LED Lighting Upgrades	13,600	-	-	-	-	-	-	10,380	4.3%	5.6	10.2%	1,200	0.3	11.3	12	(880)	-1.0%	1,350	420	0.5%
Parks & Animal Services	Exterior LED Lighting Upgrades	3,400	-	-	-	-	-	-	3,110	1.3%	-	-	360	0.1	9.4	10	(160)	-0.9%	400	240	1.5%
Parks & Animal Services	Solar Photovoltaics	154,000	-	-	-	-	-	-	56,900	23.8%	44.0	73.5%	6,650	1.6	23.2	25	(23,570)	-1.3%	-	N/A	N/A
Parks & Animal Services	**Total**	**223,000**	-	-	**19,890**	**19.5%**	-	-	**75,460**	**31.6%**	**50.1**	**83.6%**	**13,390**	**40.3**	**16.7**	**20**	**(3,220)**	**-0.1%**	**6,725**	**3,500**	**0.2%**
Parks & Animal Services	Electrification Measures	456,100	-	-	99,760	97.9%	-	-	(531,200)	-222.3%	(185.9)	-337.9%	(39,030)	177.9	N/A	20	(1,096,720)	N/A	35,500	(1,060,730)	N/A
Donevan Recreation Complex	Roof Top Unit Upgrades	19,000	-	-	1,870	1.4%	-	-	40,360	4.0%	3.0	2.4%	5,950	4.7	3.2	20	78,700	28.7%	470	79,200	29.5%
Donevan Recreation Complex	Demand Control Ventilation - RTU-3 & RTU-4	2,400	-	-	400	0.3%	-	-	2,700	0.3%	-	-	500	0.8	4.8	20	5,800	18.0%	1,000	6,800	33.0%
Donevan Recreation Complex	Compressor Defouling Application	11,180	-	-	-	-	-	-	18,800	1.9%	-	-	2,570	0.5	4.4	10	12,000	16.6%	-	N/A	N/A
Donevan Recreation Complex	Motorized Pool Cover	30,000	940	8%	3,910	2.9%	-	-	12,660	1.3%	-	-	5,000	7.9	6.0	15	34,400	12.3%	-	N/A	N/A
Donevan Recreation Complex	High Efficiency Pool Boilers	10,000	-	-	2,660	1.9%	-	-	-	-	-	-	630	5.1	15.9	25	2,400	1.9%	5,000	7,400	9.7%
Donevan Recreation Complex	Condensing Domestic Hot Water Heaters	9,000	-	-	2,850	2.1%	-	-	-	-	-	-	670	5.5	N/A	12	(1,900)	-3.6%	710	(1,200)	-2.4%
Donevan Recreation Complex	Interior LED Lighting Upgrades	46,000	-	-	-	-	-	-	51,790	5.1%	11.5	9.0%	7,080	1.5	6.5	12	29,100	8.9%	12,950	42,000	16.4%
Donevan Recreation Complex	Exterior LED Lighting Upgrades	39,000	-	-	-	-	-	-	28,870	2.9%	5.9	4.6%	3,940	0.8	9.9	10	(3,540)	-1.7%	7,220	3,700	2.1%
Donevan Recreation Complex	Low Flow Plumbing Fixtures	30,400	1,090	9%	500	0.4%	-	-	-	-	-	-	2,800	1.0	10.9	15	5,700	2.3%	-	N/A	N/A
Donevan Recreation Complex	**Total**	**196,980**	**2,030**	**16%**	**12,190**	**8.9%**	-	-	**155,180**	**15.4%**	**20.4**	**16.0%**	**29,140**	**27.9**	**6.8**	**20**	**281,300**	**11.5%**	**27,350**	**308,700**	**14.1%**
Donevan Recreation Complex	Roof Top Unit Upgrades - Air Source Heat Pumps	30,000	-	-	11,800	8.6%	-	-	(38,900)	-3.9%	(29.1)	-22.9%	(2,500)	21.7	N/A	20	(71,030)	N/A	13,900	(57,130)	N/A
Donevan Recreation Complex	Electric Zamboni	126,000	-	-	7,100	100.0%	-	-	(8,000)	-0.8%	(3.3)	-2.6%	1,910	10.8	N/A	20	(94,650)	N/A	-	N/A	N/A
