NEW WESTMINSTER

Corporate Energy & Emissions Reduction Strategy (CEERS 2020)

September 1, 2020



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EXECUTIVE SUMMARY

The City of New Westminster's first Corporate Energy & GHG Emissions Management Plan (CEEMP) was adopted in 2008 and was effective at reducing emissions by over 12% (by 2018). To keep momentum going, and seeing the need for an updated and more aggressive plan, City Council supported the development of a new strategy.

Within the timeframe of updating CEERS, there have been a number of developments which have and will continue to influence the actions and their associated timeframe within this strategy. The City has declared a climate emergency which necessitates more aggressive actions and focus on mitigating climate change. Periodic review of innovative emission reducing opportunities and continuous action will be required throughout the life of the period encompassed in this report.



CLIMATE EMERGENCY

On March 11, 2019, City Council declared a climate emergency and established the following corporate greenhouse gas (GHG) reduction targets.

45% by 2030
60% by 2040
Net zero by 2050

Below 2010 emission levels (baseline)

7 BOLD STEPS

To support the climate emergency declaration, the City established a new climate action budgeting framework and seven bold steps with the goal of moving New Westminster towards a zero carbon future by 2050. Through Bold Step number 1, Carbon Free Corporation, the City pledged that it will work to exceed its 2030 climate emergency target of 45% (below 2010 emissions levels) by striving to be net zero by 2030. In order to reach this aggressive target, the City will need to take big measures to reduce its emissions.

This CEERS will primarily help the City achieve Bold Step number 1, however many of the recommended strategies within this document will also advance other bold steps.

SUMMARY OF CORPORATE ENERGY AND EMISSION GOALS (SECTION 2):

1. Maximize energy efficiency
2. Build new buildings to net-zero or net-positive.
3. Use local renewable, low impact energy sources.
4. Transition to an efficient and low-carbon fleet.
5. Prioritize active and shared transportation.
6. Minimize energy and emissions impacts.
7. Partner externally to advance common objectives.
8. Move towards zero waste generation.
9. Maximize reuse, recycling and material recovery.



The new updated CEERS has been developed to outline strategies for the City to implement to reach its GHG reduction targets. It provides a long-term direction with a 2050 horizon as well as short-term targets and actionable strategies. CEERS builds on existing policies and makes recommendations to strengthen climate actions into all city operations. The strategy recognizes the evolving public policy environment in which the City operates, including an increased urgency for action at the international, national, provincial and local levels.

COVID-19 PANDEMIC, RESPONSE, RECOVERY

In early 2020, the COVID-19 pandemic spread globally, putting strain on healthcare systems and causing cities to shut down. The improvement in air quality resulting from COVID-19-induced shutdowns shows the benefits of reducing emissions, but these short-term reductions may be reversed as restrictions ease. The pandemic provides a once-in-a-lifetime responsibility to accelerate the response to the climate crisis in Canadian cities.

Our response to this health crisis will shape how we will deal with a climate crisis in the next decades. Times of change can lead to the introduction of long-lasting sustainable habits, such as the reduction of travel and personal consumption. The City of New Westminster will utilize this opportunity and position itself to thrive as we embrace a “new normal” and a better “business-as-usual” through a decarbonized economy.

EMISSIONS TRAJECTORY

As community population grows, so do our services to meet the needs of our residents. In support of increasing population and servicing needs, the City of New Westminster’s asset inventory and level of service will continue to expand over the coming years. The anticipated asset acquisitions along with service delivery expansion are incorporated into a “Business As Usual” (BAU) scenario which projects the trajectory of the City’s corporate emissions without corrective action. In order to meet the City’s Climate Emergency targets, it needs to take drastic measures to reduce its corporate emissions trajectory.

The table below summarizes the projected growth in emissions under BAU and the estimated reduction that is possible with the successful implementation of the CEERS strategies.

Table A. Comparison of Corporate GHG Emissions under a Business As Usual Scenario and Implementation of CEERS Strategies Scenario

Asset Class	2010 GHG Emissions (tCO_2e)	2018 GHG Emissions[1] (CEERS Base Year) (tCO_2e)	2019 GHG Emissions (Most Recent Data Year) (tCO_2e)	BAU Scenario: Estimated 2030 GHG Emissions (tCO_2e)	Emission Reduction Potential: 2018 – 2030 CEERS Strategies (tCO_2e)	2030 GHG Emissions with CEERS Implementation (tCO_2e and % Reduction from 2010 levels)
Buildings	2,319	2,150	1,999	2,175	-1,137	1,038 (55%)
Fleet	1,667	1,543	1,395[2]	1,987	-816	1,171 (30%)
Lighting	93	27	28	27	0	27 (71%)
Water & Wastewater	10	5	4	4	0	4 (60%)
Total	4,089	3,725	3,426	4,193	-1,953	2,240 (45%)

Under a BAU scenario, the City of New Westminster would see an emissions increase of 13% from 2018 to 2030. If the City were to follow the energy conservation strategies outlined within this report, it has the opportunity to not only prevent this natural increase, but reduce emissions below 2010 levels. Modelling suggests that the City could achieve a 40% reduction by 2030 from its CEERS initiation year of 2018, if it were to implement the recommended building and fleet projects. As a result, the implementation of the recommended path will result in 45% GHG emissions reduction over 2010 levels; meeting the 2030 target as outlined in the City's climate emergency declaration. The cost premium to implement the strategies in this report are in the order of $13.45M.

The CEERS builds on the City's past and current efforts in working towards a net zero carbon future. As outlined in this report, achieving the 2030 GHG emissions reduction target rests largely on the City's ability to implement deep emissions reduction strategies including development of the new pool site (NWACC) and those related to the electrification of our fleet. Tracking progress of the implementation of CEERS and its 25 Strategies will be integral to ensuring success. This will include regular monitoring of end-use-related GHG emissions, annual financial planning to ensure resources are in place and sharing challenges and opportunities by all moving forward. A summary of the CEERS strategies are outlined in Appendix 1.

All strategies and measures within this document were developed based on consultation with City staff, the Energy Management Committee (EMC) and the results of two comprehensive studies conducted by subject matter experts (consultants).

[1] 2018 is the base reference year for the CEERS 2020 as it represented the most recent full year of data at the onset of fleet and buildings studies which were initiated in 2019.

[2] Majority of emission reduction in fleet between 2018 -2019 are related to services delivered to Recycle BC. That entity is now accounting for those emissions and therefore removed from our inventory as of the 2019 data year.

1. INTRODUCTION

1.1 CLIMATE EMERGENCY

In 2019, a report was published by the world's leading climate scientists, the International Panel on Climate Change (IPCC), warning that limiting global warming to 1.5°C would require rapid, far-reaching and unprecedented changes in all aspects of society. The report, which included ninety-one authors and review editors from 40 countries from around the world, stresses that we are already seeing the consequences of 1°C of global warming through more extreme weather, rising sea levels and diminishing Arctic sea ice. It highlights a number of climate change impacts that could be avoided by limiting global warming to 1.5°C rather than 2°C, such as the loss of entire ecosystems. With clear benefits to people and natural ecosystems, limiting global warming to 1.5°C compared to 2°C could go hand in hand with ensuring a more sustainable and equitable society.

The IPCC report finds that limiting global warming to 1.5°C would require "rapid and far-reaching" transitions in land, energy, industry, buildings, transport, and cities. Simply put, society is not acting fast enough to reduce carbon dioxide (CO2) emissions. Global net human-caused emissions of CO2 would need to fall by 45% from 2010 levels by 2030, reaching net zero by 2050.

Recognizing this report, in 2019, cities around the world started to declare a 'Climate Emergency'. In declaring a climate emergency, a government admits that global warming exists and the measures taken up until this point are not enough to limit changes brought by it. The decision typically comes with a plan to take more aggressive measures to reach our global climate targets.

> *"Our immediate response to the climate emergency is crucial. In order to reduce our greenhouse gases significantly, we need to keep climate top of mind as we plan our budget and prioritize items on our strategic plan."*
>
> **– Mayor Jonathan X. Coté**

The City of New Westminster was the second municipality in Metro Vancouver to declare a climate emergency in March 2019. To support the climate emergency declaration, the City established a new climate action budgeting framework and seven bold steps with the goal of moving New Westminster towards a zero carbon future by 2050.

THE SEVEN BOLD STEPS ARE:



CARBON FREE CORPORATION

The City of New Westminster will reduce its overall carbon footprint and will strive to achieve net zero carbon emissions by 2030



CAR LIGHT COMMUNITY

Accelerate the Master Transportation Plan targets for mode split: 60% of all trips within the city will be by sustainable modes of transportation (walk, transit, bike, multi-occupant shared) by 2030



CARBON FREE HOMES AND BUILDINGS

Community carbon emissions for all homes and buildings will be reduced significantly. By 2030, all new and replacement heating and hot water systems will be zero emissions



POLLUTION FREE VEHICLES

By 2030, 50% of kilometres driven by New Westminster registered vehicle owners will be by zero emissions vehicles



CARBON FREE ENERGY

The city of New Westminster will invest in a smart electrical grid in order to accomodate the required rapid conversion to building and vehicle electrification



ROBUST URBAN FOREST

New Westminster's Urban Forest Canopy cover will be increased to 27% by 2030 to support the removal of 4,050 tonnes of carbon pollution every year and increase our forest's carbon storage capacity by 50%



QUALITY PEOPLE-CENTRED PUBLIC REALM

A minimum of 10% of today's street space that currently only serves motor vehicles, excluding transit, will be reallocated for sustainable transportation or public gathering by 2030. The natural environment will be integrated with the public realm



1.2 CURRENT CLIMATE AND GREENHOUSE GAS EMISSIONS PROJECTIONS

Global climate models project temperatures will continue to increase over the century. By the 2050s, we can expect the number of summer days over 25°C to more than double what it was in the past, and the annual hottest day temperature to reach 35°C by the 2050s (compared to 31°C in the averaged past). Together with these temperature increases, our region can expect to see a significant decrease in summer precipitation (20% by 2050, on average) and an increase in fall and winter precipitation, (5% to 10%), with more rain and snow falling during extreme events[3]. This could result in more seasonal variations in water availability, flooding and heat events during the summer. For local governments, increasingly variable temperatures and weather conditions may impact demands on municipal infrastructure, and potentially affect the energy and utility loads associated with operating public works and facilities.

Actions that encourage energy efficiency and conservation and promote the use of renewable energy will assist local governments in developing energy resilient communities, in addition to mitigating climate change. Other benefits from increasing energy efficiency and reducing GHG emissions may include improved ambient and indoor air quality and improved comfort in buildings and less pollution from vehicles and equipment.

We have seen significant changes to climate policy at all levels of government since the development of the City's 2008 Corporate Energy and GHG Emissions Management Plan. The causes and predicted impacts of climate change have become better understood as we begin to experience a changing climate. As global GHG emissions increase and average temperatures rise, the best available research indicates that more significant reductions in GHG emissions are required to avoid catastrophic social, economic and environmental impacts from climate change.

[3] Climate projections were prepared for Metro Vancouver by the Pacific Climate Impacts Consortium, and are summarized in this report: http://www.metrovancouver.org/services/air-quality/AirQualityPublications/ClimateProjectionsForMetroVancouver.pdf

The Paris Agreement was ratified by Canada in 2016. This is the current framework for international climate change policy, with a target of limiting global warming to 2°C and Canada has committed to undertake the joint action needed to reduce greenhouse gas emissions by at least 30 per cent from 2005 levels by 2030.

Canada declared a national climate emergency in Canada in 2019.

1.3 NATIONAL POLICY

The Government of Canada has made a series of commitments to tackle climate change. In December 2015 Canada adopted the Paris Agreement (an International agreement ratified by 175 National Governments) which is a commitment to accelerate and intensify the actions and investments to limit global average temperature rise to well below 2°C above pre-industrial levels this century, and to pursue efforts to limit the increase to 1.5°C. This will require taking action on long-lived GHGs such as carbon dioxide and short-lived climate pollutants such as methane, hydrofluorocarbons and black carbon. The signing of the Paris agreement was the culmination of a series of federal steps to address climate change.

To build on the momentum of the Paris Agreement, the federal government developed a new concrete plan which, when implemented, will allow Canada to achieve its international commitments. This plan is called the Pan-Canadian Framework on Clean Growth and Climate Change[4], and it is both a commitment to the world that Canada will do its part on climate change, and a plan to meet the needs of Canadians.

Canada's emissions trajectory is improving, but still a substantial 66 Megatonne gap exists between Canada's best-case scenario for reductions, and a new net-zero target by 2050 has been stated[5]. As of April, 2019, all Canadian provinces and territories have been required to pay a national carbon tax, which is harmonized with provinces that already have a pricing system in place – this will begin to increase the speed of Canada's climate mitigation efforts, but further work will still be required.

> *"Climate change is a real and urgent crisis, driven by human activity"*
>
> **– Environment and Climate Change Minister, Catherine McKenna (2019)**

1.4 PROVINCIAL CONTEXT

The BC Climate Action Charter is a voluntary commitment that was introduced by the Province of BC (Province) in 2007 to encourage local governments to reduce energy and emissions from their operations. Signatory local governments including New Westminster committed to achieve carbon neutrality in their operations beginning in 2012.

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[4] Pan-Canadian Framework on Clean Growth and Climate Change: http://publications.gc.ca/site/eng/9.828774/publication.html

[5] On December 5, 2019, the Parliament of Canada throne speech indicates plans to set a net-zero target for 2050 (which is in-line with current IPCC scenarios to maintain temperatures below 1.5°C) https://www.canada.ca/content/dam/pco-bcp/documents/pm/Speech-from-the-Throne_2019.pdf

Signatories to the BC Climate Action Charter are eligible for an annual grant from the Province called the Climate Action Revenue Incentive Program (CARIP) with a value equivalent to the amount of carbon tax paid. Currently, the City of New Westminster's (City) carbon tax liability is around $115,000 based on $30/tonne CO2 emitted. Since the signing of the Charter, the City has annually received it's CARIP rebate grant and used the funds for energy and emissions reduction projects.

As of November, 2018, the Province has passed both a new greenhouse gas regulation, as well as a new BC climate plan, Clean BC[6]. This plan gets BC 75% of the way to its 2050 commitment of lowering overall GHG emissions by 80%. Some of the policies that will come into effect over this time period include: 1) increasing the transportation low carbon fuel standard to 20% by 2030, 2) mandate 100% of all new cars to be zero-emission vehicles (ZEVs) by 2040, and 3) making every new building "net-zero energy ready" by 2032.

1.5 CLIMATE ACTION IN NEW WESTMINSTER



The City has been a member of the Federation of Canadian Municipalities (FCM) program Partners for Climate Protection (PCP) since 1996. PCP program empowers municipalities to take action against climate change through a five-milestone process:

1. **creating GHG inventories,**
2. **setting GHG reduction targets,**
3. **developing local action plans,**
4. **implementing actions to reduce emissions, and**
5. **monitoring and reporting on results.**

In 2016, the City received recognition from FCM for completion of all five milestones for its corporate stream.

A number of policies and initiatives have been instrumental in achieving our GHG reductions to date. The following policies and initiatives will continue to guide us in the next 10 years and beyond:

Energy Management Committee: City staff across various departments meet regularly to discuss ways to improve energy performance (e.g., civic buildings, fleet, lighting) and reduce corporate greenhouse gases.

2008 Corporate Energy & GHG Emissions Management Plan (CEEMP): The City's first 10-year plan which kick-started our corporate action to reduce GHG emissions. We set a target to reduce 15% of our corporate emissions by 2017 (from 2007 levels) and outlined various projects (e.g., for facilities and fleet) that would need to be undertaken in order to achieve the target.

2009 LEED Gold Policy for new civic facilities: Council adopted policy in 2009 that was an initiative under the 2008 CEEMP.

2011 Community Energy and Emissions Plan (CEEP): The City's first 10-year plan which initiated our community action to reduce GHG emissions. We set a target to reduce 15% of our community emissions by 2030 (from 2011 levels). Energy Save New West, the City's community energy program that arose from the CEEP, has been instrumental in improving energy efficiency and reducing GHG emissions in homes and businesses.

[6] 2018 Clean BC Plan: https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/cleanbc/cleanbc_2018-bc-climate-strategy.pdf

2011 Low Carbon Fleet Policy: Council adopted policy to manage City fleet based on the 2008 CEEMP GHG reduction targets.

2013 Envision 2032: The City's sustainability framework created under social, cultural, economic and environmental pillars. One major area of the framework is Energy & Emissions.

2017 Official Community Plan: City land use plan with policies for an energy-efficient and low-carbon community that reduces greenhouse gas emissions and is resilient to the impacts of climate change.

2018 Environmental Strategy and Action Plan: The City's master environmental plan that builds upon previous work and includes new actions to conserve energy and reduce emissions, encourage the use of renewable, low carbon energy systems, foster continuous measurable improvements in energy use and emissions reductions and prepare for the risks related to climate change.

2019 Climate Emergency Declaration: On March 11, 2019, City Council declared a climate emergency that concurs with the position of the Intergovernmental Panel on Climate Change[7] (IPCC) that dramatic action is required globally in the next 12 years to reduce GHGs in order to avert catastrophic social, economic, and environmental impacts on future generations. In response to the climate emergency declaration, the City adopted the bold steps to demonstrate its commitment to meeting its new targets.

2020 Climate Action Division: In 2020, the City formed a new Climate Action Division to support all departments in the corporation in achieving the City's climate targets.



[7] 2018 Intergovernmental Panel on Climate Change (IPCC) Report: https://www.ipcc.ch/sr15/

2. CORPORATE ENERGY & EMISSIONS VISION AND GOALS

The following guiding vision and set of goals were developed by the Energy Management Committee and endorsed by Council on March 5, 2018.

VISION

The City of New Westminster will become a recognized leader in reducing non-renewable energy use and emitting Greenhouse Gases (GHGs) and other harmful by-products from energy consumption in its corporate operations. We will aggressively pursue net –zero corporate energy use and GHG emissions by the end of this plan in a fiscally responsible manner.

ADOPTED GOALS

1. **Maximize energy efficiency in the delivery of services and existing buildings.**
2. **Build new buildings net-zero or net-positive with respect to energy and emissions.**
3. **Aggressively pursue local renewable, low impact energy sources.**
4. **Transition to an efficient and low-carbon fleet.**
5. **Prioritize walking, cycling, transit and shared pool vehicles as the preferred ways to get around.**
6. **Minimize the Wenergy and emissions impacts of all corporate assets.**
7. **Partner with external organizations to advance common energy and emission objectives**
8. **Move towards zero corporate waste generation**[8]
9. **Maximize reuse, recycling and material recovery** [8]

Changing the way that we use energy is key to reducing the our corporate emissions. Although the primary source of electricity in British Columbia is hydroelectric power, which emits relatively few GHGs, fossil fuels are still readily used in many areas of municipal operations. We need to continue to seek opportunities for reducing energy consumption and shifting to cleaner sources of energy, such as renewable energy (e.g., hydroelectric power, solar) and to improve the City's environmental performance.

[8] Waste-related goals # 8 and 9 are being addressed through the City's Environmental Strategy and Action Plan. Emissions related to goals # 8 and 9 are currently not tracked; further action presented in section 5.1.

3. OBJECTIVES OF RENEWED CORPORATE GHG PLAN

The purpose of this renewed plan is to demonstrate continued leadership in taking actions on climate mitigation and charting a new path forward using new technological advancement and knowledge. Under the climate emergency declaration, we established three significant corporate GHG reduction targets: 45% by 2030, 65% by 2040 and net zero by 2050 below 2010 levels. These targets in turn set the level of actions needed. The renewed plan will specifically focus on the next 10 years and outline a suite of actions that would help us reach the target by 2030 (and put us on the path to achieve the targets in the next period ahead).

The plan is not designed to be prescriptive but rather it outlines a set of measures that are expected to help us reach our target. Given the complexity and uncertainty of projecting future emissions and technological changes, the estimates are best understood as orders of magnitude of reductions and associated costs.

Our experiences with the previous 10-year CEEMP found that unforeseen factors9 may inevitably affect our ability to achieve the target. As this renewed plan may also be exposed to a level of uncertainty, it should be considered a living document and the actions should be regularly reviewed and revised based on current technologies, new conditions (e.g., new asset acquisition) or changes to senior level government policies.