Donevan Recreation Complex	Solar Wall - HRV-2	17,400	-	-	1,740	1.3%	-	-	-	-	-	-	410	3.4	N/A	20	(10,670)	N/A	-	N/A	N/A
Northview Community Centre	RTU Upgrades with Energy Recovery	52,000	-	-	12,500	37.6%	-	-	13,600	3.6%	20.5	25.3%	5,050	24.5	10.3	20	30,900	5.3%	18,750	49,600	11.9%
Northview Community Centre	RTU Demand Control Ventilation	30,000	-	-	7,000	21.0%	-	-	7,000	1.9%	0.8	1.0%	2,740	13.7	10.9	20	15,000	4.5%	12,500	27,500	12.4%
Northview Community Centre	Interior LED Lighting Upgrades	18,850	-	-	-	-	-	-	20,660	5.5%	5.4	6.6%	2,920	0.6	6.5	12	12,100	9.0%	2,690	14,800	12.3%
Northview Community Centre	Exterior LED Lighting Retrofit	8,840	-	-	-	-	-	-	4,490	1.2%	-	-	630	0.1	N/A	10	(3,170)	-7.5%	3,000	(170)	-0.5%
Northview Community Centre	Solar Photovoltaic	245,000	-	-	-	-	-	-	86,800	23.1%	70.0	86.4%	12,270	2.4	20.0	25	(4,340)	-0.1%	-	N/A	N/A
Northview Community Centre	Low Flow Plumbing Fixtures	14,500	390	23%	50	0.2%	-	-	-	-	-	-	1,350	0.1	10.7	20	7,700	4.8%	-	N/A	N/A
Northview Community Centre	Irrigation Controller	3,200	140	8%	-	-	-	-	-	-	-	-	480	-	6.7	20	4,700	11.7%	-	N/A	N/A
Northview Community Centre	**Total**	**372,390**	**530**	**31%**	**19,550**	**58.8%**	-	-	**132,550**	**35.2%**	**96.7**	**119.4%**	**25,440**	**41.5**	**14.6**	**20**	**45,200**	**1.2%**	**36,940**	**82,100**	**2.3%**
Northview Community Centre	Roof Replacement (R-40)	74,000	-	-	1,440	4.3%	-	-	7,100	1.9%	6.3	7.7%	1,360	3.0	N/A	20	(51,680)	N/A	360	(51,320)	N/A
Northview Community Centre	Point-of-Use Domestic Hot Water Heater - Kitchen	2,500	-	-	300	0.9%	-	-	-	-	-	-	80	0.6	N/A	12	(1,650)	N/A	-	N/A	N/A
Northview Community Centre	Electrification	373,000	-	-	32,800	98.6%	-	-	(178,100)	-47.3%	(56.6)	-69.9%	(16,980)	58.4	N/A	20	(651,700)	N/A	30,900	(620,800)	N/A
G1 Parking Garage & Bus Terminal	Temperature Control Setpoints - RTU	800	-	-	1,600	14.0%	-	-	2,000	0.4%	-	-	800	3.1	1.0	20	12,300	96.2%	-	N/A	N/A
G1 Parking Garage & Bus Terminal	Temperature Control Setpoints - Electric Heating Systems	4,500	-	-	-	-	-	-	9,500	2.0%	3.3	1.8%	1,200	0.3	3.8	20	15,200	24.0%	-	N/A	N/A
G1 Parking Garage & Bus Terminal	Point-of-Use Domestic Hot Water Heater	500	-	-	-	-	-	-	700	0.2%	-	-	100	0.02	5.0	12	560	14.7%	-	N/A	N/A
G1 Parking Garage & Bus Terminal	Interior LED Lighting Upgrades	9,100	-	-	-	-	-	-	12,400	2.7%	4.6	2.6%	1,500	0.3	6.1	12	6,800	10.3%	1,600	8,400	14.7%
G1 Parking Garage & Bus Terminal	Exterior LED Lighting Upgrade	53,400	-	-	-	-	-	-	73,200	15.8%	14.6	8.2%	9,000	2.0	5.9	10	27,600	8.7%	9,500	37,100	13.5%