4. ENERGY & EMISSIONS INVENTORIES 2010, 2017, 2018, 2019

The City's first corporate energy and GHG emissions plan of 2008 had a baseline year of 2007. This renewed plan and its target are based on corporate emissions data estimated from year 2010, which follows the baseline year of the IPCC report[4]. This plan also includes the more recent data sets from 2017, 2018 and 2019 which provide a more current and detailed picture of our emissions levels to date. Like the 2008 corporate plan, a detailed set of information has been outlined for the same four asset classes: Fleet, Buildings, Outdoor Lighting and Water & Wastewater.

Based on 2007 corporate baseline emissions, the City was able to reduce GHGs by 5.3% by 2017 and 12.6% by 2018 (target was 15% by 2017).

[9] The decision to renew the Canada Games pool led to the City not undertaking additional energy retrofit work that could have resulted in significant emissions reductions.

4.1 2010 EMISSIONS TARGET BASELINE YEAR

The target of 45% reduction of GHG emissions by 2030 is measured from the 2010 baseline; however, corporate emissions were not originally inventoried for that year so an energy model was built using the regression analysis technique. The 2010 weather adjusted baseline model is built on 2009/2011 inventories. The resulting total corporate emissions for 2010 is estimated to be 4,089 tCO_2e (Table 1).

4.2 2017 EMISSIONS INVENTORY YEAR

A 2017 corporate energy and emissions inventory indicated that the total GHG emissions from all asset classes of corporate operations was 4,037 tCO_2e. Civic buildings produced the largest amount of GHGs (2,355 tCO_2e) followed by the fleet which emitted 1,649 tCO_2e (Table 1).

Provincial software has been used since 2013 to track corporate energy and emissions data.

Table 1: Estimated GHG emission profile by asset class for 2010 (target baseline year) and 2017.

Asset Class	2010 GHG Emissions (tCO_2e)	2017 GHG Emissions (tCO_2e)
Buildings	2,319[10]	2,355
Fleet	1,667	1,649
Outdoor Lighting	93	28
Water & Wastewater	10	5
Total	**4,089**	**4,037**

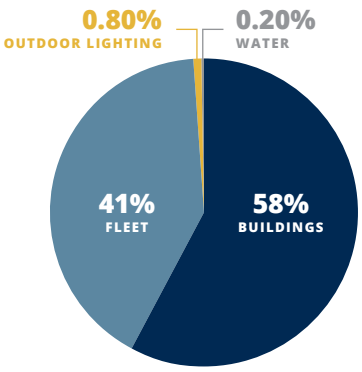


Figure 1: 2017 Corporate Emissions By Asset Class

Currently local governments are not required to report on emissions related to solid waste generation, business travel and employee commuting. Therefore the City does not have in place monitoring frameworks, inventories and reduction strategies at this time. Further discussion relating to these emission sources is presented in section 5.1.

[10] Electrical emissions related to buildings was averaged between 2009 and 2011. Natural gas consumption (and associated emissions) was estimated based on a regression analysis performed against annual heating degree days observed (as 2010 was a warmer year than 2009 or 2011).

BUILDINGS

The City operates 25 civic facilities, 22 of which have natural gas consumption (Table 2). All civic properties that were owned by the City in 2017 were included in the 2017 GHG inventory. Civic facilities leased to third parties were excluded.

Building emissions resulting from natural gas and electrical consumption account for approximately 58% of the City's total GHG emissions (Figure 1). Most of the emissions (95%) result from on-site combustion (45,274 GJ) of natural gas. The remaining emissions from buildings result from electrical consumption (5%). The generation of electrical energy through hydropower (the primary source of electricity in British Columbia) emits relatively few GHG emissions.

Although electricity consumption is not responsible for the majority of emissions, the City recognizes the importance of energy efficiency as a way to reduce operational and equipment maintenance costs. Savings through energy efficiency retrofits can further fund fuel switching efforts, which in turn will continue to reduce the City's emissions.

The Canada Games Pool is the top energy consumer of natural gas, resulting in 22% of the City's total corporate emissions (Table 2). The Anvil Centre facility, which was added to the City's assets in 2014, is ranked second in energy consumption and emissions and City Hall is ranked third. Compared to the 2008 original baseline year, City Hall has increased in space occupied by about 30%, and energy consumption has increased accordingly. Total energy costs related to the operation of the City's facilities is approximately $1.2M.



Table 2: 2017 Corporate energy and GHG emissions inventory for City facilities (ranked by largest GHGs emitted and for only those assets with ≥ 1 Tonne of GHGs)

Asset Class	Natural Gas Consumption (GJ)	Electricity Consumption (kWh)	GHG Emissions (tCO_2e)	Energy Costs ($)	Area (m^2)	% of Total Buildings Emissions
Canada Games Pool	17,684	1,741,111	901	269,206	4,522	38
Anvil Centre	5,363	1,033,611	279	136,508	7,804	12
City Hall	2,696	717,500	142	84,508	5,490	6
Queens Park Arena	2,410	654,167	127	83,846	7,544	5
Queens Park Greenhouses	2,206	56,944	111	24,945	1,384	5
Glenbrook Fire Hall (#1)	1,704	259,722	88	43,548	1,343	4
Moody Park Arena	1,528	750,278	84	75,689	3,109	4
Police Building	1,415	819,722	79	83,907	4,900	3
Public Library	1,437	430,278	76	48,501	4,060	3
Parks Admin & Century House + Youth Centre	1,243	222,778	65	39,575	3,005	3
Engineering Ops. + Electrical	1,140	592,500	63	71,382	3,074	3
Queensborough Community Centre	1,148	315,833	61	39,884	2,593	3
Queensborough Fire Hall #3	998	118,056	51	24,676	621	2
Centennial Community Centre	957	116,389	48	21,622	1,918	2
Moody Park Outdoor Pool	835	176,389	43	34,449	499	2
Hume Park Pool & Washroom	833	14,722	42	8,336	104	2
Queens Park Carpenters Shop	586	100,556	30	19,776	327	1
Queens Park Centennial Lodge	331	33,055	17	17,044	742	1
West End Fire Hall (#2)	296	33,055	15	7,669	353	1
Museum & Archives Building	276	107,222	15	15,706	1,093	1
Queens Park Gardeners / Caretakers House	126	8,333	6	2,131	274	0.26
Queens Park Arenex (Demolished)	62	–	3	–	1,254	0.13
Mercer Stadium	–	124,167	1	19,060	683	0.04
Animal Control Shelter[11]	–	104,167	1	13,117	184	0.04
Total	**45,274**	**8,530,556**	**2,348**	**1,185,000**	**56,880**	**100**

[11] The animal control shelter has been replaced with a new building in 2019. This data applies to the previous facility which is no longer in operation.

Heavy duty diesel vehicles include trucks that provide services for Fire Services, Electrical Utility, Garbage & Recycling, Towing, Water and Sewer Utilities and road maintenance Services.

VEHICLE AND EQUIPMENT FLEET

Vehicle and equipment fleet (termed collectively as "Fleet") includes all motorized vehicles and equipment operated by the City, as well as personal vehicle use for City business. The City's fleet is predominantly comprised of light and medium-duty vehicles. Emissions from fleet are the second largest source of GHG emissions after buildings, representing approximately 41% of the City's total emissions. In 2017, the City's vehicles emitted 1,649 tCO_2e (Table 1). These emissions are from the use of diesel, gasoline and propane fuels[12]. Currently, diesel fuel that is purchased has a 5% biodiesel blend and gasoline has a 10% ethanol blend.

City employees use their personal vehicles for business purposes and recover travelling costs from the City. This data has been tracked since 2016 and is included in the 2017 emissions inventory. Personal vehicle use was estimated to be 15,106 L of gasoline consumed resulting in 35 tCO_2e of emissions.

Table 3 below provides a ranking of GHGs emitted from three vehicle classes. Heavy duty diesel vehicles consume the majority of fuel and have the largest influence on GHG emissions (844 tCO_2e) or 51% of the fleet emissions.

Table 3: 2017 Energy and emissions inventory for City fleet, ranked by largest GHG emitter.

Vehicle Class	Number of Units in Class	Gasoline Consumption (L)	Diesel Consumption (L)	Propane Consumption (L)	Total Fuel Costs ($)	GHG Emissions (tCO_2e)	% of Total Fleet Emissions
Heavy Duty Vehicles	49	27,138	266,469	34,967	333,519	844	51
Light Duty Vehicles	58	145,778	–	22,140	181,501	380	23
Light Duty Trucks	65	83,891	18,322	32,114	134,719	302	18
Total	**172**	**256,807**	**284,807**	**89,221**	**649,739**	**1,526**	**92**

[12] Electricity use for fleet and equipment is currently accounted for in the Buildings asset class. The amount of electricity use would be minimal relative to building electrical use.

OFF ROAD EQUIPMENT

Off-road equipment includes vehicles and equipment not used on streets and ranges from mowers, tractors and chippers to hand-held devices such as those used for landscaping and maintenance. Fuel for off-road equipment is supplied by various fuel tanks that are situated around the city. Some equipment is electric powered. A summary of fuel consumption and GHGs emitted for off-road equipment is shown in Table 4 below.

Table 4: 2017 Corporate energy and emissions inventory for fossil fuel-based off road equipment.*

# Vehicles in Class	Gasoline Consumption (L)	Diesel Consumption (L)	Propane Consumption (L)	Total Fuel Costs ($)	GHG Emissions (tCO_2e)	% of Total Fleet Emissions
26	6,235	36,227	547	45,939	123	8

OUTDOOR LIGHTING

The majority of energy consumed in this asset class is related to streetlights and traffic signals (83%). Other lighting assets include ornamental lighting, heating of bridges (i.e., Third and McInnes St. overpasses) and lighting used for parks, stadiums and sports fields (17%). The emissions inventory for this asset class in 2017 amounted to 28 tCO_2e (Table 5). Most lighting accounts are metered which provide actual electrical consumption. For those assets billed under flat-rates, consumption is estimated (e.g., overhead street lighting, traffic signals, WiFi nodes).

The lighting asset class has been greatly influenced by changes in carbon intensity from BC Hydro's electrical power generation (GHG emissions conversation factor). As a result, this asset class experienced a decrease in emissions by approximately 50% between 2007 and 2017 even though consumption was reduced by only 25%. To date, all traffic signals have been converted to LED and streetlights are gradually being converted to LED from high pressure sodium (HPS) and metal halide.

Table 5: Summary of Lighting Asset Class Energy and Emissions and Costs (2017)

Energy Type	Consumption (kWh)	Energy Costs ($)	GHG Emissions (tCO_2e)
Electricity	2,620,669	120,161	28

WATER & WASTEWATER ASSET CLASS

The majority of the energy consumed in the water and wastewater asset class is for motors that drive sanitary and storm sewer pumps. City assets include five drainage pump stations, 26 sanitary pump stations and 10 pressure reducing valve (PRV) stations (chambers) that reduce the high pressure of Metro Vancouver's water supply system. Energy (electrical) consumption is relatively low for the wastewater asset class. Queensborough sewage pumps do not have to pump against significant elevations due to the flat topography of Lulu Island and the proximity to the Annacis Island treatment plant. Pumping is generally not required on the mainland of New Westminster. Overall for the water and wastewater asset class, 429,019 kWh (1544 GJ) of electricity was consumed in 2017 which resulted in the release of 5 tCO_2e (Table 6).

Table 6: Summary of Water & Wastewater Energy and Emissions and Costs (2017)

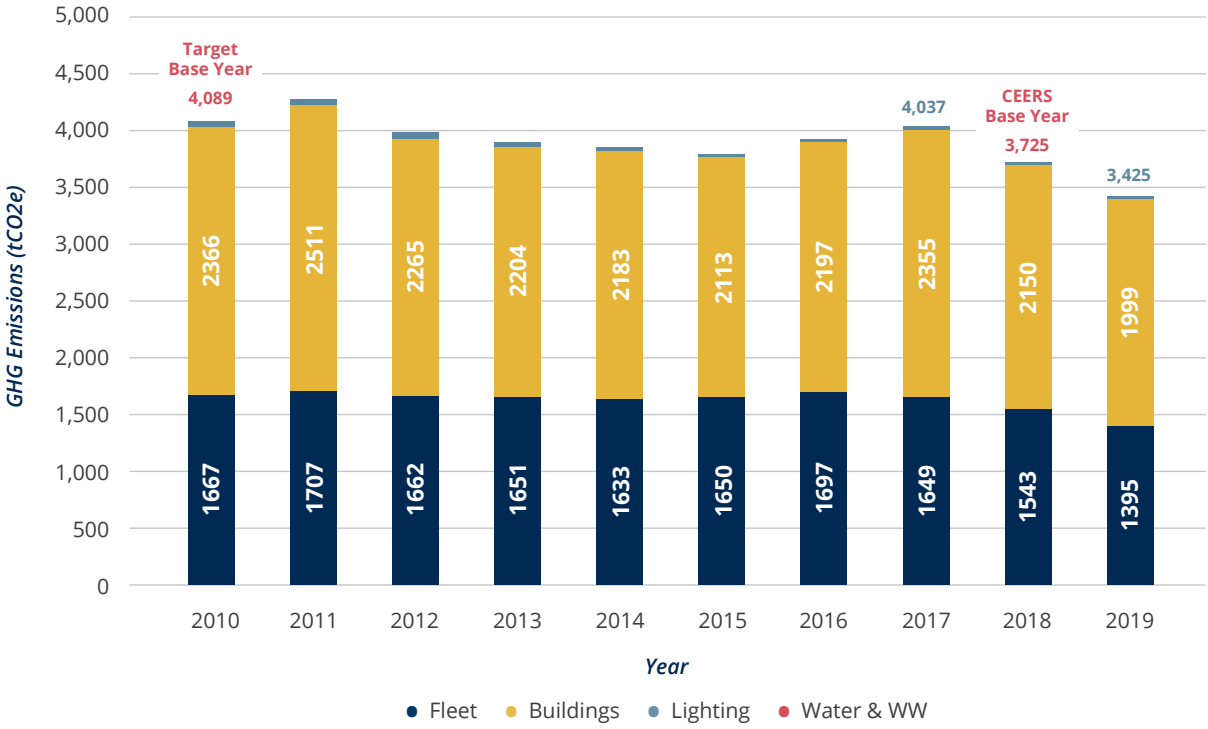
Energy Type	Consumption (kWh)	Energy Costs ($)	GHG Emissions (tCO_2e)
Electricity	429,019	19,670	5



4.3 2010 - 2019 EMISSIONS PROFILE

The slight downward trend in total GHG emissions of all corporate operations from 2010 to 2019 is shown in Figure 2. Total GHG emissions for 2019 - our most recent inventory - is 3,426 tCO_2e. In 2019, the Buildings asset class produced the largest amount of GHGs (1,999 tCO_2e) followed by the Fleet asset class (1,395 tCO_2e). Emissions from both the Building and Fleet decreased significantly from 2017 to 2018 due to the fact that 2017 was a colder year. Colder temperatures result in more heating required for buildings during winter months and fleet emissions are often affected due to increased snow removal service. Emissions from Buildings and Fleet decreased significantly from 2018 to 2019 because of recommissioning activities at the Anvil Center and, as of 2019, fleet emissions related to services delivered to Recycle BC are being reported by that entity and therefore have been removed from the City's emission inventory. GHG emissions from the Lighting asset class only decreased by 1 tCO_2e in 2018 compared to 2017 and those from the Water & Wastewater asset class decreased by 1 tCO_2e due to changes in the electricity generation emission factors reported by BC Hydro.

Figure 2: Emissions profile for all asset classes between years 2010 - 2019



5. SETTING THE TARGET AND FORECASTING

The City's climate emergency declaration stipulates a corporate GHG reduction target of 45% below 2010 emissions levels of 4,089 tCO_2e by 2030; which sets 2,249 tCO_2e as the maximum allowable emissions in 2030 from all corporate assets (target illustrated in Figure 3). However, in order to achieve this target amount, reductions in GHG emissions will need to include those emissions associated with anticipated growth.

A "business as usual" (BAU) scenario forecasts the rising level of emissions from expanding City services and infrastructure to meet population growth demands. Forecasting the amount of corporate GHG emissions that will need to be reduced by 2030 needs to account for those emissions associated with projected growth of City assets and services. An emission trend line can be extrapolated from 2018 data (i.e., CEERS base year) to 2030 assuming an annual growth rate of 0.85% in services for fleet[13], inclusion of contracted services emissions and other forecasted growth of other asset classes.

Anticipated asset changes from 2018 to 2030 for each asset class and related impact on GHGs are shown in Table 7. Total emissions are expected to increase by 362 tCO_2e.

Table 7: Anticipated Asset Changes from 2018 to 2030 – for each asset class (BAU Scenario).

Asset Class	Anticipated Asset Growth from 2018-2030	BAU Scenario: Change in GHG Emissions (tCO_2e)	BAU Total GHG Forecast to 2030 (tCO_2e)
Buildings	The rebuild of the Canada Games Pool (Aquatic Centre) Facility (size: 4,522m2) and Centennial Community Centre (1,918m2) built to achieve LEED Gold.	0	**2,175**
	City Hall is currently undergoing renovations and is expected to increase occupied heated space by 901m^2.[14]	+ 20	
	The City will acquire Massey Theatre in late 2020.	+ 183	
	A new, expanded Animal Shelter is built to LEED equivalency but is three times larger and uses natural gas.[15]	+ 11	
	A new Arenex "SportsPlex" building fueled exclusively by electricity. Note the former Arenex emissions excluded from City inventory as of 2017.	+ 3	
	Hume Park Pool rebuild to the same	0	
	Queens Park Concession Stand and Washrooms replacement building	+ 1	
	Museum and Archives Building to be demolished	- 15	
	Anvil Centre recommissioning of boiler and chiller operation (completed in 2019)	- 178	
	Buildings Subtotal:	**+ 25**	

[13] Population of New Westminster is anticipated to grow by 1.7%. However, service provided by City fleet is anticipated to only increase by half this amount as more stringent senior government energy and emissions regulations for new vehicles are expected to be released before 2030.

[14] City Hall growth in emissions is based on new information from Engineering - buildings department, March 2020.

[15] Animal Shelter growth in emissions is based on new information from Engineering - buildings department, March 2020

Asset Class	Anticipated Asset Growth from 2018-2030	BAU Scenario: Change in GHG Emissions (tCO_2e)	BAU Total GHG Forecast to 2030 (tCO_2e)
Fleet	Service levels are predicted to increase by 0.85% which would require additional vehicles and equipment. The BAU scenario continues with fossil fuels.	+ 168	
	A new heavy duty Hydrovac truck will be purchased to provide a water utility service that is currently provided by a contractor.	+ 50	
	Emissions related to contracted services have not been included in previous annual reports to council as it was not included in the baseline year (2010). Going forward, emissions for contracted services valued at over $25,000 will be included.	+ 226	
	Fleet Subtotal:	**+ 444**	**1,987**
Lighting	A small increase in new lighting installations is anticipated (e.g., 8 streetlight arrays); however new lighting and replacements will be LED resulting in minimal overall impact.	0	**27**
Water and Wastewater	One new pump station (SA-30) will be added in the next 10 years. It will likely have a larger capacity and be more energy efficient. BAU decrease due to BC Hydro electricity emission factor update in 2019.	- 1	**4**
All Corporate Assets (BAU Change and Total Forecast)		**+ 468**	**4,193**

If no measures are taken to reduce energy consumption or emissions, the City's corporate emissions inventory in 2030 would rise to approximately 4,193 tCO_2e. This value represents the amount of emissions in 2018 (3,725 tCO_2e) plus the growth in the BAU scenario (468 tCO_2e). To reach the greenhouse gas emissions target of 45 % reduction in GHG emissions below 2010 levels (2,249 tCO_2e) by 2030, or better carbon neutral, the City will need to implement energy measures or initiatives that reduce GHG emissions by at least 1,944 tCO_2e (Figure 3).

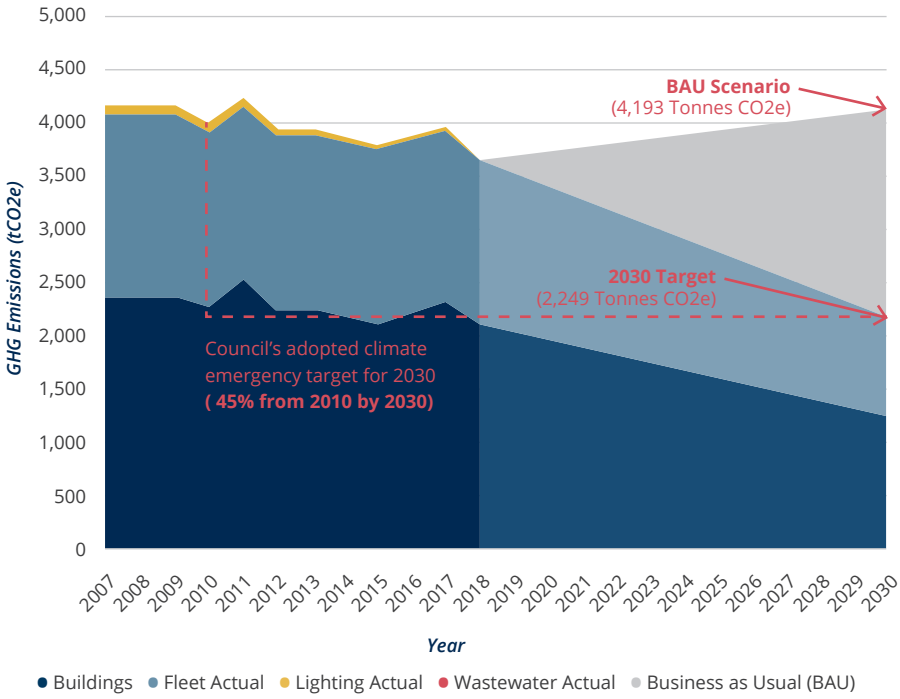


Figure 3. Impact of anticipated asset growth on the City's carbon footprint, from 2018 to 2030 and potential reductions needed to achieve the 2030 target.

5.1 OTHER EMISSIONS

Due to the lack of available data for emissions related to activities such as those from solid waste, business travel and employee commuting, they have been omitted from the current BAU projections. While local governments are not currently accountable for emissions in these areas, including them in monitoring frameworks, inventories and reduction strategies demonstrates leadership and accountability. In the future, should reporting requirements change to incorporate a larger scope of emissions, local governments that have systems in place to track emissions in these areas will be in a position to provide accurate data and reporting. Additionally, reduction activities in these areas tend to be highly visible to and top-of-mind for employees. The reduction of paper use and waste in the workplace serves as a tangible example of change, and efforts to support alternative commutes tend to be appreciated by staff. The City will initiate the development of monitoring and reporting procedures to expand the scope of emissions included in the corporate energy and emission profile. Continuous review and adjustments to the BAU scenario will result from these activities.

6. ENERGY & EMISSION REDUCTIONS OPPORTUNITIES

Emissions reduction measures presented in this section will help the City meet its adopted corporate climate emergency GHG emissions target of 2,249 tCO_2e (45% reduction below 2010 levels) by 2030 and help meet the CEERS vision and goals.

The specific building and fleet asset class measures were developed by subject experts and are outlined in detail within Appendices 3 and 4. The recommended existing building measures were developed to complement work plans that are currently underway. For instance, some energy upgrades for existing buildings are included into the 5-year capital planning process. A set of strategies were then developed based on these measures and the City's adopted vision and goals. A compilation of all CEERS strategies can be found in Appendix 1.

6.1 BUILDINGS ASSET CLASS

ADOPTED GOALS

1. **Maximize energy efficiency in the delivery of services and existing buildings.**
2. **Build new buildings net-zero or net-positive with respect to energy and emissions.**
3. **Aggressively pursue local renewable, low impact energy sources**

As part of the previous 10-year corporate energy & emission plan, various mechanical system upgrades have already been completed (e.g., energy efficient boilers) as well as other "low hanging fruit" projects for City's buildings which have a simple payback (less than 5 years). In 2009, the City adopted a LEED (Leadership in Energy and Environmental Design) Gold policy for civic buildings, and as a result two buildings – Anvil Centre and Queensborough Community Centre addition – were built to this standard. In order to meet more aggressive forthcoming GHG emissions reduction targets, the City will need to adopt a more stringent green building policy for new buildings and find other innovative ways to achieve deeper emissions reductions in existing buildings.

NEW BUILDINGS

The most significant opportunity for greenhouse gas reductions in this current plan is the replacement of the Canada Games Pool and Centennial Community Centre site (NWACC). A new green building guideline is planned to be applied to the site that integrates CaGBC's Zero Carbon Building[16] Standard with the current LEED Gold policy. Following these guidelines, the new NWACC could achieve a significant greenhouse gas reduction in the order of 815 tCO_2e as compared to the existing facility on the site (based on 2018 operations). If applied it could result in a new annual emission of only 82 tCO_2e for the entire building. The cost premium is estimated to be in the order of $2.2M[17] to meet the new standard.

Although no other civic building is anticipated to be built in the next 10 years, the new green building policy could be applied to major building renovations, if applicable, and therefore could result in additional energy and emissions savings.

Strategy #1: Apply the Zero Carbon Building Standard for the NWACC facility

Applying the Zero Carbon Building standard as part of the lifecycle cost analysis strategy for the new NWACC facility will lead to the elimination of natural gas use, resulting in substantial corporate emissions reductions.

Strategy #2: Implement the updated Civic Green Building Policy for new construction and major renovations.

Update the City's current Green Building Policy to include CaGBC's Zero Carbon Building Standard with the LEED Gold and implement the policy in the construction or renovations of new buildings, as applicable.

EXISTING BUILDINGS

As part of an ASHRAE Level 1 energy study, a prioritized list of 13 civic facilities underwent a detailed energy assessment. Consideration was given to those buildings that fit into the City's current 5-year capital upgrade plan (2020-2024). A set of energy measures were identified for each building, with each measure subject to full lifecycle cost analysis and effect on greenhouse gas emissions. Recommendations ranged from lower cost measures such as the building automation system (BAS) controls recommissioning to higher cost measures such as upgrading mechanical systems. BAS installation and/or recommissioning was recommended for most of the 13 buildings studied. Optimizing controls was recommended to be completed initially as this can inform the design of higher cost measures. It should be noted that the Anvil Centre was not included in this study. The Anvil Centre was the second largest GHG emitter in 2017 which prompted immediate action. Recommission activities on the boiler and chiller were concluded in 2019 which significantly reduced the building's natural gas consumption resulting in a GHG emission reduction of 178 tCO_2e (68% reduction as compared to the previous 3 years of operation).

In summary, the implementation of all measures in the energy study within the next 5 years could amount to a reduction of 6,295 GJ in total energy consumption which results in 322 tCO_2e (Appendix 2). A ranking of buildings (with measures) having the largest to smallest GHG emissions reduction opportunities is provided in Table 8 below including estimated energy cost savings and simple payback period. Implementation of recommended measure(s) for each building would be reviewed on an annual basis as part of the capital budgeting process.

[16] A zero carbon building is a highly energy-efficient building that produces onsite, or procures, carbon-free renewable energy in an amount sufficient to offset the annual carbon emissions associated with operations

[17] Estimated GHGs and cost analysis provided by Turnbull Construction Project Managers

Table 8: Existing Civic Buildings and Anticipated GHG Reduction Identified in the Level 1 Energy Study.

Rank (GHG Reduction Potential)	Civic Facility	Capital Cost Premium of Measures ($)	Annual Avoided Energy Costs ($ / year)	Simple Payback (years)	Estimated Annual Emissions Reduction (tCO_2e / year)	Estimated Marginal Abatement Cost[18]* ($ / tCO_2e)
1	City Hall	341,700	26,500	11.6	67.9	113
2	Queens Park Arena	277,500	27,250	10.2	65.6	8
3	Moody Park Arena	271,000	29,600	9.2	46.0	- 54
4	Glenbrook Fire Hall	85,300	8,760	9.7	39.1	- 6
5	Moody Park Pool	60,600	9,130	6.6	28.2	- 109
6	Eng Ops Building	91,500	9,010	10.2	18.2	8
7	Queensborough Fire Hall	34,000	3,440	9.9	15.3	- 3
8	Police Building	56,300	8,000	7.0	14.5	- 163
9	Century House	44,200	6,370	6.9	13.6	- 143
10	Library	25,000	4,400	5.7	5.5	- 345
11	Queensborough Community Centre	26,000	3,700	7.0	4.7	- 234
12	Electrical Operations	15,000	1,300	11.5	2.1	95
13	Queens Park Gardeners Building	1,800	360	5.0	1.0	- 180
	Total	**1,329,900**	**137,820**	**9.6**	**322**	**- 15**

Existing buildings that were not part of the Level 1 energy study (i.e., those that were not part of the 2020-2024 five-year plan) may still be subject to energy upgrades or controls recommissioning in the future. Determining energy conservation measures for these remaining buildings within the next five-year plan will provide additional opportunities to help the City reach its 2030 target. At the minimum, a Level 1 Energy Study should be conducted for the remaining buildings every five years with the next review in 2025. In order to realize deeper retrofit opportunities, an ASHRAE Level 2 or 3 study should be done on a select few buildings that were identified in previous studies as potential high greenhouse gas emitters.

It is important to note that the existing Canada games pool is not in the table above (Table 8) because it was omitted from the study. The City had already committed to building the new NWACC facility and its emissions reduction opportunity has been accounted for. As mentioned in the previous section, the cost premium for the replacement of the Canada Games pool is in the order of $2.2 M and will achieve a reduction of 815 tCO_2e. When analyzing the cost per tonne of reduction against many other civic facilities, the new development of the NWACC pool will achieve a conservative cost of $180 per tCO_2e (not including benefit of lifetime annual energy cost savings from high efficiency equipment and above baseline building standards).

[18] Detailed description of the Marginal Abatement Cost in 7.2. Average life of the emission reducing measures estimated to be 10 years (mix of new controls (5yrs), and equipment (15yrs))

Strategy #3: Implement Measures for Existing Civic Buildings as per the Level 1 Energy Study

Implement recommended energy conservation measures for the 13 civic buildings identified in the study and ensure adequate capital is annually allocated. Consider undertaking controls recommissioning or installation in advance of completing other measures. (See Appendix 2: Level 1 Building Energy Study)

Strategy #4: Conduct a Level 1 Energy Study for remaining Civic Buildings to determine additional emissions reduction opportunities for existing buildings every 5 years.

Establish a priority list of additional civic facilities for a Level 1 (at minimum) Energy Study to determine energy and GHG emissions reduction projects that could be included in the next capital program, every 5 years. Ensure budget is allocated to conduct this study. An estimated cost for a Level 1 Energy study could be in the order of $50,000 - $75,000 depending on the level of detail required.

The City undertakes a number of maintenance and facility upgrade projects each year to address operational needs and deferred maintenance. As part of these activities, staff will need to evaluate whether proposed equipment or systems would contribute to the corporate carbon footprint or would alternatively improve energy and emissions reduction performance. A protocol will need to be developed to ensure this evaluation is captured before the project begins. An implementation strategy was developed (Strategy #24 as part of section 7.2 Project Prioritization and Decision Making Tools section) which will help to address this need.

The City has been reducing fuel consumption and emissions through the implementation of the following initiatives:

- ***Conversion of 50 gasoline fueled vehicles to propane/gasoline dual fuel system***
- ***Telematics global positioning system (GPS) installed in fleet***
- ***Revising Low Carbon Fleet Policy to incorporate new climate action directions***

6.2 FLEET AND EQUIPMENT ASSET CLASS

ADOPTED GOALS:

> **3. Aggressively pursue local renewable, low impact energy sources**
>
> **4. Transition to an efficient and low-carbon fleet.**
>
> **5. Prioritize walking, cycling, transit and shared pool vehicles as the preferred ways to get around.**

The City's Low Carbon Fleet Policy and Procedure was adopted in 2011 and Fleet Services has been implementing the policy since that time. The growth of the fleet in response to increased service levels has been a continual challenge to reduce the City's overall corporate emissions. Nevertheless, the City has made progress in reducing GHGs by fuel switching to a less carbon intensive fuel – propane. The City continues to work towards eliminating the dependence on fossil fuels and will monitor the progress of new technologies that allow it to do so.

A suite of measures have been identified for the fleet asset class to help reduce GHG emissions. These measures will improve the efficiency and utilization of its fleet assets and encourage travel by non-auto modes (Corporate Fleet Roadmap - Appendix 3). Although the City's fleet is projected to increase by 0.85% over the next 10 years, the most prominent action to counterbalance this increase will be the switch from fossil fuels to electric power. Even with recent advances in electric vehicle (EV) technology, we are still uncertain when EV models for medium and heavy duty applications will be available for reliable City operations. Some of the biggest challenges to electrify the fleet are related to electrical capacity and high charging infrastructure costs. The Roadmap in Appendix 3 illustrates a scenario of measures that should be implemented over the 10 year period. These measures will be reviewed and updated every five years to ensure the roadmap stays relevant for the City.

FUEL-SWITCHING

Significant electrification of the fleet is anticipated to take place within the next 10 years. Light duty or passenger cars will likely be the first fleet to be switched to electric vehicles (EV) as models are more readily available, followed by medium duty trucks. The City currently has a Nissan Leaf and a Chevy Volt for staff use. Light duty trucks, SUVs and medium duty vehicles currently do not have viable electric options, but the market is changing rapidly and we anticipate that options will be available between 2021-2023. In order to accommodate the wide-spread use of electric vehicles in municipal operations, it is imperative that EV charging infrastructure is in place. Anticipated significant costs related to the installation of infrastructure and the increase in electrical capacity that will be needed, needs to be determined in advance.

Table 9: Estimated annualized cost premium and emission reductions to convert vehicles to electric by 2028

# of vehicles replaced by EV	Estimated Annual Operational Savings ($ / yr)	Annualized Vehicle Capital Cost Premium ($)	Annualized Infrastructure Capital Cost ($ / year)	Estimated Annual GHGEmissions Reduction (tCO_2e / year)	Estimated Marginal Abatement Cost[19]* ($ / tCO_2e)
84	484,000	382,000	199,000	740	131

A more thorough study will need to be conducted to analyze the City's electrical system capacity, provide more details on infrastructure costs and to determine where it may be possible to integrate corporate electric charging needs with community-at-large charging needs to maximize benefits through shared use models.

Strategy #5: Develop an integrated corporate and community EV Strategy

Develop a comprehensive corporate EV strategy outlining charging infrastructure and capacity, needs and costs. In order to identify efficiencies and cost savings this strategy should be completed in conjunction with an assessment of anticipated community-wide electric transportation needs.

Strategy #6: Install EV charging infrastructure and associated upgrades

Establish annual plans to upgrade existing infrastructure in preparation to receive additional EV vehicles beginning with light duty vehicles (e.g., Police). See Appendix 3: Fuel-based & technical initiatives of Roadmap.

Strategy #7: Purchase light duty electric vehicles and equipment, as applicable

Purchase electric vehicles for fleet, as appropriate, and ensure infrastructure is adequately in place for EV arrival. Availability and delays of arrival should be considered.

[19] Detailed description of the Marginal Abatement Cost in 7.2.

Fuel consumption is largely influenced by the City's use of heavy-duty vehicles, such as garbage collection trucks and fire trucks. Currently, there are limited low carbon alternatives for heavy-duty electric vehicles. Electric heavy-duty vehicles are not expected to be in the mainstream market until 2028 and beyond. Until that time, alternative low carbon fuels such as renewable diesel may be the most achievable means of reducing heavy-duty fleet emissions. Availability and potential sustainability impacts associated with these low carbon alternatives still needs to be determined. In 2019, a cost analysis was completed to assess the possible switch of diesel fuel to natural gas. Due to cost and space constraints in relation to the installation of natural gas infrastructure, the study did not recommend that a switch be implemented. Staff will continue to monitor other potential opportunities to fuel switch for heavy-duty vehicles in the interim.

Strategy #8: Monitor the potential use of non-fossil/renewable fuels (e.g., EV) for the City's heavy-duty fleet and purchase vehicles, as applicable

Monitor availability of heavy-duty electric vehicles and/or the potential for use of renewable diesel or other low carbon fuel types and purchase vehicles, as appropriate.

The City's Parks and Engineering Operations utilize a variety of small hand-held equipment such as leaf blowers to carry out daily job functions. Landscaping equipment has typically been gas-powered and only recently have technological advances emerged to allow the performance of electric-powered units to match their fossil fuel-powered counterparts. Staff have been piloting and procuring various electric-powered equipment as they become available. Co-benefits of fossil fuel-free tools include reduction in noise levels and health effects related to the elimination of combustion exhaust.

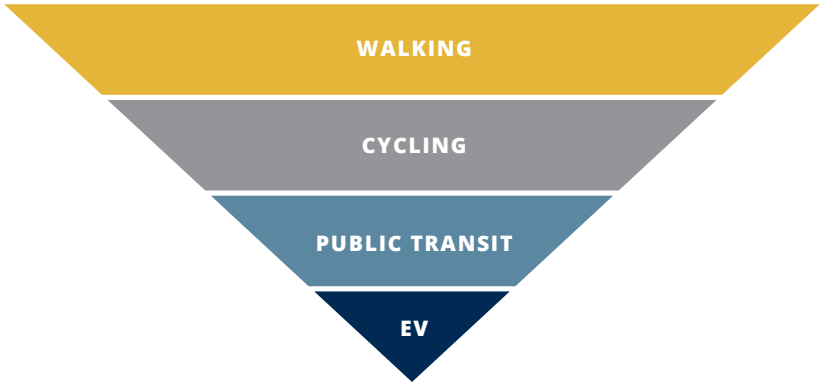
Strategy #9: Phase out the use of fossil fuels in hand-held landscaping equipment

Staff will continue to pilot and gradually acquire a fossil fuel-free suite of hand-held equipment and tools.

EMPLOYEE TRIP REDUCTION AND ENERGY EFFICIENT POOL VEHICLES

The City will encourage travel to and from work by non-auto modes, and encourage the use of non-auto modes during the course of business, where feasible (Figure 4). The City has purchased pool bicycles and e-bikes for staff to use for City business. Where a bicycle is not suitable for a specific job function, the range of alternative travel options will be widened by establishing a larger pool of fuel efficient vehicles and encouraging travel by other sustainable transportation modes such as public transit.

Figure 4: Hierarchy of Sustainable Transportation Modes for Employee Trips



Strategy #10: Promote e-bike fleet use and explore increasing the size of this fleet

Currently the City has e-bikes (6) situated at six facilities that are available for staff use. Staff will promote and monitor usage of existing e-bike fleet, analyze success, and determine the level of expansion required.

Strategy #11: Promote existing two-way car share option and pursue a one-way service option for staff use

Staff will streamline and promote the existing two-way (MODO) car share option, and pursue a one-way service option (e.g., EVO) for work-related travel. Regional car share fleets are currently comprised of hybrid vehicles, and could offer on-going benefits to the City and the community at-large.

Strategy #12: Expand and promote existing Employee Trip Reduction Program.

This initiative will expand the promotion of the City's Employee Trip Reduction Program. It will look to encourage the use of sustainable multi-modal transportation for work-related travel (e.g., transit, walking, cycling, carpooling and car sharing). The use of incentives will be explored. Additionally work from home policies, as it relates to trip reduction, will be examined, as the COVID-19 pandemic has demonstrated the possibility of reducing work related travel for meetings through the use of virtual conferencing.

TRAINING AND BEHAVIOUR-BASED INITIATIVES

Driver training (i.e., energy efficient driving techniques) has been shown to demonstrate an average of 10-15% reduction of fuel use & emissions depending on individual driver habits. Combining effective trip/route planning choices and efficiencies through GPS system operation with driving techniques (e.g., reduced idling) can boost fuel efficiency by 25-30%. The City will deliver driver training and refresher opportunities on a regular basis. Staff will also continue to look for new technologies to improve operations.

Strategy #13: Deliver annual refresher driver training

Driver training can be used to raise awareness of fuel-efficient driving and promote new ways to accommodate and reward multi-modal transportation choices. Staff will schedule regular driver training for new and existing employees including energy efficient practices.