Building Name	Energy Conservation Measure	Opinion of Probable Cost	Water Savings		Natural Gas Savings		Propane Savings		Electrical Savings		Demand Savings		Total Cost Savings	GHG Reduction	Simple Payback	Measure Life Expectancy	Net Present Value	Internal Rate of Return	Estimated Incentive	Adjusted Net Present Value	Adjusted Internal Rate of Return
		$	m^3	%	m^3	%	L	%	kWh	%	kW	%	$	Tonnes eCO_2	Years	Years	$	%	$	$	%
G1 Parking Garage & Bus Terminal	**Total**	**68,300**	-	-	**1,600**	**14.0%**	-	-	**97,800**	**21.1%**	**22.5**	**12.6%**	**12,600**	**5.8**	**5.4**	**20**	**138,500**	**15.5%**	**11,100**	**149,600**	**19.2%**
G1 Parking Garage & Bus Terminal	Lighting Control Opportunities	10,000	-	-	-	-	-	-	28,100	6.1%	11.2	6.3%	3,400	0.8	2.9	12	26,000	30.3%	-	N/A	N/A
G1 Parking Garage & Bus Terminal	RTU with Air Source Heat Pump	75,000	-	-	10,880	94.9%	-	-	(34,500)	-7.4%	(18.8)	-10.5%	(500)	20.1	N/A	20	(83,210)	N/A	10,000	(73,210)	N/A
G2 Parking Garage McMillan Parkade	Temperature Control Setpoints - Electric Heating Systems	2,400	-	-	-	-	-	-	9,370	3.8%	-	-	1,310	0.3	1.8	20	19,100	51.6%	-	N/A	N/A
G2 Parking Garage McMillan Parkade	Window Air Conditioner - Office Control Room	500	-	-	-	-	-	-	290	0.1%	0.2	0.2%	40	0.01	12.5	15	20	0.4%	-	N/A	N/A
G2 Parking Garage McMillan Parkade	Point-of-Use Domestic Hot Water Heater	500	-	-	-	-	-	-	710	0.3%	-	-	100	0.02	5.0	12	560	14.7%	-	N/A	N/A
G2 Parking Garage McMillan Parkade	LED Lighting Upgrades	6,740	-	-	-	-	-	-	4,930	2.0%	1.3	1.2%	690	0.1	9.8	12	570	1.3%	130	700	1.7%
G2 Parking Garage McMillan Parkade	Lighting Control - Parking Garage	20,570	-	-	-	-	-	-	8,600	3.5%	-	-	1,200	0.2	N/A	10	(9,770)	-10.5%	2,810	(6,960)	-8.4%
G2 Parking Garage McMillan Parkade	Lighting Control - Stairwell	4,000	-	-	-	-	-	-	5,990	2.4%	-	-	840	0.2	4.8	10	3,600	14.2%	1,990	5,600	37.7%
G2 Parking Garage McMillan Parkade	Lighting Control - Administration & Service Areas	1,130	-	-	-	-	-	-	60	0.0%	-	-	10	0.002	N/A	12	(1,020)	N/A	180	(840)	N/A
G2 Parking Garage McMillan Parkade	**Total**	**35,840**	-	-	-	-	-	-	**29,950**	**12.1%**	**1.5**	**1.3%**	**4,190**	**0.8**	**8.6**	**20**	**32,900**	**7.8%**	**5,110**	**38,000**	**10.1%**
Airport - Hanger	Temperature Control Setpoints - Radiant Heating System	250	-	-	160	10.0%	-	-	30	0.1%	-	-	40	0.3	6.3	20	410	12.8%	-	N/A	N/A
Airport - Hanger	Temperature Control Setpoints - Electric Heating Systems	400	-	-	-	-	-	-	440	2.0%	-	-	70	0.01	5.7	20	750	14.5%	-	N/A	N/A
Airport - Hanger	Point-of-Use Domestic Hot Water Heater	500	-	-	-	-	-	-	500	2.3%	-	-	70	0.01	7.1	12	240	7.0%	-	N/A	N/A
Airport - Hanger	LED Lighting Upgrades	7,125	-	-	-	-	-	-	8,240	37.4%	3.4	38.2%	1,230	0.2	5.8	12	5,900	11.3%	1,070	7,000	15.1%
Airport - Hanger	Solar Photovoltaic	20,040	-	-	-	-	-	-	9,870	44.8%	6.0	66.7%	980	0.3	20.4	25	(820)	-0.3%	-	N/A	N/A
Airport - Hanger	**Total**	**8,275**	-	-	**160**	**10.0%**	-	-	**9,210**	**41.8%**	**3.4**	**38.2%**	**1,410**	**0.6**	**5.9**	**20**	**14,900**	**14.0%**	**1,070**	**15,900**	**16.7%**
Airport - South Field Buildings	Condensing Gas Unit Heaters	6,000	-	-	1,480	6.2%	-	-	970	0.9%	0.1	-	770	2.9	7.8	20	6,600	9.2%	370	7,000	10.2%
Airport - South Field Buildings	Centralized Unit Heater Control	13,500	-	-	2,380	10.0%	-	-	730	0.7%	-	-	1,110	4.6	12.2	20	4,700	3.3%	600	5,300	3.8%
Airport - South Field Buildings	RTU Smart Thermostat	250	-	-	100	0.4%	-	-	470	0.4%	-	-	110	0.2	2.3	20	1,600	41.2%	-	N/A	N/A
Airport - South Field Buildings	Stores - Infiltration Reduction	1,000	-	-	220	0.9%	-	-	-	-	-	-	90	0.4	11.1	12	(50)	-0.7%	-	N/A	N/A
Airport - South Field Buildings	Compressed Air Leak Mitigation	500	-	-	-	-	-	-	1,540	1.4%	-	-	230	0.04	2.2	10	1,600	42.1%	-	N/A	N/A
Airport - South Field Buildings	Interior LED Lighting Upgrades	8,600	-	-	-	-	-	-	6,830	6.4%	5.0	-	1,020	0.2	8.4	12	2,200	3.9%	890	3,100	5.9%
Airport - South Field Buildings	Exterior LED Lighting Upgrades	2,500	-	-	-	-	-	-	1,750	1.6%	-	-	260	0.05	9.6	10	(160)	-1.2%	230	70	0.6%
Airport - South Field Buildings	Solar Photovoltaics	210,000	-	-	-	-	-	-	76,800	71.6%	60.0	-	11,520	2.2	18.2	25	15,900	0.6%	-	N/A	N/A
Airport - South Field Buildings	Low Flow Plumbing Fixtures	2,600	30	17%	-	-	-	-	-	-	-	-	150	-	17.3	20	(140)	-0.5%	-	N/A	N/A
Airport - South Field Buildings	**Total**	**244,950**	**30**	**17%**	**4,180**	**17.5%**	-	-	**89,090**	**83.1%**	**65.0**	**-**	**15,260**	**10.6**	**16.1**	**20**	**5,500**	**0.2%**	**2,090**	**7,600**	**0.3%**
Airport - South Field Buildings	Point of Use Domestic Hot Water Heater	1,200	-	-	360	1.5%	-	-	-	-	-	-	150	0.7	8.0	12	390	4.8%	-	N/A	N/A
Airport - South Field Buildings	Bathroom Exhaust Fan Upgrade	1,500	-	-	-	-	-	-	200	0.2%	-	-	30	0.01	N/A	20	(1,010)	N/A	-	N/A	N/A
Howden Public Works Depot	Temperature Control Setpoints - Radiant Heating System	1,275	-	-	-	-	1,860	8.9%	80	0.1%	-	-	1,290	2.9	1.0	20	19,900	97.3%	-	N/A	N/A
Howden Public Works Depot	Interior LED Lighting Retrofit	1,300	-	-	-	-	-	-	1,240	2.0%	1.0	4.7%	150	0.03	8.7	12	290	3.4%	160	450	5.8%
Howden Public Works Depot	Exit Sign Upgrade	300	-	-	-	-	-	-	250	0.4%	-	-	30	0.01	10.0	12	20	0.9%	-	N/A	N/A
Howden Public Works Depot	Solar Photovoltaic	45,500	-	-	-	-	-	-	16,600	26.2%	13.0	60.5%	2,070	0.5	22.0	25	(4,900)	-0.9%	-	N/A	N/A
Howden Public Works Depot	**Total**	**48,375**	-	-	-	-	**1,860**	8.9%	**18,170**	**28.7%**	**14.0**	**65.2%**	**3,540**	**3.4**	**13.7**	**20**	**9,700**	**1.9%**	**160**	**9,900**	**2.0%**
Arts Resource Centre	Exterior Window Replacement	39,600	-	-	1,860	11.9%	-	-	420	0.4%	6.6	17.8%	570	3.6	N/A	30	(26,760)	N/A	500	(26,260)	N/A
Arts Resource Centre	RTU-1 Demand Control Ventilation	3,300	-	-	100	0.6%	-	-	3,000	3.2%	5.3	14.2%	400	0.3	8.3	20	3,300	8.3%	500	3,800	10.9%
Arts Resource Centre	RTU-2 Upgrade with Energy Recovery	15,000	-	-	3,900	25.0%	-	-	(1,100)	-1.2%	4.5	12.2%	940	7.5	16.0	20	430	0.3%	6,250	6,700	6.6%
Arts Resource Centre	LED Lighting Upgrades	11,000	-	-	-	-	-	-	9,550	10.1%	3.9	10.5%	1,200	0.3	9.2	12	1,700	2.4%	1,240	3,000	4.5%
Arts Resource Centre	Low Flow Plumbing Fixtures	7,900	150	37%	20	0.1%	-	-	-	-	-	-	1,440	0.04	5.5	20	15,700	15.2%	-	N/A	N/A
Arts Resource Centre	**Total**	**76,800**	**150**	**37%**	**5,880**	**37.8%**	**-**	-	**11,870**	**12.6%**	**20.2**	**54.7%**	**4,550**	**11.7**	**16.9**	**20**	**(2,120)**	**-0.3%**	**8,490**	**6,400**	**0.9%**
Arts Resource Centre	Electrification Measures	290,000	-	-	15,520	99.6%	-	-	(92,200)	-97.7%	(58.5)	-158.1%	(7,280)	27.4	N/A	20	(409,490)	N/A	16,600	(392,890)	N/A
Arts Resource Centre	Exterior Window Replacement (Double Pane)	409,500	-	-	1,130	7.3%	-	-	110	0.1%	1.0	2.7%	330	2.2	N/A	30	(402,070)	N/A	300	(401,770)	N/A
Arts Resource Centre	RTU-2 Upgrade with Hydronic Heating Coil	24,000	-	-	3,400	21.8%	-	-	(1,830)	-1.9%	(1.0)	-2.7%	710	6.5	N/A	20	(12,350)	-6.4%	1,700	(10,650)	-5.8%