POLICY BASED INITIATIVES

The City currently has two fleet policies – City Vehicles Driven Home Policy and Low Carbon Fleet Policy – that guide the use and/or purchase of vehicles that are used for City business. Both policies are currently being reassessed in light of the new climate emergency directions and endorsed CEERS vision and goals.

The Low Carbon Fleet Policy has been revised to include a new, more clear set of goals. It guides staff to rethink new purchases, optimize the fleet size by eliminating unused or underused vehicles, apply right-sizing and increase the use of low carbon fuel (low emissions) vehicles. It also outlines the need to increase the use of energy efficient pool vehicles and alternative modes of transportation by staff (e.g., transit, cycling).

Strategy #14: Implement the revised Low Carbon Fleet Policy

As part of the updated Low Carbon Fleet Policy, there are new roles for staff to review and approve new vehicle purchases. The City should adopt a new process and/or procedure to ensure the new Policy is adequately implemented. A new vehicle request assessment form is currently being developed to assist with the review and approval process.

Strategy #15: Continue to review the corporate Vehicles Driven Home Policy

This policy will need to be reviewed in light of the climate emergency declaration and the revised Low Carbon Fleet Policy. For instance, fuel consumption for vehicles that are being driven home, resulting from non-work related travel, should be factored out of the corporate emissions inventory.

A summary of the proposed fleet initiatives as part of the Fleet Roadmap and estimated emissions reductions and costs is shown in Table 10. The high level cost to implement the fleet initiatives is approximately 10M. Installation of charging infrastructure and ensuring capacity is estimated to be approximately $6.5M, while costs related to EV acquisition (premium) is estimated to be $3.4M. Please see Funding in Section 7 for more information on budgeting.

Table 10: Proposed fleet initiatives with emission reductions and cost implications (2018–2028).

Fleet Initiative	Estimated Annual Emissions Reduction by 2028 (tCO_2e)	Estimated Cost Premium ($ / year)	Estimated Marginal Abatement Cost[20] ($ / tCO_2e)
Fuel switching: Electric vehicles & infrastructure, Landscaping power tools, Renewable diesel[21] (to be determined)	740 (EVs & Infrastructure)	9,900,000	131
Employee oriented Trip Reduction and Energy Efficient Pool vehicles and Take Home policy	3.6	2,000[22]	111[23]
Increased use of Propane to displace use of gasoline	10.5	5,000	95[24]
Training and Behaviour-Based Initiatives	62	4,000	65[25]
Total	**816[26]**	**137,820**	**100**

6.3 OUTDOOR LIGHTING

ADOPTED GOAL

6. Minimize the energy consumption and emissions impacts of all corporate assets.

The majority of energy consumed in this asset class is from streetlights (70%) and traffic signals (12%). Traffic signals have been converted to LED (light emitting diode) technology and streetlights are gradually being replaced with LED on an opportunistic basis. LED technology has advanced and is still advancing at a rapid rate which includes a 30-40% reduction in electricity consumption compared to high pressure sodium (HPS) lights which have been used in the past. LED luminaries are known to last longer before they need to be replaced, in turn reducing maintenance costs and they also emit a whiter light than HPS lights which improves visibility.

Over the last few years, the City has piloted LED technology in street lighting in three neighbourhoods: Glenbrook North, Fraserview and Thompson Landing in Queensborough. Approximately one hundred streetlight heads have been converted to LED technology in the pilot. In 2020, it is anticipated that the Moody Park overhead lighting will be converted to LED. In order to provide clear direction and consistency for the use of LED lighting, a Citywide strategy is needed.

[20] Detailed description of the Marginal Abatement Cost in 7.2.
[21] Currently speculative; supply is low and more detailed research on environmental and social impacts of renewable diesel needs to be undertaken
[22] Cost estimate for staff time; no capital costs impacts to budget
[23] Measure life for policy changes is estimated to be 5 years
[24] Measure life for propane as a transitional fuel is estimated to be 5 years
[25] Measure life for behavioural changes is estimated to be 1 year
[26] Does not include potential emissions reductions related to fuel switching to renewable diesel.

Although park lighting is only a small portion of the corporate emission inventory, some work has been completed related to energy use reduction for sports field lighting. The City's sports field lighting is controlled by a timer software in which the user must enter a code to turn it on and off. If not turned off by the user, the system is automatically switched off based on the user's reservations of the sports field. These kinds of systems are the most effective way to reduce electrical consumption (for lighting systems without photocells) and they do not require an on-site caretaker.

Due to the existing efficient operating policy, LED upgrades for existing sports field lighting will be conducted at current fixture end of life and all new lighting will use LED technology.

Strategy #16: Develop and implement a LED Street Lighting Conversion Strategy

Adopt a Street Lighting Conversion Strategy to ensure that street light replacement and retrofits are standardized for design, operations and maintenance. The Strategy will outline requirements to reduce electricity use which will subsequently reduce energy costs and greenhouse gas emissions.

Strategy #17: Sports field and Stadium Lighting

Include LED lighting as part of new sports field and stadium lighting installations. The City will continue to monitor LED technology costs and quality related to retrofitting existing lighting.

6.4 WATER & WASTEWATER

ADOPTED GOAL

6. Minimize the energy and emissions impacts of all corporate assets.

The amount of energy consumed in this asset class relative to the total amount consumed by the City is very small (less than 1%) with the majority consumed by drainage and liquid waste pump stations. As in the previous 2008 Corporate Energy and Emissions Plan, there are minimal options to reduce consumption in this asset class. Two actions are outlined below.

Strategy #18: Upgrade Pumps to Higher Efficiency Pump Systems as part of lifecycle replacement

As wastewater flow increases or pump stations age, pumping equipment will need to be replaced. Replacements will include higher efficiency units that are equipped with self-monitoring features and variable frequency drives. These features prevent overheating motors and minimize energy consumption.

Strategy #19: Consider energy recovery from pressure reducing valve (PRV) stations using an in-line turbine generator, where supported by a business case.

This strategy will be considered on a site-by-site basis. Excess energy (head) available within Metro Vancouver's water system could be used to generate electricity by using in-line turbine generator within a PRV chamber. The renewable energy generated by the turbines could then support the power requirements for the operation of the station. A net positive business case analysis should be performed before this measure is pursued.

6.5 ACHIEVING THE 2030 TARGET

In order to achieve the corporate GHG emissions target, 1,897 tCO_2e will need to reduced over the next ten years. The City has identified a number of measures that could result in GHG reductions (as described in sections 6.1 - 6.4). The estimated GHG reductions from these measures are summarized for each asset class as follows:

BUILDINGS

- **NWACC built to LEED Gold + Zero Carbon Building Standard (815 tCO_2e)**
- **Energy efficiency retrofits in Existing Buildings (322 tCO_2e)**

FLEET

- **Complete Fuel-switching strategies as identified in the Fleet Roadmap (740 tCO_2e)**
- **Complete Behaviour and Policy-related strategies (76 tCO_2e)**

These anticipated GHG reductions are estimated to total 1,953 tCO_2e resulting in a 45% reduction in GHG emissions from 2010 levels. This amount, if achieved, meet the target and will set the City on the path towards meeting its next target of 65% reduction by 2040 (see Table 11; Figure 5). The timing of each initiative as identified in Section 6 of CEERS will need to be further analyzed by the operational departments and resources approved through the City's 5-year capital budgeting process.

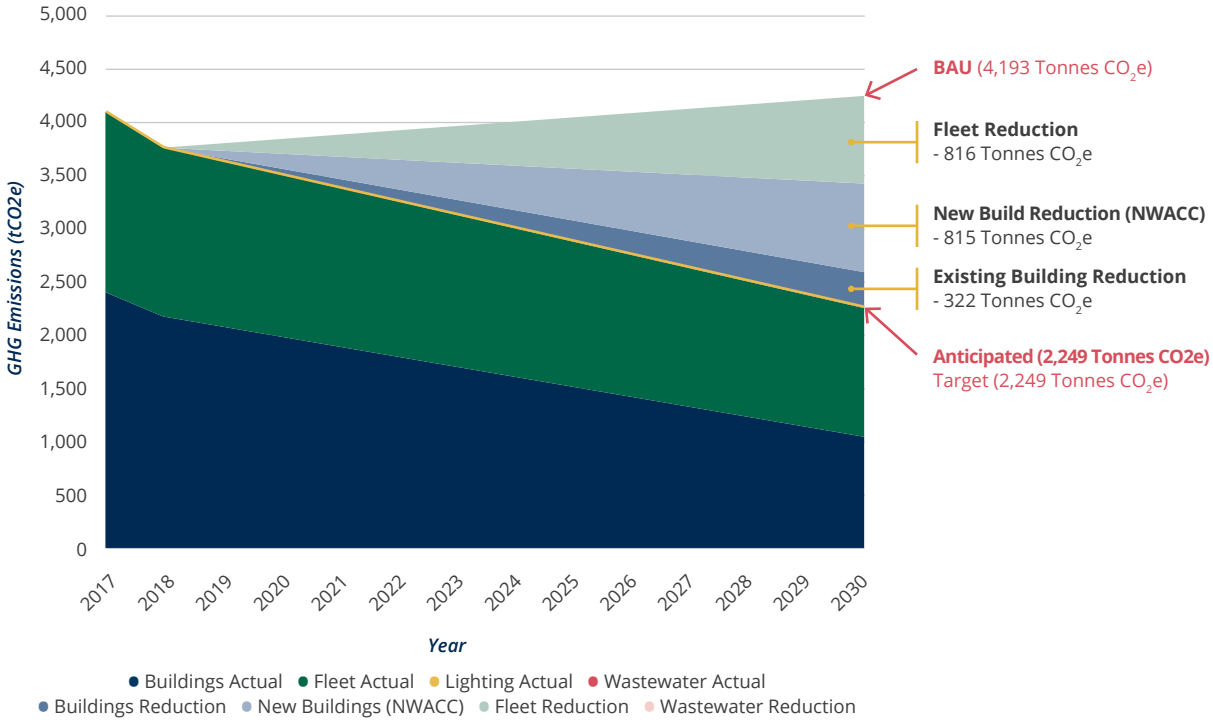
Table 11: Anticipated GHG reductions outcome upon implementation of strategies outlined in section 6.

Asset Class	2010 Year Emissions (tCO_2e) (Target Base Year)	2018 Year Emissions (tCO_2e) (a)	BAU Emissions (tCO_2e) (b)	GHG Reductions From Measures (tCO_2e) (c)	Anticipated Corporate Emissions in 2030 (tCO_2e) (b-c)
Buildings	2,319	2,150	2,175	1,137	1,038
Fleet	1,667	1,543	1,987	816	1,171
Lighting	93	27	27	0	27
Water & Wastewater	10	5	4	0	4
Total Corporate Asset Emissions	4,089	3,725	4,193	1,953	2,240

6.6 ACHIEVING CARBON NEUTRALITY

The actions set out in this document outline how the City will reach its GHG emission reduction target of 45%, as compared to 2010 levels, by 2030, however in order to push towards the ambitious aspirations of Bold Step #1, striving to become carbon neutral by 2030, the City will need to take more aggressive actions to reduce emissions. Within the next 5 years, the City will complete a study of the buildings that were not included in the first energy study. Additionally, by exploring renewable energy sources (i.e. renewable natural gas, solar), creating carbon offsets (i.e. reforestation) or purchasing carbon offsets, the City will strive to accelerate the timeframe set out for reaching carbon neutrality by 2050.

Figure 5. This diagram graph illustrates the forecasted carbon footprint (BAU) and the ability to achieve the emissions target through implementation of identified building and fleet measures.



7. IMPLEMENTATION

This Strategy, including its goals, targets and strategies, is intended to be a living document that will evolve with changes in policies, legislation and technologies over time. While key staff in specific areas, such as Engineering and Development Services, will take a lead role in implementing a number of energy and emissions projects, all City staff play a role in advancing our collective goal and showing leadership to the community when it comes to taking climate action. City staff will need to fully appreciate the corporate energy goals and how they relate to their work and be empowered to reduce energy use and emissions in their particular service areas.

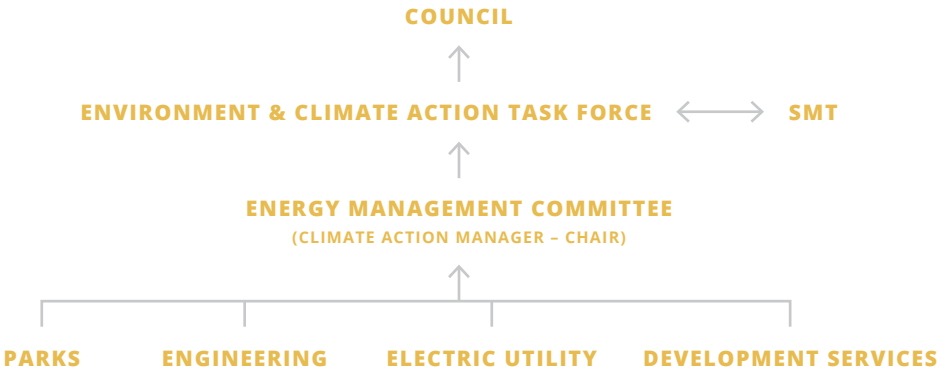
Although GHG reductions are not specifically calculated for the strategies outlined in this section of CEERS, they should incrementally contribute to overall emissions reduction to reach the 2030 target and help achieve the deeper reduction targets of the future.

7.1 STAFF ENGAGEMENT

The success of achieving the targets and goals of this Strategy will require efforts and commitments of all departments and leadership and support from Senior Management Team, the City's Energy Management Committee (EMC) and Council. Being visible to the community, our organization plays an important role in taking leadership and showing the way forward in reducing energy consumption and GHG emissions.

A corporate, interdepartmental EMC was established in 2007 to oversee energy management and improvement for the City. This Committee reports to the Senior Management Team and meets regularly to ensure the implementation of the strategies/actions in corporate energy and emissions plans and report on progress. Members also share new technological advances that may become available and suggest innovative ideas to reduce energy use or emissions. The corporate energy and emission management governance structure is shown in Figure 6.

Figure 6: Energy Management Committee Governance Structure



Communication and raising awareness about energy conservation, GHGs emissions and climate change is important in promoting all City staff buy-in and stewardship and fostering energy efficient and climate-conscious behaviors. Changing day-to-day habits in lighting, heating, and office equipment use can result in new energy savings and reduce GHG emissions with little up-front investment. To foster behavioral or cultural shifts across the organization, support and direction from senior management and climate action staff will be necessary. Staff outreach may include general lunch-and-learn sessions for all staff or specific workshops with departments working collectively on capital projects such as energy renovations or new builds. It will be important to establish a clear communication strategy to outline the types of outreach activities needed to achieve success.

Strategy #20: Empower the Energy Management Committee in implementing CEERS

Continue to support and empower the interdepartmental Energy Management Committee. With the leadership of the Climate Action Team, the EMC plays a pivotal role of implementing the CEERS and the members will need to be empowered to , regularly monitor progress and report on outcomes. Staff from various departments will work together with the Climate Action Team to ensure projects are included in annual budgets and implementation of each achieves success.

Strategy #21: Complete and implement an outreach strategy focused on energy conservation and climate change awareness

Create an outreach strategy to align with the city-wide climate action engagement and communications strategy. The outreach program should express the importance of energy conservation and GHG emissions reduction, encourage staff to contribute ideas, empower them to take action and provide ongoing updates on the achievement of goals. Metrics can be developed to help evaluate the success of the outreach programs.

Strategy #22: Ensure operations and maintenance teams are involved as stakeholders in the project planning process

Frontline operations and maintenance staff input is valuable to planning and designing new projects. This insight during the planning phase can help identify energy opportunities and challenges and can reduce the amount of unforeseen alterations to the design during later stages; thus saving time and money. Stakeholder involvement could also help with the buy-in and success of the overall project. The City will ensure that operations and maintenance staff are listed in the Project Charter.

7.2 PROJECT PRIORITIZATION AND DECISION MAKING TOOLS

The City will utilize a variety of decision making tools in order to support project implementation prioritization. The following sections describe a suite of analytical and financial tools which will be used alongside capital and infrastructure planning processes to influence and support implementation scheduling.

CARBON PRICING, MARGINAL ABATEMENT COST & SUSTAINABLE PROCUREMENT

ADOPTED GOALS

> **6. Minimize the energy and emissions impacts of all corporate assets.**
>
> **8. Move towards zero corporate waste generation.**
>
> **9. Maximize reuse, recycling and material recovery.**

CARBON PRICING

On March 5, 2018, a comprehensive multiple accounts evaluation framework (e.g., social, economic, environmental) for the procurement of goods and services was endorsed by Council. As part of this framework, greenhouse gas emissions are included as an environmental consideration and "carbon pricing" is included as a financial consideration as part of a multiple accounts evaluation framework (see Appendix 4). Carbon pricing is a way to capture the cost impact of greenhouse gas emissions to society – it is a measure of the social or economic harm from the impacts of climate change such as air pollution, floods, and droughts. It is expressed as the dollar value of the total damages from emitting one tonne of carbon dioxide into the atmosphere for a year. This external cost, which is factored into internal procurement decisions, helps to evaluate the impacts and risks of a particular product or service on climate change.

On August 26, 2019 the City adopted an internal price on carbon of $\$150/tCO_2e$[27] which is to be included as a part of corporate multiple accounts evaluation (also known as full lifecycle cost accounting). This price on carbon is applied to the GHG emissions expected to be emitted over the operating life of the particular purchase option. The intent is to incorporate carbon cost in the purchase decision of City assets and services over $15,000 where carbon emissions can be determined and low-carbon alternatives are available. The corporate carbon pricing policy is in essence an internal "price on paper" or "shadow price" used in financial analyses to compare actual and/or notional costs for different options (it is not the same as a carbon tax which is a direct price that is put on carbon). An example of an application of carbon pricing is shown in Appendix 5.

Although the City has adopted internal carbon pricing as part of full lifecycle cost analysis, two strategies have been identified to help formalize the application of carbon pricing and to ensure energy and emissions are included early on as part of our internal processes.

Strategy #23: Establish a protocol to implement internal Carbon Pricing

Develop a protocol to formally apply carbon pricing (and build internal capacity) for operational and capital investment decisions. The protocol would cover the points at which the shadow price would be applied during multiple accounts evaluation. A carbon pricing calculation tool will need to be developed for staff use and record keeping.

---

[27] Government of Canada has determined that $150/tCO2e is an appropriate price on carbon, the "social price of carbon". $150/tCO2e is now being applied or considered by a number of Canadian jurisdictions, including the City of Vancouver, Metro Vancouver, Victoria and Toronto. This price is not static and may rise along with Federal and Provincial increases. See carbon price policy for price schedule.

Strategy #24: Establish a process or tool to ensure energy and emissions considerations including carbon pricing are included in the design process for facilities and infrastructure projects

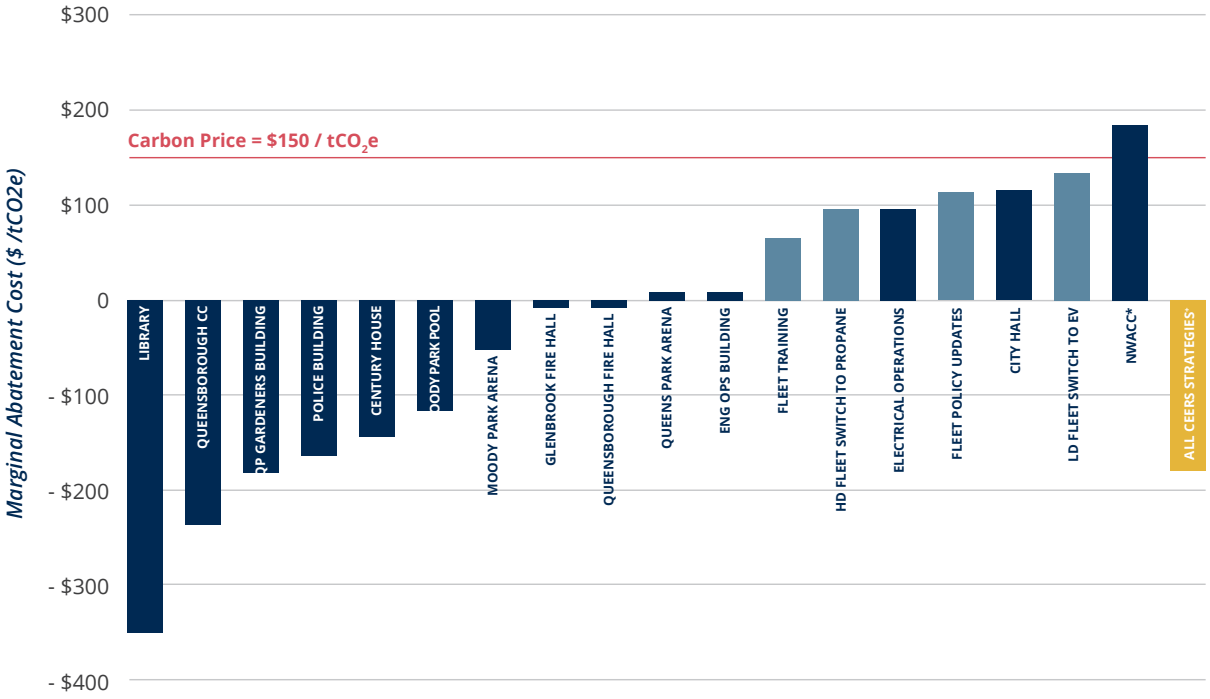
Develop a process or evaluation tool for project managers to identify projects with climate change impacts. This process or tool would provide an efficient and coordinated way to ensure energy and emissions reductions are considered early in the procurement decision. The process may also identify whether the multiple accounts evaluation framework would need to be applied. Some examples of where the tool could be applied include facility upgrades, new builds or major construction.

MARGINAL ABATEMENT COST

$$MAC = \frac{(Cost\ Premium - Lifetime\ Energy\ Cost\ Savings)}{Lifetime\ GHG\ Emission\ Reduction}$$

As detailed in this report, the cost premium to implement the building and fleet strategies is in the order of $13.45M. To support evaluation and prioritization of emission reducing projects, the carbon price serves as a valuable reference point. The following graph illustrates the estimated marginal abatement cost (MAC) for the major groupings of projects to be delivered in this 10 year strategy. The MAC demonstrates the estimated cost of reducing one tonne of existing GHG emissions, taking into account the project cost premium, lifetime operating cost savings and lifetime GHG emission reduction. When the MAC is lower than the carbon price (i.e. $150/tCO$_2$e), it indicates that implementing the project in order to reduce the related emissions is financially advantageous over purchasing carbon offsets to reduce these emissions. It should be anticipated that it will become incrementally more expensive to reduce emissions through retrofit projects once lower marginal abatement cost projects are implemented. The benefit of the operational cost savings beyond the simple payback on lower cost projects should be considered as capital reserve funds to support the implementation of higher cost projects. When all building and fleet strategies are combined, the resulting MAC is $102/tCO$_2$e.

Figure 7. Estimated Marginal Abatement Cost of CEERS Strategies



* NWACC MAC is a conservative estimate; it does not include energy cost savings to doing better than baseline.

+ All CEERS Strategies is the average MAC for all strategies included in this graph

SUSTAINABLE PROCUREMENT

The City's Environmental Strategy & Action Plan calls on the City to create a procurement policy that clearly articulates its goals and expectations for contractors and suppliers around environmental sustainability. The City is currently working on a social and sustainable procurement policy which will include consideration of environmental elements such as energy and emissions. The City could develop an separate energy and emissions policy that could include guidance around third-party rating systems or labeling programs (e.g., Energy Star), reporting requirements around energy consumption and GHG emissions from services rendered (e.g., contracted emissions related to CARIP reporting). Reference may also be made to the City's Low Carbon Fleet Policy and to energy conservation targets in facility management contracts.

Strategy #25: Adopt a procurement policy that considers energy and GHG emissions

The City will incorporate energy and emissions as part of sustainability considerations as part of the City's procurement document update. A separate energy and GHG emissions policy may be developed and referred to in the procurement document.

7.3 MONITORING AND REPORTING

Regular monitoring and reporting is an integral part of energy management. Tracking consumption and emissions can help assess progress, better understand how energy is consumed and show the value of projects. The City is currently monitoring and reporting corporate energy consumption and emissions annually to both Council and to the Province[28] through the Climate Action Revenue Incentive Program (CARIP), as part of its Climate Action Charter commitment. Every three to five years, a more comprehensive review of CEERS implementation will be conducted to ensure that the City is on track to meet its targets. The review may include changing and adding reduction strategies as necessary and ensure resources needed to reach the goals are included in the next 5-year capital planning process. Key performance indicators (e.g., total corporate emissions) will be developed to help monitor progress. A more comprehensive analysis of cost savings and GHG emissions reduction related to projects implemented should also be considered.

7.4 FUNDING

ADOPTED GOAL

7. Partner with external organizations to advance common energy and emission objectives.

In 2019, the City allocated capital funds that would be used to implement CEERS building and fleet-related projects within the 2020-2024 Financial Plan based on the carbon price of $150/tCO$_2$e applied to the total corporate emissions inventory (~4,300 tCO$_2$e). The total annual carbon fund was calculated to be $650,000 (4,300 tCO$_2$e x $150/t) and included into the capital budget. This carbon fund would incorporate the existing Provincial Climate Action Revenue Incentive Program (CARIP) rebate which is currently approximately $115,000 per year.

Given the availability of the new carbon fund, fleet and buildings will each be given $1.63 million over a 5-year financial period specifically for carbon reduction projects. It is anticipated that this amount would complete the cost premium associated with the existing buildings projects as indicated in the Energy Study (see Table 8, Strategy #3). The costs related to the energy projects associated with the development of the new NWACC facility would be incorporated into the overall project capital budget.

[28] CARIP reporting does not include emissions from non-traditional services (e.g., to police or electric utility services). The City's past and current corporate energy and emissions plan however includes GHG emissions related to these services.

The high level financial study undertaken for fleet revealed that the amount of funding to support fleet strategies could be in the order of $10M over the 10-year CEERS implementation period (see Table 10). As mentioned above, $1.63M has been identified for the current 5-year financial plan (2020-2025). The balance of funding for the remaining 5 years (2025-2029) could be in the order of $8M. This high level cost estimate of $10M, which is mostly related to costs to install new EV infrastructure and capacity ($6.6M), will be re-assessed as part of the development of an integrated community and corporate EV Strategy (see Strategy #5).

Although internal carbon funding is included in the current capital plan it will be important to look for and take advantage of other funding sources throughout the implementation of this plan. External funding (i.e., financial incentives) and partnership with agencies such as BC Hydro, Fortis BC, and federal and provincial governments should continue to be explored in support of CEERS initiatives. City staff will actively monitor and apply for electric vehicle and EV infrastructure funding as it becomes available.

The document was initiated in 2018 with major studies completed prior to 2020. These studies therefore have not accounted for potential implications related to the COVID19 pandemic. Timelines and priorities may be reassessed as the City navigates the evolving needs of the community and dynamic operations of buildings and fleets through the health crisis. Climate action is a high priority, a green recovery is being explored, and opportunities to accelerate strategic priorities are being investigated. Projects will continue to be advanced based on overall impact and financial assessment.

APPENDIX 1
SUMMARY OF STRATEGIES AND IMPLEMENTATION ELEMENTS

APPENDIX 1: SUMMARY OF STRATEGIES AND IMPLEMENTATION ELEMENTS

Strategies	Lead Departments	Estimated Expense	GHG Reduction Estimate	Timeline: Short / Medium / Long Term or Ongoing
Civic Building Asset Class				
Strategy #1: Apply the Zero Carbon Building Standard for the NWACC facility	Parks, Climate Action	$$$	***	ST
Strategy #2: Implement the updated Civic Green Building Policy for new construction and major renovations.	Eng., Parks, Climate Action	Variable	N/A	OG
Strategy #3: Implement Measures for Existing Buildings as per the Level 1 Energy Study (Appendix 2)	Climate Action, Eng., Parks	$$$	***	OG
Strategy #4: Conduct a Level 1 Energy Study for remaining Civic Buildings to determine additional emissions reduction opportunities for existing buildings every 5 years.	Eng., Climate Action	$ (For Study)	N/A	MT
Fleet Asset Class				
Strategy #5: Develop an integrated corporate and community EV Strategy	Climate Action, Electric Utility	$$	N/A	MT
Strategy #6: Install EV charging infrastructure and associated upgrades	Electric Utility, Climate Action	$$$	***	MT
Strategy #7: Purchase light duty electric vehicles and equipment, as applicable	Eng. Ops, Climate Action	$$$	***	MT
Strategy #8: Monitor the potential use of non-fossil/renewable fuels (e.g., EV) for the City's heavy-duty fleet and purchase vehicles, as applicable	Eng. Ops, Climate Action	$$$	***	OG
Strategy #9: Phase out the use of fossil fuels in hand-held landscaping equipment	Parks, Eng. Ops	$	*	ST
Strategy #10: Promote e-bike fleet use and explore increasing the size of this fleet	Eng., Transport.	$	*	ST
Strategy #11: Promote existing two-way car share option and pursue a one-way service option for staff use.	Eng. (Transport)	$	*	ST
Strategy #12: Expand and promote existing Employee Trip Reduction Program	Eng. Transport	$	*	ST
Strategy #13: Deliver annual and or refresher driver training	Eng Ops; Climate Action	$	*	ST
Strategy #14: Implement the revised Low Carbon Fleet Policy	All Depts., (EMC)	$	**	OG
Strategy #15: Continue to review the corporate Vehicles Driven Home Policy	HR; Climate Action, Eng Ops	$	*	ST

Estimated Expense
$ – < $100,000
$$ – $100,000-$500,000
$$$ – > $500,000

GHG Reduction Estimate
* under 50 tonnes
** 50-100 tonnes
*** 100+ tonnes

Strategies	Lead Departments	Estimated Expense	GHG Reduction Estimate	Timeline: Short / Medium / Long Term or Ongoing
Lighting Asset Class				
Strategy #16: Develop and Implement LED Street Lighting Conversion Strategy	Eng.	$	*	ST
Strategy #17: Include LED lighting as part of new sports field and stadium lighting installations.	Parks, Electric Utility	$	*	OG
Water & Wastewater Asset Class				
Strategy #18: Upgrade Pumps to Higher Efficiency Pump Systems as part of lifecycle replacement.	Eng.	$	*	OG
Strategy #19: Consider energy recovery from PRV stations using an in-line turbine generator	Eng.	$$	*	OG
Implementation Strategies				
Strategy #20: Empower the Energy management Committee in implementing CEERS 2020	SMT, Climate Action, All Depts.	N/A	N/A	OG
Strategy #21: Complete and implement an outreach strategy focused on energy conservation and climate change awareness	Dev. Serv./ Communications	$$	*	MT
Strategy #22: Ensure operations and maintenance teams are involved as stakeholders in the project planning process	Eng., Climate Action, Parks	N/A	N/A	OG
Strategy #23: Establish a protocol to implement internal Carbon Pricing	Climate Action, Purchasing	N/A	N/A	ST
Strategy #24: Establish a process or tool to ensure energy and emissions (including carbon pricing) considerations are included as part of the design process for facility and construction projects	Climate Action, Purchasing	N/A	N/A	ST
Strategy #25: Adopt a procurement policy that considers energy and GHG emissions	Climate Action, Purchasing	N/A	N/A	ST

Estimated Expense
$ – < $100,000
$$ – $100,000-$500,000
$$$ – > $500,000

GHG Reduction Estimate
* under 50 tonnes
** 50-100 tonnes
*** 100+ tonnes

APPENDIX 2
LEVEL 1 BUILDING ENERGY STUDY

City of New Westminster
Benchmarking and Level 1 Studies

Energy Study for:

City of New Westminster 24 Buildings

Attention:

Tobi May

Project Manager

City of New Westminster

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January 13, 2020

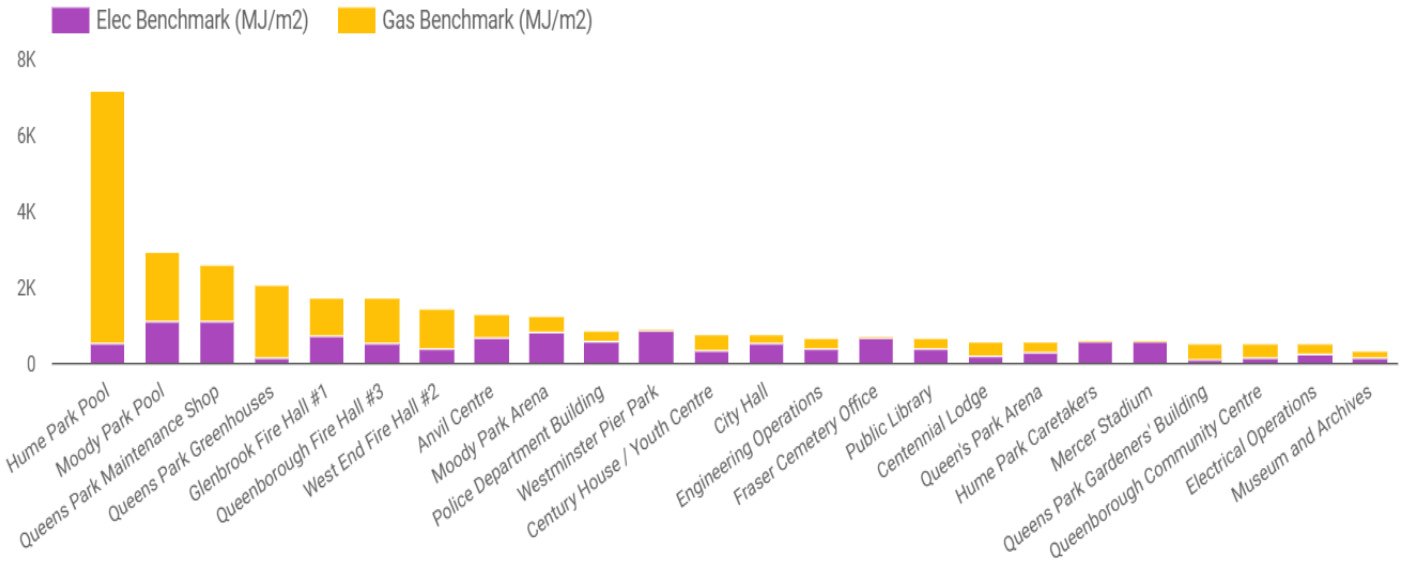
Executive Summary

I. Background of the Project

SES Consulting Inc. was engaged to provide a benchmarking study for 24 buildings within the City's portfolio of properties. Based on the benchmarking results, 13 buildings were prioritized for an ASHRAE Level 1 Energy Study[1]. These buildings were selected because they had significant energy reduction opportunities and were considered a high priority by the City of New Westminster (CNW).

II. Consumption and Benchmarking

The Energy Use Intensity (EUI) baseline of each of the 24 buildings included in the benchmarking study was calculated based on the energy use data provided to us. A summary of the results is presented below. The monthly energy consumption of each building can be found in the SES benchmarking web tool, Audette[2]. This benchmarking data was used to determine which buildings had the highest potential for energy reduction.



[1] ASHRAE Level 1, 2 and 3 Study Descriptions: http://www.energyadvantage.com/blog/the-difference-between-ahsrae-level-1-2-3-energy-audits/

[2] City of New Westminster Audette Link: https://datastudio.google.com/u/0/reporting/1jOPnZgTGJCjAPPDZzy1RbwH4hFxBjJzi/page/AXwz

III. Results

A variety of measures were selected for each of the 13 buildings that had a Level 1 Energy Study analysis. These results are summarized below. They can also be found in the bundling tool that was provided along with this report. The report has identified that the majority of the buildings have excellent opportunities for BAS upgrades and recommissioning. We recommend that these measures are implemented prior to higher cost mechanical upgrades because of their relative low cost and payback. In addition, focusing on controls first increases our overall understanding of the buildings performance and systems, which informs the design of any additional measures planned for implementation.

	kWh	GJ	GHG
Project Portfolio wide consumption	7,590,850	24,358	1,291
Estimated L1 Energy Reduction	722,500	6,295	322
Percent Energy Reduction	10%	26%	25% [3]

[3] This project considered 24 buildings within the City's portfolio of properties. Some City-owned buildings were excluded from this study because they are slated for demolition and replacement, or are in the process of being replaced. These include the Animal Shelter, Canada Games Pool, Centennial Community Centre, the Arenex and Sportsplex. It should be noted that the 2010 emissions for all CNW owned and operated buildings was 2,366 tonnes. This number will be used to calculate the target 45% reduction by 2030. For the purposes of this study, the Project Portfolio-wide consumption refers to the 24 buildings identified in the table above.

City of New Westminster
- Benchmarking and Level 1 Studies -

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Appendix A - Recommissioning Project Descriptions

1. Building Overview

Please refer to the Energy Analysis table in Audette for the list of buildings that were included as part of the original benchmarking study. The following buildings were selected for a Level 1 ASHRAE Study due to their energy reduction opportunities and overall energy consumption.

1. City Hall
2. Library
3. Police Building
4. Moody Park Arena
5. Queensborough Community Centre
6. Queensborough Fire Hall
7. Moody Park Pool
8. Electrical Operations
9. Engineering Operations
10. Glenbrook Fire Hall
11. Century House and Youth Centre
12. Queens Park Arena
13. Queens Park Gardeners Building

The buildings that were not included in the Level 1 Energy Study as well as the reason each one was excluded is summarized below. The decision to exclude these buildings from further Level 1 Energy Study at this time was made in consultation with the City of New Westminster project manager as part of an ongoing effort to manage the scope of this project. It is was noted that these buildings should be reviewed in the near future as part of the City's continuing effort to manage energy use and reduce GHG emissions

1. Anvil Centre
    a. The Anvil Centre heat recovery chiller (HRC) has been recently recommissioned and is now working effectively. This can be seen in the monthly energy consumption, which has significantly decreased since the recommissioning. As this is working effectively, it is not a high priority for ECMs. We recommend waiting until the energy consumption of the building has stabilized prior to performing a detailed energy study as this will allow for better analysis and ECM recommendations. We recommend completing a L2 energy study on this building in a year or two when the energy consumption has stabilized and the building is deemed a priority for upgrades.
2. Centennial Lodge
    a. There are no maintenance or replacement projects for this building in the current 5 Year Capital Plan, therefore it is not considered a priority at this time.
3. Hume Park Pool
    a. There are no maintenance or replacement projects for this building in the current 5 Year Capital Plan, therefore it is not considered a priority at this time. The preference is to wait until a new condition assessment is done on this building to determine the plan before implementing any energy conservation measures. The City is undertaking a separate project "Building Condition Assessment and Asset Management", the results of which should inform next steps taken on this building and several others
    b. The ECMs that are relevant for this location will be very similar to the ones recommended for the Moody Park Pool. Moody Park Pool recommendations can therefore be used as a reference when this location is assessed in the future.
4. Mercer Stadium
    a. The only relevant measures for this building were LED lighting opportunities in the stadium space. Stadium lighting fixtures are quite costly and the operating hours are typically low. Because of this, the paybacks for stadium lighting projects are expected to be long (~ 50-100 years) and therefore not recommended as a prioritized project or use of available resources.

5. Westminster Pier Park, Concession & Washroom
    a. There are no maintenance or replacement projects for this building in the current 5 Year Capital Plan, therefore it is not considered a priority at this time. The major opportunity in this building is to fix the kitchen window gate, which currently does not fully close, to reduce air infiltration. This may be addressed as a maintenance project.
6. Queens Park Greenhouses
    a. There are no maintenance or replacement projects for this building in the current 5 Year Capital Plan, therefore it is not considered a priority at this time.
7. Museum, Archive and Irving House
    a. The Irving house has an efficient geothermal loop that is currently operating effectively and note expected to have significant energy reduction opportunities. The Museum is in need of structural improvements and deprioritized until the structural concerns are addressed.
8. Fraser Cemetery Office and Tool Shed
    a. There are limited ECM opportunities for this building and it is very small. This makes it a lower priority for an energy study. In addition, there are no maintenance or replacement projects for this building in the current 5 Year Capital Plan, therefore it is not considered a priority at this time
9. Queens Park Maintenance Shop
    a. There are no maintenance or replacement projects for this building in the current 5 Year Capital Plan, therefore it is not considered a priority at this time. However, there may be some opportunities available when the older equipment is due for replacement.
10. Hume Park Caretakers
    a. There are no maintenance or replacement projects for this building in the current 5 Year Capital Plan, therefore it is not considered a priority at this time. The preference is to wait until a new condition assessment is done on this building to determine the plan before implementing any energy conservation measures.