APPENDIX B – ASSESSMENT METHODOLOGY

Appendix B Assessment Methodology

Site Visits

The visit included a detailed interview with City of Oshawa staff regarding the building's function as well as discussing any issues that were persistent and opportunities for operational optimization. A comprehensive tour of the site was also conducted to evaluate the HVAC, lighting, and controls systems.

Utility Analysis

An analysis of the Facility's utility consumption provides a good starting point from which to:

- Identify potential Energy Conservation Measure (ECMs) and Water Conservation Measures (WCMs); and,
- Develop a baseline against which ECMs and WCMs performance can be quantified.

The consumption (and demand) registered on historical data for each utility meter can also be examined to identify issues that are affecting the energy performance of the site.

The City of Oshawa provided utility data for natural gas, electricity, and water dating back to January 2019.

Utility Rates

In terms of savings related to the identified measures, a blended rate is used which effectively assumes that reduction in consumption will only reduce the cost by the rate that applies to the last unit of energy used. The blended rates naturally include all fees, taxes, and bulk charges which may be included in each utility provider's billings.

Envelope System Assessment

The envelope and architectural assessment involve a non-intrusive visual assessment of the Facility and a review of any available drawings to determine the condition and type of construction.

Mechanical System Assessment

The mechanical portion of the assessment involves taking an inventory of mechanical components and an appraisal of operational times and efficiencies for each mechanism.

Electrical System Assessment

A comprehensive assessment of the site's lighting includes a detailed review the existing fixtures, lighting levels and controls throughout the site if applicable. Consideration is also given to operational hours and the diligence of occupants at switching off manually operated lighting.