1.1 Energy Analysis

1.1.1 Annual Consumption

The energy use intensity (EUI) for each of the 24 buildings was calculated based on the historical energy data provided by City of New Westminster and is presented in Figure 1. The monthly energy usage for each of the buildings is presented in the SES benchmarking web tool, Audette[4]. This information was used in conjunction with CNW's priorities for their 5-year plan to prioritize the buildings selected for level 1 energy studies. As presented below, the pools have the highest EUI. Although the Hume Park Pool was not selected for reasons listed in Building Overview section, many of the ECMs recommended for the Moody Park Pool will also apply for the Hume Park Pool. These should be considered when the Hume Park Pool condition assessment is complete and it is deemed a priority.

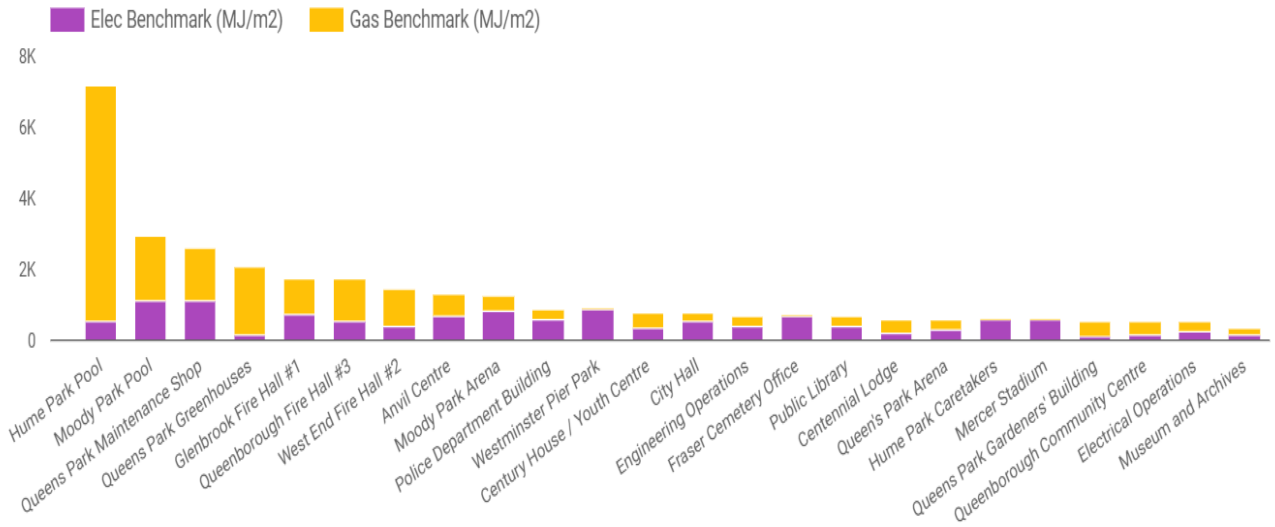


Figure 1: Energy Intensity Benchmarking

1.1.2 Total energy consumption

The electrical and gas consumpton of all the buildings are presented in Figure 2 and Figure 3. More detailed information can be found in the Consumption section of Audette. Building specific energy summaries can be found in the Energy Data section. All of the large electricity and gas consumers were selected for level 1 energy studies with the exception of the Anvil Centre. The reason that Anvil Centre was excluded is discussed in the Building Overview section of this report.

[4] City of New Westminster Audette Link:
https://datastudio.google.com/u/0/reporting/1jOPnZgTGJCjAPPDZzy1RbwH4hFxBjJzi/page/AXwz

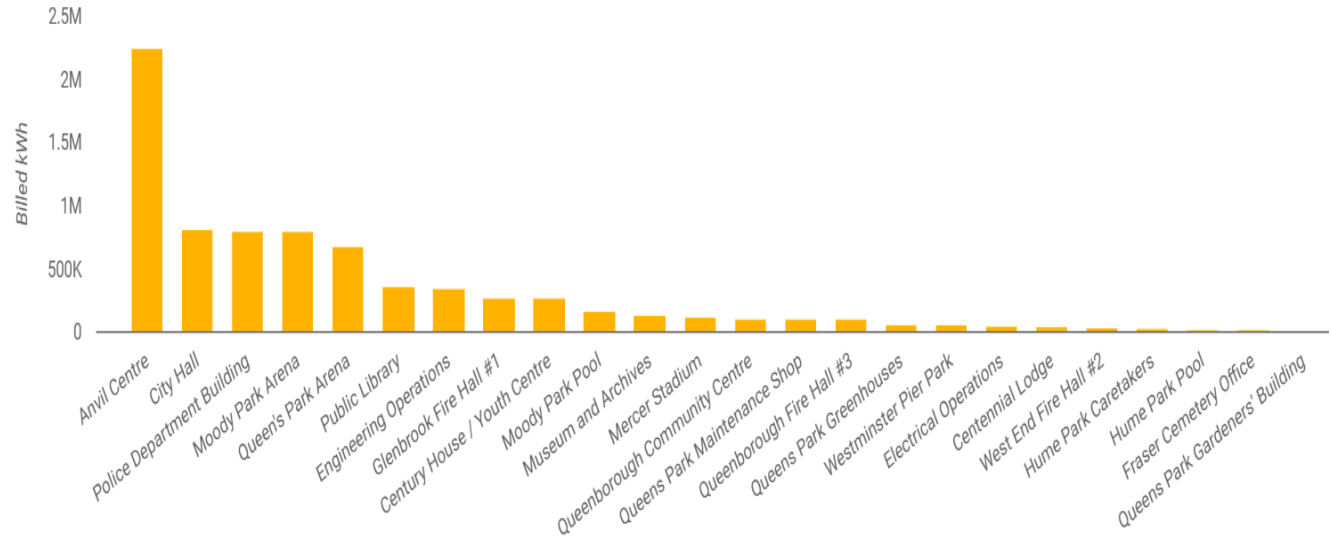


Figure 2: Electrical Consumption by Building

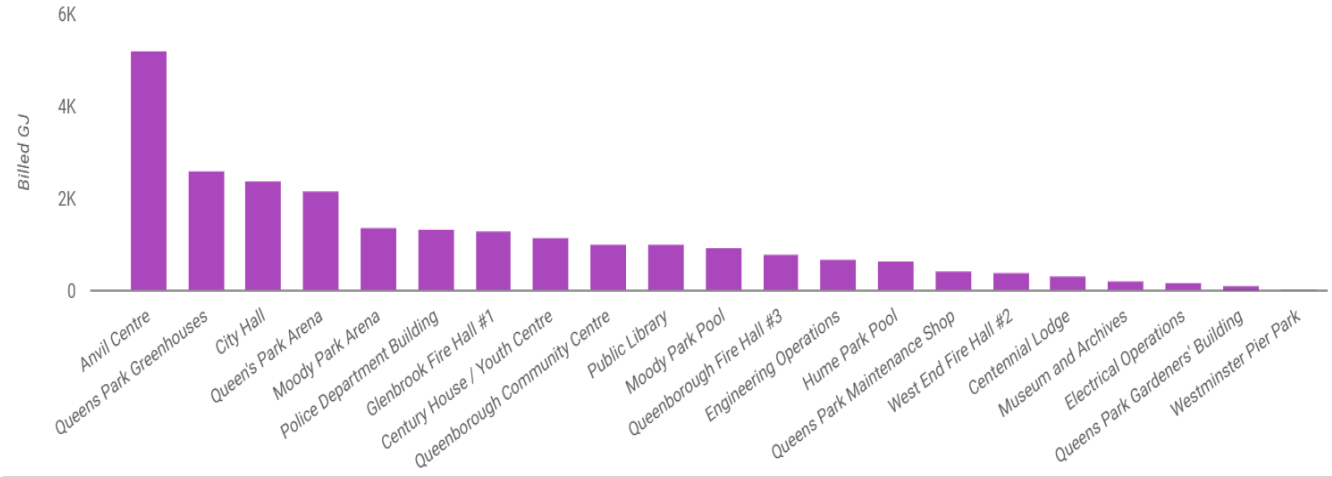


Figure 3: Gas Consumption by Building

2. Energy Conservation Measures

The primary objective of this study was to identify and analyse energy conservation opportunities for the 13 buildings that were selected for the level 1 energy studies. The rate schedules used for the financial savings estimates were provided by City of New Westminster and were based on the specific utility supplier for each building. The financial savings estimates include goods and services tax (GST) and provincial sales tax (PST). The carbon tax rate used for the analysis was $150 per ton of Greenhouse Gases (GHG). The financial analysis is based an annual fuel cost escalation rate of 2.1%, and a discount rate of 7.5%. Please note that a weighted average life expectancy has been used to analyze the 'Total' NPV of these projects. We have used emissions factors of 0.022 kg CO_2e / kWh of electricity in BC, and 49.7 kg CO_2e / GJ for gas. Incremental cost analysis was used where equipment is near end of life.

A number of potential conservation opportunities have been analyzed for each of the 13 buildings. Each of these 13 buildings is summarized below along with the project descriptions and estimated cost and energy reduction for each of the projects analyzed. The individual building's energy use can be found in Audette.

2.1 City Hall

The City Hall building, located at 511 Royal Avenue in New Westminster, was originally constructed in 1953. It is a 2-storey building that consists of offices, a cafeteria, Council Chambers and public reception areas. The total square footage of the building is 54,000 ft^2 (5,017 m^2). The building is occupied from 8 am to 7 pm on Mondays and 8 am to 5 pm on Tuesday through Friday with some portions having extended hours for meetings or public services.

City Hall is ventilated by four air handling units (AHUs). A rooftop unit (RTU), equipped with gas heating and direct expansion (DX) cooling, provides air to various offices and public spaces in the police wing of the building. MZ-AHU is a multi-zone (MZ) unit with a heating water pre-heat coil and DX cooling from the central DX compressor. It provides conditioned air to the first and second floor spaces in the south and north wings of the building. AHU-1 and AHU-3 provide conditioned air to the 2nd floor offices and basement spaces respectively. They are both equipped with heating water pre-heat and DX cooling also supplied by the building's central DX compressor. Heating water for the AHUs as well as various hot water radiators located throughout the building is provided by two natural gas boilers. Cooling for AHUs mentioned above is provided by the buildings central DX compressor and condensing unit. There are also eight smaller condensing units (CUs) that provide cooling to the planning room and server room in the basement. It should be noted that four of these CUs have recently been replaced with heat pumps. Additionally, there are two packaged RTU heat pump units, HP-1 and HP-2, that provide heating and cooling to the council chambers.



Figure 4: City Hall Building

2.1.1 Recommended Measures

A summary of the analysis for the all recommended measures for the City Hall building is presented in Table 1. The financial analysis of all recommended measures is presented in Table 2. Detailed descriptions for each project are presented below.

Table 1: City Hall Recommended Measures Summary

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
2.1.1.1	BAS Recommissioning	$50,000	5.0	$10,100	360		65,100	18.6
2.1.1.2	AHU VSD Upgrade	$8,700	6.2	$1,400			23,500	0.3
2.1.1.3	ASHP Upgrade	$210,000	17.8	$11,800	780	(60)	(16,000)	38.7
2.1.1.4	DX Compressor Upgrade	$25,000	9.6	$2,600		60	31,800	0.3
2.1.1.5	Air Gap Sealing	$15,000	12.5	$1,200	70			3.5
2.1.1.6	Roof Insulation	$33,000	13.8	$2,400	130		600	6.5
Total		**$341,700**	**11.6**	**$29,500**	**1,340**		**105,000**	**67.9**

Table 2: City Hall Financial Analysis

Item	Description	Cost	Payback	Annual Savings	Life Expectancy	NPV	IRR
2.1.1.1	BAS Recommissioning	$50,000	5.0	$10,100	10	$26,900	18%
2.1.1.2	AHU VSD Upgrade	$8,700	6.2	$1,400	15	$5,600	16%
2.1.1.3	ASHP Upgrade	$210,000	17.8	$11,800	15	($89,900)	(0%)
2.1.1.4	DX Compressor Upgrade	$25,000	9.6	$2,600	15	$1,500	8%
2.1.1.5	Air Gap Sealing	$15,000	12.5	$1,200	15	($2,800)	5%
2.1.1.6	Roof Insulation	$33,000	13.8	$2,400	20	($3,800)	6%
Total		**$341,700**	**11.6**	**$29,500**	**14.8**	**($55,000)**	**5%**

2.1.1.1 BAS Recommissioning

The CanmetENERGY Recommissioning Guide recommends that building systems be recommissioned every 3-5 years. Aside from energy reduction presented in this report, there are numerous co-benefits, including improvements operational efficiency and asset value. It's uncertain when the controls at this facility were last recommissioned. During controls recommissioning, it is recommended that the following measures be investigated.

- Schedule and Optimal Start
- Zone level scheduling
- Night Time Setback
- Demand controlled ventilation
- Reduce Minimum Damper Positions
- Occupancy Sensors for Zone Control
- Cooling OAT Lockout
- Heating OAT Lockout
- Weather Predictor
- Domestic Hot Water (DHW) Pump Scheduling
- Connect domestic hot water to building automation system (BAS)

The building currently undergoing a phased renovation converting existing storage space into offices and reconfiguring existing office areas and public interfaces. This is an opportunity to increase the delta zoning controls in the new office sections and improve the controls in the existing sections. Increasing the zoning will ensure that areas of the building are only heated when they are in use. For example, the council chamber is

heated late night but the other areas of the building can be switched off. While this is currently in place, a more granular approach would add further benefits.

The savings analysis assumes: the planned renovations will upgrade BAS zone controls without optimizing for energy usage, opportunities exist to reduce HVAC schedules, add schedules for exhaust fans, and reduce the AHU outdoor air rates. It should be noted that the BAS zone control upgrade assumption significantly impacts project cost and energy reduction opportunity. It allows the BAS to take advantage of additional control capabilities while minimizing the amount of new BAS zone devices need to be installed as part of the measure.

2.1.1.2 AHU VSD Upgrade

Some of the large AHUs in the building do not have variable speed drives (VSDs). This results in excessive energy use when the demand for fresh air is low as the fans cannot modulate their speed.

We recommend installing VSDs on all large fans in the building to control motor speed based on demand. This measure only includes the costing and savings associated with installing a VSD on MZ-1 as it was noted to be the largest SF without a VSD and was therefore had the largest opportunity for energy reduction.

2.1.1.3 ASHP Upgrade

Currently the building's central DX compressor and condensing unit provides cooling for the AHUs.

We recommend upgrading the existing DX cooling system with a variable refrigerant flow (VRF) heat pump system when it reaches end of life. The increased efficiency of the ASHP will result in significant energy and GHG reuctions. In addition, the ASHP can be used for both heating and cooling. The ASHP could be used for heating to take load of the baseboard heating system. This measure will be expensive as the current compressor setup is not compatible with an ASHP and a reconfiguration of the cooling system will be required. This recommendation should be considered with caution as a detailed design must be completed prior to the implementation of this measure.

2.1.1.4 DX Compressor Upgrade

The existing compressor is at it's end of life. As an alternative to the ASHP Upgrade the existing compressor may be upgraded.

When upgrading the compressor, choose a high efficiency model, rather than a like for like replacement. The compressor setup is atypical, detailed options and product selections should be reviewed with refrigeration contractor.

2.1.1.5 Air Gap Sealing

A visual assessment of the air leakage at City hall was completed. It was observed that air gaps were present at entrance doors, roof access and at all penetrations. Secondary air leakage is also expected around windows and at slab bands. An initial estimate of 8ACH@50 Pa was estimated on the basis of the above noted observations. Simple retrofit of doors, caulking of cracks around windows and sealing of holes at the roof is expected to reduce the air leakage to 6 ACH@50 Pa. The impact of air sealing was modeled and energy reduction calculated.

2.1.1.6 Roof Insulation

Current insulation level is estimated at R-10. An insulation upgrade to R-30 is proposed. It is assumed that the upgrade will occur when the roof of city hall is replaced. This will minimize cost of the upgrade

2.1.2 Measures Analyzed, but not Recommended

The following projects presented in Table 3 were evaluated but we do not recommend proceeding with these options at this time for a variety of reasons. These may be worth considering at a later date, but are not considered a priority at this time.

Table 3: Measures Analyzed, but not Recommended for City Hall

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
2.1.2.2	Server Room AC Upgrade	$11,000	55.0	$200			3,300	

2.2 Library

The Library building located at 716 6th Avenue in New Westminster was originally constructed in 1958 and renovated in 2019. The total square footage of the building is 44,000 ft^2 (4,061 m^2). The building is occupied during regular business hours, Monday to Sunday.

The Library is conditioned by 11 RTUs each equipped with gas heating and DX cooling. There are 2 condensing boilers and an atmospheric back-up boiler to provide reheat to certain spaces, while other spaces are reheated using electric baseboards. Domestic hot water (DHW) is supplied by a 175-litre electric water heater. A majority of these systems are controlled by a Delta BAS.

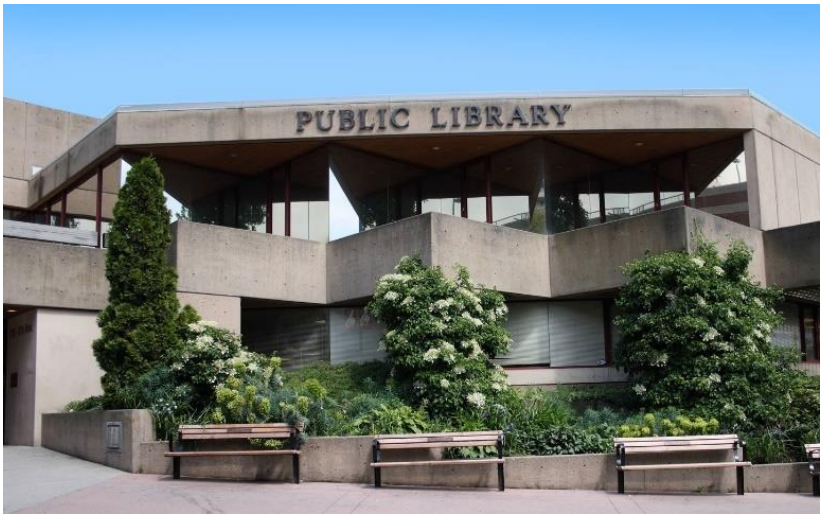


Figure 5: Library Building

2.2.1 Recommended Measures

A summary of the analysis for the all recommended measures for the Library building is presented in Table 4. The financial analysis of all recommended measures is presented in Table 5. Detailed descriptions for each project are presented below.

Table 4: Library Recommended Measures Summary

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
2.2.1.1	BAS Recommissioning	$25,000	5.7	$4,400	100		50,300	5.5

Table 5: Library Financial Analysis

Item	Description	Cost	Payback	Annual Savings	Life Expectancy	NPV	IRR
2.2.1.1	BAS Recommissioning	$25,000	5.7	$4,400	10	$8,500	14%

2.2.1.1 BAS Recommissioning

The CanmetENERGY Recommissioning Guide recommends that building systems be recommissioned every 3-5 years. Aside from energy reduction presented in this report, there are numerous co-benefits, including improvements operational efficiency and asset value. It's uncertain when the controls at this facility were last recommissioned. During controls recommissioning, it is recommended that the following measures be investigated.

- Schedule and Optimal Start
- Zone level scheduling
- Night Time Setback
- Demand controlled ventilation
- Reduce Minimum Damper Positions
- Occupancy Sensors for Zone Control
- Cooling OAT Lockout
- Heating OAT Lockout
- Weather Predictor
- Domestic Hot Water (DHW) Pump Scheduling
- Connect domestic hot water to building automation system (BAS)

The savings analysis assumes there are opportunities to reduce HVAC schedules and the AHU outdoor air rates. It also assumes most HVAC equipment is already connected to the BAS and a minimal amount of BAS devices need to be installed.

2.3 Police Building

The Police building located at 555 Columbia St in New Westminster was originally constructed in 1939. The total square footage of the building is 52,740 ft^2 (4,900 m^2). The building is open to the public during regular business hours Monday to Sunday.

The Police Building is conditioned by 2 make up air units, MUA-1 and MUA-2, as well as terminal heat pumps. MUA-1 serves most of the building and heats supply air with HW coil. MUA-2 serves the cell block and heats supply air with a gas-fired heating section. There are 2 condensing boilers that provide HW to MUA-1 and the terminal heat pumps. The heat pump water loop is also connected to 2 cooling towers in order to meet cooling needs in the summer months. Domestic hot water (DHW) is supplied by 4 instantaneous water heaters connected to 2 storage tanks. A majority of these systems are controlled by a Delta BAS.



Figure 6: Police Building

2.3.1 Recommended Measures

A summary of the analysis for the all recommended measures for the Police building is presented in Table 6. The financial analysis of all recommended measures is presented in Table 7. Detailed descriptions for each project are presented below.

Table 6: Police Building Recommended Measures Summary

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
4.3.1.1	BAS Recommissioning	$26,000	5.9	$4,400	120		41,100	6.4
4.3.1.2	Cooling Tower VSD	$9,300	6.6	$1,400		27	21,100	0.2
4.3.1.3	DHW Heat Pump	$21,000	9.5	$2,200	160		(11,700)	7.9
Total		**$56,300**	**7.0**	**$8,000**	**280**	**27**	**50,500**	**14.5**

Table 7: Police Building Financial Analysis

Item	Description	Cost	Payback	Annual Savings	Life Expectancy	NPV	IRR
4.3.1.1	BAS Recommissioning	$26,000	5.9	$4,400	10	$7,500	13%
4.3.1.2	Cooling Tower VSD	$9,300	6.6	$1,400	10	$1,400	10%
4.3.1.3	DHW Heat Pump	$21,000	9.5	$2,200	15	$1,400	8%
Total		**$56,300**	**7.0**	**$8,000**	**11.9**	**$9,200**	**11%**

2.3.1.1 BAS Recommissioning

The CanmetENERGY Recommissioning Guide recommends that building systems be recommissioned every 3-5 years. Aside from energy reduction presented in this report, there are numerous co-benefits, including improvements operational efficiency and asset value. It's uncertain when the controls at this facility were last recommissioned. During controls recommissioning, it is recommended that the following measures be investigated.

- Schedule and Optimal Start
- Zone level scheduling
- Night Time Setback
- Demand controlled ventilation
- Reduce Minimum Damper Positions

- Occupancy Sensors for Zone Control
- Cooling OAT Lockout
- Heating OAT Lockout
- Weather Predictor
- Domestic Hot Water (DHW) Pump Scheduling

The savings analysis assumes some areas of the building are occupied 24 hours per day, however, HVAC configuration has zone isolation ability, through variable air volume (VAV) boxes or zone isolation dampers, allowing for zone scheduling opportunities afterhours. It also assumes most HVAC equipment is already connected to the BAS and a minimal amount of BAS devices need to be installed.

2.3.1.2 Cooling Tower VSD

The cooling tower fan motor is constant speed. This measure will install a variable speed drive (VSD) and modulate based on water temperature leaving the cooling tower. During periods of low cooling, this will reduce the fan speed and energy consumption

The savings analysis assumes there is only one cooling tower fan and the motor will not need to be upgraded as part of the scope of work.

2.3.1.3 DHW Heat Pump

The building's DHW is supplied by 4 high efficiency gas fired instantaneous water heaters and two 119-gallon AO Smith glass lined storage tanks. This is a good opportunity for a hybrid heat pump (HP) system, which will replace storage tanks with packaged HP heaters, keep tankless heaters (or boiler connection) to serve peak loads.

The savings analysis assumes this cost will be similar to HP heater budget prices received for comparable sized systems. The existing DHW sizes and boiler piping require confirmation to verify the feasibility of this measure. The new DHW HP should be sized based on peak DHW demand.

2.3.2 Measures Analyzed, but not Recommended

The following projects presented in Table 8 were evaluated but we do not recommend proceeding with these options at this time for a variety of reasons. These may be worth considering at a later date, but are not considered a priority at this time.

Table 8: Measures Analyzed, but not Recommended for Police Building

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
4.3.2.1	Window Sealing	$95,000	43.2	$2,200	130			6.5

2.4 Queensborough Community Centre

The Queensborough Community Centre located at 920 Ewen Avenue in New Westminster was originally constructed in 1974, but an addition was completed in 2014. The total square footage of the building is 27,900 ft^2 (2,600 m^2). The building is occupied 7 am to 9:30 pm during the week and reduced hours on the weekend.

The Queensborough Community Centre is conditioned by an MUA, an AHU, two enthalpy recovery ventilators (ERVs), and two rooftop units, RTU-1 and HV-2. The MUA provides gas heating and ventilation to the kitchen. The AHU serves the Library with HW heating and ventilation. The ERVs provide heating through a combination of the heat recovery wheel and the HW heating coil. ERV-1 ventilates the offices and multipurpose room, when ERV-2 conditions the child care activity area. RTU-1 supplies the Gym with gas-fired heating and DX Cooling. HV-2 provides HW heating and ventilation to the community living room. There are 2 gas-fired condensing boilers that provide HW to the original building's heating loop. The new building is equipped with an air-source heat pump (ASHP) serving a heating/cooling loop and a supplemental gas-fired condensing boiler. The original and the new building each have a gas-fired DHW heater. A majority of these systems are controlled by a Delta BAS.



Figure 7: Queensborough Community Centre

2.4.1 Recommended Measures

A summary of the analysis for all of the recommended measures for the Queensborough Community Centre is presented in Table 9. The financial analysis of all recommended measures is presented in Table 10. Detailed descriptions for each project are presented below.

Table 9: Queensborough Community Centre Recommended Measures Summary

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
2.4.1.1	Lighting Upgrade	$12,000	6.0	$2,000		113	20,600	0.2
2.4.1.2	BAS Recommissioning	$14,000	8.2	$1,700	90		4,300	4.5
Total		**$26,000**	**7.0**	**$3,700**	**90**	**113**	**24,900**	**4.7**

Table 10: Queensborough Community Centre Financial Analysis

Item	Description	Cost	Payback	Annual Savings	Life Expectancy	NPV	IRR
2.4.1.1	Lighting Upgrade	$12,000	6.0	$2,000	15	$8,400	17%
2.4.1.2	BAS Recommissioning	$14,000	8.2	$1,700	10	($1,100)	6%
Total		**$26,000**	**7.0**	**$3,700**	**12.3**	**$6,300**	**12%**

2.4.1.1 Lighting Upgrade

While some lighting has been replaced with LED lamps, a number of areas remain lit with T8 fluorescents. We recommend retrofitting all T8 fixtures with longer-life LED Lamps. Energy consumption, demand and maintenance costs for these lamps are lower. As lighting measures were considered outside of scope for this report, the presented analysis is based on estimated lighting counts for the Port Royal room, Wreck room, Samson room, Library and building exterior. The savings analysis assumes the existing lamps wattage in these areas is 32 Watts. Accurate lighting counts must be done before implementing this opportunity.

During the site visit, the exterior lights were said to be 400 W metal halides (MH). This measure would also replace these lights with LED equivalent. However, the estimated annual electricity consumption is higher than expected when compared with historical electricity consumption. The exterior lighting type and actual counts should be verified before proceeding with implementation.

2.4.1.2 BAS Recommissioning

The CanmetENERGY Recommissioning Guide recommends that building systems be recommissioned every 3-5 years. Aside from energy reduction presented in this report, there are numerous co-benefits, including improvements operational efficiency and asset value. It's uncertain when the controls at this facility were last recommissioned. During controls recommissioning, it is recommended that the following measures be investigated.

- Schedule and Optimal Start
- Zone level scheduling
- Night Time Setback
- Demand controlled ventilation
- Reduce Minimum Damper Positions
- Occupancy Sensors for Zone Control
- Cooling OAT Lockout
- Heating OAT Lockout
- Weather Predictor
- Domestic Hot Water (DHW) Pump Scheduling

The savings analysis assumes there are opportunities to reduce HVAC schedules, add schedules for exhaust fans, and reduce the AHU outdoor air rates. It also assumes most HVAC equipment is already connected to the BAS and a minimal amount of BAS devices need to be installed. This recommendation should be considered with caution due to the uncertainty regarding current BAS control capabilities.

2.5 Queensborough Fire Hall

The Queensborough Fire Hall building located at 1011 Ewen Avenue in New Westminster was originally constructed in 1998. The total square footage of the building is 6,680 ft^2 (621 m^2). The building is occupied 24 hours per day, 7 days a week.

The Fire Hall is ventilated by a make up air (MUA) unit and 3 furnaces. The MUA serves the hose tower. It is controlled by a timer switch and local supply air temperature (SAT) setpoint for the gas-fired heating section. The truck bay is conditioned by 2 gas-fired unit heaters (UH) and exhaust fans. The rest of the building is conditioned by the 3 furnaces equipped with gas heating and DX cooling. Domestic hot water (DHW) is supplied by an 80-gallon gas-fired water heater. A majority of these systems are controlled by a Reliable BAS.



Figure 8: Queensborough Fire Hall

2.5.1 Recommended Measures

A summary of the analysis for the all recommended measures for the Queensborough Fire Hall is presented in Table 11. The financial analysis of all recommended measures is presented in Table 12. Detailed descriptions for each project are presented below.

Table 11: Queensborough Fire Hall Recommended Measures Summary

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
2.5.1.1	ASHP DHW	$9,000	6.9	$1,300	190		(25,300)	9.2
2.5.1.2	Replace Truck Bay UHs with Radiant Heaters	$13,000	9.3	$1,400	70		6,600	3.6
2.5.1.3	High Performance Roof Assembly	$12,000	16.2	$740	50		200	2.5
Total		**$34,000**	**9.9**	**$3,440**	**310**		**(18,500)**	**15.3**

Table 12: Queensborough Fire Hall Financial Analysis

Item	Description	Cost	Payback	Annual Savings	Life Expectancy	NPV	IRR
2.5.1.1	ASHP DHW	$9,000	6.9	$1,300	15	$4,200	14%
2.5.1.2	Replace Truck Bay UHs with Radiant Heaters	$13,000	9.3	$1,400	15	$1,300	9%
2.5.1.3	High Performance Roof Assembly	$12,000	16.2	$740	30	($1,000)	7%
Total		**$34,000**	**9.9**	**$3,440**	**20.3**	**$7,800**	**10%**

2.5.1.1 ASHP DHW

Currently there is a single gas fired DHW heater serving the building. This measure will replace the DHW with an ASHP DHW heater. This will significantly decrease the natural consumption and greenhouse gas emissions in the building.

The savings analysis assumes this cost will be similar to HP heater budget prices received for comparable sized DHW heaters. The new DHW HP should actually be sized based on the building's specific DHW demand.

2.5.1.2 Replace Truck Bay UHs with Radiant Heaters

The truck bay is heated by gas-fired unit heaters. This measure will replace the unit heaters with radiant heaters. This provides heating directly where the people are located when there is demand rather than trying to heat the entire air in the garage.

This recommendation should be considered with caution as further investigation is required before implementation. The savings analysis assumes the gas-fired unit heaters will be replaced by 4 radiant heaters. Furthermore, assumptions were made on the current size of the UHs' heating capacity and blower fan motor. As the units are mounted to the ceiling of the truck bay, this information could not be confirmed during the site visit.

2.5.1.3 High Performance Roof Assembly

The current roof insulation level is estimated at R-10. The roof is at its end of life and replacement is in the 5 Year Capital Plan. This measure proposes an insulation upgrade to R-30. The savings analysis uses incremental cost as it assumes that the upgrade will occur when the roof of city hall is replaced. This will minimize cost of the upgrade

2.6 Moody Park Arena

The Moody Arena located at 701 8th Avenue in New Westminster was originally constructed in 1975. The total square footage of the building is 33,500 ft^2 (3,100 m^2). The building is open 7 days a week including early mornings and late evenings. The ice-skating programs are offered between the months of July and March, each year and the floor is used for Lacrosse from April through June.

Moody Park Arena is conditioned by two gas fired furnaces that serves the change rooms, offices, and concession area. The ice rink is served by 2 dehumidifiers to control humidity levels, while the spectator area is heated by gas fired infrared heaters. The ice plant comprises of two compressors, a cooling towers and a brine chiller. The ice plant is also connected to de-superheaters which recovers heat from the refrigerant and transfers it to the snow melt pit and the under-floor heating system. There are two DHW systems: one serving the Zamboni fill station and the other serving the change rooms. All of the equipment is controlled locally as this building is not equipped with a BAS.



Figure 9: Moody Park Arena Building

2.6.1 Recommended Measures

A summary of the analysis for the all recommended measures for the Moody Park Arena building is presented in Table 13. The financial analysis of all recommended measures is presented in Table 14. Detailed descriptions for each project are presented below.

Table 13: Moody Park Arena Recommended Measures Summary

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
2.6.1.1	BAS Installation	$53,000	7.0	$7,600	160		89,100	8.9
2.6.1.2	Realice - Zamboni Cold Water Conversion	$34,000	7.2	$4,700	200		29,000	10.3
2.6.1.3	Refrigeration - Compressors Upgrade	$65,000	7.6	$8,600		251	91,700	1.0
2.6.1.4	ASHP Furnace Replacement	$34,000	15.5	$2,200	270	(66)	(15,100)	13.3
2.6.1.5	Waste Heat Recovery	$85,000	13.1	$6,500	240		50,900	12.5
Total		**$271,000**	**9.2**	**$29,600**	**870**	**185**	**245,600**	**46.0**

Table 14: Moody Park Arena Financial Analysis

Item	Description	Cost	Payback	Annual Savings	Life Expectancy	NPV	IRR
2.6.1.1	BAS Installation	$53,000	7.0	$7,600	20	$39,400	15%
2.6.1.2	Realice - Zamboni Cold Water Conversion	$34,000	7.2	$4,700	15	$13,800	13%
2.6.1.3	Refrigeration - Compressors Upgrade	$65,000	7.6	$8,600	15	$22,500	12%
2.6.1.4	ASHP Furnace Replacement	$34,000	15.5	$2,200	15	($11,600)	2%
2.6.1.5	Waste Heat Recovery	$85,000	13.1	$6,500	15	($18,800)	4%
Total		**$271,000**	**9.2**	**$29,600**	**16.0**	**$30,300**	**9%**

2.6.1.1 BAS Installation

The HVAC systems and ice plant equipment are controlled locally as no BAS is present. This measure would install a BAS and connect it to a majority of the HVAC systems and ice plant equipment. The BAS would allow for advanced control strategies to be implemented such as:

- Schedule and Optimal Start
- Night Time Setback
- Demand controlled ventilation
- Reduce Minimum Damper Positions
- Cooling OAT Lockout
- Heating OAT Lockout
- Weather Predictor

The savings analysis assumes a scope for the BAS installation and estimates the number of BAS end devices needed to control a majority of the systems. The scope of the new BAS should be further discussed and refined before implementing this measure. Focusing the scope to equipment with higher savings potential will improve the financial payback.

2.6.1.2 Realice - Zamboni Cold Water Conversion

The Zamboni uses hot water for ice resurfacing. This increases the load on the ice plant to compensate for the increased temperature of the ice.

This project involves installing a special device for vortex generated resurfacing water which removes air bubbles and filaments from the resurfacing water. This eliminates the need to heat the resurfacing water before application. It also generates thermal and electricity savings through reducing the need to heat up resurfacing water and reducing electricity on the ice rink refrigeration plant.

The savings analysis assumes similar results to the 2014 Fortis Pilot Project that installed this system on 10 ice rinks and reported on the results of a 2-month measurement & verification (M&V) period. Results will verify based on the arena specific operations, for example the ice resurfacing frequency.

2.6.1.3 Refrigeration - Compressor Upgrade

The existing ice plant compressors have constant speed motors. This measure would install a new high efficiency motor and VSD on one compressor. This would become the main compressor with the other only operating when necessary.

This recommendation should be considered with high caution due to the uncertainty regarding the operation of the ice plant. The savings analysis assumes the annual operating hours of the ice plant as there were no historical ice plant logs available or BAS trends. Further investigation is recommended to understand the annual hours of ice plant operation.

2.6.1.4 ASHP Furnaces

The current furnaces are equipped with gas fired heating stages to meet the heating requirements of the offices, change rooms and concession areas.

This measure involves replacing the gas fired heating stages with ASHPs to drastically reduce the need for natural gas for space heating. The analysis assumes an operating efficiency of the furnaces as well as a coefficient of performance (COP) for the new heat pump. The savings analysis uses the incremental cost as it assumes the unit will be replaced at the end of its service life. This recommendation should be considered with high caution due to the long payback and the assumptions regarding existing and new efficiency.

2.6.1.5 Waste Heat Recovery

The ice plant's ammonia refrigerant loop has been equipped with two de-superheaters that serve as limited preheat for the snow melt pit and the under-floor heating systems. This is believed to be capturing only a small amount of the potential high-grade thermal energy.

This measure intends to capture additional high-grade thermal energy by adding another de-superheater and connecting it to additional heating loads, such as the DHW systems. This is an excellent opportunity to provide the building's heating needs and reduce the natural gas consumption.

This recommendation should be considered with high caution as the savings analysis assumes the amount of high-grade thermal energy potential. This measure may have a better financial payback if the Realice – Zamboni Cold Water Conversion measure does not proceed. Further discussion and investigation must be done before proceeding to implementation. Safety risks must also be considered when installing a new de-superheater on an ammonia refrigerant system, including proper sizing of the new de-superheater.

2.6.2 Measures Analyzed, but not Recommended

The following projects presented in Table 15 were evaluated but we do not recommend proceeding with these options at this time for a variety of reasons. These may be worth considering at a later date, but are not considered a priority at this time.

Table 15: Measures Analyzed, but not Recommended for Moody Park Arena

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
2.6.2.1	Caulking to Improve Air Tightness	$70,000	25.9	$2,700	180			9.0

2.7 Moody Park Pool

Moody Park Pool located at 701 10th Street in New Westminster was originally constructed in 2008. The site is composed of a 5,400 ft² (499 m²) building and 140,000 gallon outdoor pool. The building houses the administration area, first aid, change rooms, pool equipment room, mechanical room and the park's public washrooms. The pool facilities are open between the months of June and September while the park's public washrooms are accessible year-round.

The building is ventilated with a combination of exhaust fans and outdoor air dampers that are controlled by occupancy sensors and humidistats. The rooms are heat by electric unit heaters connected to analog thermostats. DHW is supplied by 7 instantaneous gas-fired water heaters, while the pool is heated by 2 condensing boilers. All of the equipment is controlled locally as this building is not equipped with a BAS.



Figure 10: Moody Park Pool Building

2.7.1 Recommended Measures

A summary of the analysis for the all recommended measures for the Moody Park Pool building is presented in Table 16. The financial analysis of all recommended measures is presented in Table 17. Detailed descriptions for each project are presented below.

Table 16: Moody Park Pool Recommended Measures Summary

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
2.7.1.1	Low Flow Shower Head	$200	1.7	$120	10			0.5
2.7.1.2	Unit Heater Control Upgrade	$4,800	4.8	$1,000			17,700	0.2
2.7.1.3	Simple Pool Cover	$11,000	5.5	$2,000	140			7.0
2.7.1.4	Wind Break Around Pool Perimeter	$5,600	6.9	$810	60			3.0
2.7.1.5	Utilize Solar Energy to Heat Pool Water	$39,000	7.5	$5,200	350			17.5
Total		**$60,600**	**6.6**	**$9,130**	**560**		**17,700**	**28.2**

Table 17: Moody Park Pool Financial Analysis

Item	Description	Cost	Payback	Annual Savings	Life Expectancy	NPV	IRR
2.7.1.1	Low Flow Shower Head	$200	1.7	$120	10	$700	63%
2.7.1.2	Unit Heater Control Upgrade	$4,800	4.8	$1,000	10	$2,800	19%
2.7.1.3	Simple Pool Cover	$11,000	5.5	$2,000	10	$4,200	15%
2.7.1.4	Wind Break Around Pool Perimeter	$5,600	6.9	$810	10	$600	10%
2.7.1.5	Utilize Solar Energy to Heat Pool Water	$39,000	7.5	$5,200	20	$24,200	14%
	Total Recommendations	**$60,600**	**6.6**	**$9,130**	**16.4**	**$36,300**	**15%**

2.7.1.1 Low Flow Shower Head

Existing shower heads appear to be standard-flow fixtures. Replacing with low flow shower heads will reduce both water consumption and DHW heating energy. The analysis for this measure assumes incremental costing since low-flow fixtures are assumed to be installed only when replacement of the existing fixtures is needed. Only the DHW heating savings were considered as part of this study as a water analysis was not part of the scope of this study.