Energy and Water Conservation Measure Identification and Analysis

Each measure proposed for implementation on this project has been selected based on its viability, as measured against the following criteria:

- Costs and savings within overall criteria for evaluation guidelines;
- Appropriateness for tasks performed in the space;
- Condition of existing systems;
- Consistency of application (all areas of similar function are consistent);
- Equipment approval by facilities personnel; and,
- Impact on occupant behavior and general acceptance of changes.

The energy and water savings calculations are based on a best estimate of the anticipated reductions taking into consideration direct savings from water, electrical and gas consumption, and electrical demand where appropriate. Savings associated with heating and cooling measures are calculated relating to heating and cooling degree-days for the site which are taken from the most appropriate local weather data source, which assumes an average balance point[1] temperature of 18°C (64°F).

Costs associated with implementing the respective measures are estimated based on the approximate 'capital cost' for the materials and labor (including demolition and installation). Costs are determined from previous project experience and/or through published cost estimate data (such as RS Means). All costs represent BLDG-SCI's opinion on probable cost and are provided as approximate estimates to give economies of scale. Further investigation and detailed costing should be carried out prior to implementation.

For any systems or equipment that are on site and not functioning (not consuming energy or water), no energy or water conservation measures have been considered. The scope of this exercise is to find opportunities to reduce water consumption and energy demand and consumption and where there is no possibility to do so, no measures have been discussed.

Opinion of Probable Cost

Opinion of Probable Cost, or the project implementation cost, for each energy or water conservation measure were developed using one or a combination of:

RSMeans estimating resources accounting for geographical location, currency conversion rates, and labour rate differences;
Industry standard and accepted equipment/construction costing and allowances;
Equipment and construction costing from similar projects; and/or
Equipment and construction costing supplied through vendors or channel partners.

Recommendations

From the options considered, recommendations are put forward based on financial and practical feasibility using indicators such as simple payback, capital cost, and Net Present Value (NPV), where applicable.

[1] The balance point temperature is the external temperature at which the building's heating equipment is initiated.

Detailed Analysis of Capital-Intensive Modifications

The capital-intensive measure proposed at this Facility has been recommended based on its feasibility and its possibility for implementation. The recommended option is measured against the same criteria as the Energy Conservation Measures, but with a thorough, rigorous, and a more detailed understanding of its benefits, costs, and performance expectations. An in-depth review of the recommended measure consists of analyzing the site based on available data, examining Facility's usage patterns, operations, outlining potential configurations and using computer simulations to determine best suitable options based on the Facility's heating and cooling requirements.

The energy and energy cost savings calculations are based on a higher level of detail and accuracy. Costs associated with implementing the respective measure is estimated based on the approximate 'capital cost' for the materials and labor (including demolition and installation). Costs are determined from previous project experience, discussing with appropriate personnel and/or through published cost estimate data (such as RS Means).

Building Model Simulation

The building simulation program Hourly Analysis Program (HAP) version 6.1 was used to simulate how applicable recommendation would perform under the existing buildings characteristics. The program uses typical weather data along with input from the user of the building's HVAC equipment, building occupancy schedule, envelope materials, plug loads, and process loads to simulate design alternatives.

The architectural features for the baseline model were gathered from the Facility drawings provided which included Facility dimensions, wall construction, roof construction, window dimensions and building orientation. Insulation values were assumed based on the construction type and age of the building.

The Facility's internal gains were entered in the baseline model using occupancy counts and estimating electrical appliances such as computers; the ASHRAE Fundamentals 2021 Handbook was used as a guide for estimating the loads from this equipment.

To determine the Facility's lighting load consumption, lighting counts were taken on site.

The Facility's HVAC components were generated in the model using a combination of provided drawings, manufacturer specifications and equipment nameplates. In addition, the building operator's description of the Facility's HVAC sequences of operations was also taken into account in the model.

To ensure that the baseline model was operating similar to the existing building, the Facility's baseline consumption based on the utility billing data was compared to the building simulation's energy consumption outputs. This comparison was done both analytically by comparison to total consumption and visually by comparing monthly trends to expected consumption.

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