2.7.1.2 Unit Heater Control Upgrade

The Washrooms and changerooms are heated by electric unit heaters connected to analog thermostats. These thermostats are manually setback during the off-season. The sites energy history indicates a significant amount of electric heating is still taking place in the off-season.

Installing programmable thermostats to control unit heaters would allow for the setback to be done automatically at night. The off-season room temperature setpoint may also be reviewed and potentially reduced to further reduce heating demand in the off-season while still being considerate of freeze protection concerns.

This recommendation should be considered with high caution as the savings opportunity is highly dependent on existing manual setback setpoint and the potential for further reductions. Further information on off-season operation must be considered before implementation. The savings analysis assumes all analog thermostats will be replaced with programmable thermostats and the room temperatures setback will be reduced further during the off-season.

2.7.1.3 Simple Pool Cover

The pool is exposed to outdoor air and heated to a constant temperature 24/7. This significantly impacts the heating load overnight when outdoor air temperature reaches the daily minimum. By covering the pool afterhours, the water evaporation rate may be reduced and heating savings realized.

Facilities staff have concerns with a pool cover as people frequently jump the fence afterhours to swim. This is considered a safety risk with this measure. There are different pool cover options, such as liquid covers or a dome, that could mitigate this risk while achieving savings. This measure is considered a pilot to explore the suitable options that may be replicated at other pool facilities.

This recommendation should be considered with caution as the costs and savings will vary based on the final pool cover selected for implementation. The savings analysis carries uncertainties regarding cost as the final selection needs to consider additional factors such as safety and maintenance costs. Furthermore, the analysis excludes water use reductions which are expected to be significant but water analysis was not part of the scope of this study.

2.7.1.4 Wind Break Around Pool Perimeter

The pool is exposed to outdoor air and surrounded by a perimeter fence that leaves the pool surface exposed to wind. By putting a wind break around the perimeter fence the water evaporation rate may be reduced and heating savings realized. This has been successfully deployed in Kitsilano outdoor pool in Vancouver reducing 30% of energy.

The savings analysis carries cost uncertainties as it will depend on the circumference of the pool deck and the selected wind break option. For example, a natural wind break may be considered, such as bamboo, for aesthetics, however this would not save energy immediately since the windbreak will need some time to grow and it would require ongoing maintenance costs for landscaping. Furthermore, the analysis excludes water reductions which are expected to be significant but water analysis was not part of the scope of this study.

2.7.1.5 Utilize Solar Energy to Heat Pool Water

The pool is a summer-only facility. Current boilers already struggle to achieve target temperature. This option evaluates the concept of adding Solar Thermal Panels, Piping, and Controls to pre-heat domestic hot water and pool water. According to the analysis solar water heating is a potential option worth considering, but it is more expensive than other opportunities at this site.

The analysis assumes conditions in New Westminster are similar to a 3-year-old detailed analysis on an outdoor pool located in Abbotsford. The cost may vary depending on the heating demand of the pool as well as the selected option to lease or own the system. This recommendation should be considered with high caution as the pool heating demand and relevant climate information should be investigated before implementation.

2.8 Electrical Operations

The Electrical Operations building located at 901 1st Street in New Westminster was originally constructed in 1951. The total square footage of the building is 8,160 ft^2 (758 m^2). The building is occupied 7 am to 6 pm, 7 days per week.

The Electrical Operations building is ventilated by 3 RTUs servings the office area, while the shops are ventilated by exhaust fans. The RTUs are controlled by programmable thermostats and equipped with gas heating as well as DX cooling. The shops are heated by electric UHs. A 270-litre electric water heater provides DHW for the building. The building is said to have a Reliable BAS; however, only local controls could be found during the site visit.



Figure 11: Electrical Operations Building

2.8.1 Recommended Measures

A summary of the analysis for the all recommended measures for the Electrical Operations building is presented in Table 18. The financial analysis of all recommended measures is presented in Table 19. Detailed descriptions for each project are presented below.

Table 18: Electrical Operations Recommended Measures Summary

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
2.8.1.1	BAS Installation	$15,000	11.5	$1,300	40		5,900	2.1

Table 19: Electrical Operations Financial Analysis

Item	Description	Cost	Payback	Annual Savings	Life Expectancy	NPV	IRR
2.8.1.1	BAS Installation	$15,000	11.5	$1,300	20	$800	8%

2.8.1.1 BAS Installation

This building is said to have a reliable BAS however this could not be confirmed during the site visit. RTU are controlled through programmable stats. This measure would install a BAS to control the RTUs and an exhaust fan. The BAS would allow for advanced control strategies to be implemented such as:

- Schedule and Optimal Start
- Night Time Setback
- Demand controlled ventilation
- Reduce Minimum Damper Positions
- Cooling OAT Lockout
- Heating OAT Lockout
- Weather Predictor

The savings analysis assumes a limited scope BAS that does control DHW or the equipment in the shops. This focuses the scope of the HVAC equipment with the higher savings potential. This recommendation should be considered with caution due to the uncertainty regarding an already existing BAS. If the building is connected to a BAS, recommissioning opportunities should be explored instead of installing a new BAS.

2.8.2 Measures Analyzed, but not Recommended

The following projects presented in Table 20 were evaluated but we do not recommend proceeding with these options at this time for a variety of reasons. These may be worth considering at a later date, but are not considered a priority at this time.

Table 20: Measures Analyzed, but not Recommended for Electrical Operations

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
2.8.2.1	Roof top RTU equipment and replacement with heat pumps	$27,000	43.5	$620	150		(12,700)	7.3
2.8.2.2	Caulking to Improve Air Tightness	$18,000	27.3	$660	50			2.5
Total		**$45,000**	**35.2**	**$1,280**	**200**		**(12,700)**	**9.8**

2.9 Engineering Operations

The Engineering Operations building located at 901 1st Street in New Westminster was originally constructed in 1990. The total square footage of the building is 24,600 ft^2 (2,290 m^2). The building is occupied 7 am to 6 pm, 7 days per week.

The Engineering Operations building is ventilated by an MUA (MU-1), an RTU, and an air conditioning (AC) un. Limited information was available during the site visit on these units or their service areas. The AC is believed to serve most of the offices while the RTU only serves the second floor lunch room. MU-1 service area was unknown. The RTU and MU-1 are equipped with gas heating. The garage bay is conditioned by gas-fired unit heaters and exhaust fans. A condensing boiler provides HW to the in-slab heating system and food services. DHW is said to be provided by 5 water heaters, although only 3 could be located on site: 2 gas-fired water heaters and an electric water heater. The HVAC systems are controlled by a Reliable BAS.



Figure 12: Engineering Operations Building

2.9.1 Recommended Measures

A summary of the analysis for the all recommended measures for the Engineering Operations building is presented in Table 21. The financial analysis of all recommended measures is presented in Table 22. Detailed descriptions for each project are presented below.

Table 21: Engineering Operations Recommended Measures Summary

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
2.9.1.1	DHW Replacement	$6,500	7.1	$910	110	-	(11,800)	5.4
2.9.1.2	BAS Recommissioning	$36,000	8.6	$4,200	80	-	51,500	4.5
2.9.1.3	Caulking to Improve Air Tightness	$15,000	10.0	$1,500	30	-	16,300	1.7
2.9.1.4	RTU and MU-1 Replacement	$34,000	14.2	$2,400	130	(101)	8,300	6.6
Total		**$91,500**	**10.2**	**$9,010**	**350**	**-101**	**64,300**	**18.2**

Table 22: Engineering Operations Financial Analysis

Item	Description	Cost	Payback	Annual Savings	Life Expectancy	NPV	IRR
2.9.1.1	DHW Replacement	$6,500	7.1	$910	15	$2,800	13%
2.9.1.2	BAS Recommissioning	$36,000	8.6	$4,200	10	($4,000)	5%
2.9.1.3	Caulking to Improve Air Tightnes	$15,000	10.0	$1,500	15	$300	8%
2.9.1.4	RTU and MU-1 Replacement	$34,000	14.2	$2,400	20	($4,800)	6%
Total		**$91,500**	**10.2**	**$9,010**	**14.9**	**($3,900)**	**7%**

2.9.1.1 DHW Replacement

The building's 2 gas-fired DHW were installed in 1998. As these heaters reach end-of-life they may be replace with a hybrid heat pump (HP) system, which will replace existing units with packaged HP heaters.

The savings analysis assumes this cost will be similar to HP heater budget prices received for comparable sized systems. The financial analysis is based on the incremental cost since these units are near end-of-life. The new DHW HP should be sized based on peak DHW demand.

2.9.1.2 BAS Recommissioning

The CanmetENERGY Recommissioning Guide recommends that building systems be recommissioned every 3-5 years. Aside from energy reduction presented in this report, there are numerous co-benefits, including improvements operational efficiency and asset value. It's uncertain when the controls at this facility were last recommissioned. During controls recommissioning, it is recommended that the following measures be investigated.

- Schedule and Optimal Start
- Zone level scheduling
- Night Time Setback
- Demand controlled ventilation
- Reduce Minimum Damper Positions
- Occupancy Sensors for Zone Control
- Cooling OAT Lockout
- Heating OAT Lockout
- Weather Predictor
- Domestic Hot Water (DHW) Pump Scheduling
- Lighting Scheduling

The savings analysis assumes there are opportunities to reduce HVAC schedules, lighting schedules and the AHU outdoor air rates. Comments were heard that the BAS control devices are old and in need of replacement. The cost assumes a quantity of control devices will need replacement; however, the cost will vary depending actual number of control device replacements. This recommendation should be considered with caution as further investigation is suggested before implementing this measure.

2.9.1.3 Caulking to Improve Air Tightness

Air leakage generally contributes 25% to 40% of space heat loads. While eliminating leaks in an existing building is very difficult, significant reductions can be achieved by conducting a scan of unintentional opening in the building's air barrier and sealing these. In the current analysis, it is assumed that air leakage is reduced from 15 ACH@50 Pa to 1 ACH@50 Pa

For small cracks up to 10 mm, the use of caulking is acceptable. For larger cracks (11 mm to 75 mm) the use of foam is recommended. Covering foam and sealants with a thermal barrier is generally required. Larger gaps and holes should be treated with insulation and a sheet applied air barrier such as gypsum wall board.

Use of a blower door is recommended to both track the location of leaks as well as confirming the improvement in air tightness.

2.9.1.4 RTU and MU-1 Replacement

The RTU and MU-1 were mentioned as potential candidates for replacement. However, no information was available on these units during the study.

This recommendation should be considered with high caution as the costs and savings will vary depending on the actual size of these units. Further investigation is highly recommended before deciding to proceed with this measure.

2.10 Glenbrook Fire Hall

The Glenbrook Fire Hall located on 6th Avenue in New Westminster was originally constructed in 2002. The total square footage of the building is 14,500 ft² (1,350 m²). The building is occupied 24 hours per day, 7 days a week, however, the administration area is only occupied between the hours of 7:30 am to 4:30 pm.

The Fire Hall is ventilated by 2 AHUs. These AHUs are equipped with gas heating and DX cooling. The truck bay is conditioned by 4 gas-fired unit heaters (UH) and exhaust fans. Domestic hot water (DHW) is supplied by a gas-fired water heater. A majority of these systems are controlled by a Reliable BAS. Lighting is a mixture of LED and CFL lamps.



Figure 13: Glenbrook Fire Hall

2.10.1 Recommended Measures

A summary of the analysis for the all recommended measures for the Glenbrook Fire Hall is presented in Table 23. The financial analysis of all recommended measures is presented in Table 24. Detailed descriptions for each project are presented below.

Table 23: Glenbrook Fire Hall Recommended Measures Summary

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
2.10.1.1	Install low flow shower heads	$400	1.7	$230	20	-	-	1.0
2.10.1.2	BAS Recommissioning	$14,000	5.0	$2,800	100	-	21,200	5.2
2.10.1.3	Garage Bay Heating Lockout	$5,900	8.1	$730	50	-	-	2.5
2.10.1.4	AHU Upgrade	$65,000	13.0	$5,000	620	(162)	(51,600)	30.4
Total		**$85,300**	**9.7**	**$8,760**	**790**	**-162**	**(30,400)**	**39.1**

Table 24: Glenbrook Fire Hall Financial Analysis

Item	Description	Cost	Payback	Annual Savings	Life Expectancy	NPV	IRR
2.10.1.1	Install low flow shower heads	$400	1.7	$230	10	$1,400	60%
2.10.1.2	BAS Recommissioning	$14,000	5.0	$2,800	10	$7,300	18%
2.10.1.3	Garage Bay Heating Lockout	$5,900	8.1	$730	15	$1,500	11%
2.10.1.4	AHU Upgrade	$65,000	13.0	$5,000	20	($4,200)	7%
Total		**$85,300**	**9.7**	**$8,760**	**18.0**	**$11,400**	**9%**

2.10.1.1 Install Low Flow Shower Heads

Existing shower heads appear to be standard-flow fixtures. Replacing with low flow shower heads will reduce both water consumption and DHW heating energy. The analysis for this measure assumes incremental costing since low-flow fixtures are assumed to be installed only when replacement of the existing fixtures is needed. Only the DHW heating savings were considered as part of this study as a water analysis was not part of the scope of this study.

2.10.1.2 BAS Recommissioning

The CanmetENERGY Recommissioning Guide recommends that building systems be recommissioned every 3-5 years. Aside from energy reduction presented in this report, there are numerous co-benefits, including improvements operational efficiency and asset value. It's uncertain when the controls at this facility were last recommissioned. During controls recommissioning, it is recommended that the following measures be investigated.

- Schedule and Optimal Start
- Zone level scheduling
- Night Time Setback
- Demand controlled ventilation
- Reduce Minimum Damper Positions
- Occupancy Sensors for Zone Control
- Cooling OAT Lockout
- Heating OAT Lockout
- Weather Predictor
- Domestic Hot Water (DHW) Pump Scheduling

The savings analysis assumes some areas of the building are occupied 24 hours per day, however, HVAC configuration has zone isolation ability, through variable air volume (VAV) boxes or zone isolation dampers, allowing for zone scheduling opportunities afterhours. It also assumes most HVAC equipment is already connected to the BAS and a minimal amount of BAS devices need to be installed.

2.10.1.3 Garage Bay Heating Lockout

The truck bay is heated by 4 gas-fired unit heaters that are controlled by thermostat which may cause excessive heating if the truck bay doors are open. The intention of this measures is to equip the bay doors with interlock switches to disable the heaters when they are open. This will reduce heat loss and encourage the occupants to keep the doors closed.

The analysis assumes the interlock switches will be installed on all 6 bay doors. This recommendation should be considered with caution as the potential savings will be highly dependent how often occupants leave the bay doors open during the winter season. As this is difficult to measure within the scope of this study.

2.10.1.4 AHU Upgrade

The AHUs are original to the building and rely on natural gas for space heating. This measure would upgrade the current AHUs with a heat pump option that displaces a majority of the current natural gas usage.

The savings analysis assumes the units are due for replacement and uses incremental cost. It also assumes both AHUs are of identical size as AHU-2 nameplate information was not visible on site. This recommendation should be considered with caution as these items should be further investigated.

2.11 Century House and Youth Centre

The Century House located at 600 8th street in New Westminster was originally constructed in 1959 while the Youth Centre was added in 2010. The total square footage of the building is 28,100 ft² (2,600 m²). The building is occupied 9 am to 9 pm during the week and reduced hours on the weekend.

The Century House is conditioned by an MUA, an HP and 3 rooftop units, HV-1, HV-2 and HV-3. The MUA provides gas heating and ventilation to the kitchen. HP-1 provides heating, cooling and ventilation to the Oak Room. The HV units provide DX cooling, gas heating and ventilation to the remaining areas of century house. The Youth Center is condition by 2 AHUs and a rooftop unit, RTU-1. The AHUs are equipped with a reversible heat pump ad electric duct heater. AHU-1 serves the Youth Offices while AHU-2 serves the multipurpose room. RTU-1 provides gas heating, DX cooling and ventilation to the Youth Centre Lounge. There are 2 condensing boilers that provide HW for space heating and DHW. An additional 2 gas water heaters in the custodian room provide additional DHW and an electric water heater supplies the kitchen with DHW. A majority of these systems are controlled by a Delta BAS.



Figure 14: Century House and Youth Centre

2.11.1 Recommended Measures

A summary of the analysis for the all recommended measures for the Century House and Youth Centre is presented in Table 25. The financial analysis of all recommended measures is presented in Table 26. Detailed descriptions for each project are presented below.

Table 25: Century House and Youth Centre Recommended Measures Summary

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
2.11.1.1	Improve Wrapping on Hot Water Pipes	$200	2.9	$70	5			0.2
2.11.1.2	BAS Recommissioning	$16,000	4.2	$3,800	130		31,500	6.8
2.11.1.3	MUA Upgrade	$28,000	11.2	$2,500	130	(22)	12,300	6.6
Total		**$44,200**	**6.9**	**$6,370**	**265**	**-22**	**43,800**	**13.6**

Table 26: Century House and Youth Centre Financial Analysis

Item	Description	Cost	Payback	Annual Savings	Life Expectancy	NPV	IRR
2.11.1.1	Improve Wrapping on Hot Water Pipes	$200	2.9	$70	10	$300	36%
2.11.1.2	BAS Recommissioning	$16,000	4.2	$3,800	10	$12,900	22%
2.11.1.3	MUA Upgrade	$28,000	11.2	$2,500	20	$2,400	9%
Total		**$44,200**	**6.9**	**$6,370**	**16.3**	**$23,400**	**14%**

2.11.1.1 Improve Wrapping on Hot Water Pipes

The DHW piping surrounding the kitchen's electric water heater were noted to be exposed during the site visits. Where HW piping is accessible and exposed, it should be insulated in order to reduce standing heat loss.

The savings analysis represents a rough cost only. Actual cost will depend on the amount of exposed surface area and the type of insulation being installed.

2.11.1.2 BAS Recommissioning

The CanmetENERGY Recommissioning Guide recommends that building systems be recommissioned every 3-5 years. Aside from energy reduction presented in this report, there are numerous co-benefits, including improvements operational efficiency and asset value. It's uncertain when the controls at this facility were last recommissioned. During controls recommissioning, it is recommended that the following measures be investigated.

- Schedule and Optimal Start
- Zone level scheduling
- Night Time Setback
- Demand controlled ventilation
- Reduce Minimum Damper Positions
- Occupancy Sensors for Zone Control
- Cooling OAT Lockout
- Heating OAT Lockout
- Weather Predictor
- Domestic Hot Water (DHW) Pump Scheduling

The savings analysis assumes there are opportunities to reduce HVAC schedules and the AHU outdoor air rates. It also assumes most HVAC equipment is already connected to the BAS and a minimal amount of BAS devices need to be installed.

2.11.1.3 MUA Upgrade

The MUA serving the kitchen appears to be 11 years old. This measure would upgrade the current MUA with a heat pump option that displaces a majority of the current natural gas usage.

The savings analysis uses the incremental cost as it assumes the unit will be replaced at the end of its service life. This recommendation should be considered with caution.

2.12 Queens Park Arena

The Queens Park Arena located at 900-600 1st street in New Westminster was originally constructed in 1930 and renovated in the years 1999-2000. The roof was insulated approximately 5 years ago. The total square footage of the building is 81,200 ft^2 (7,550 m^2). The building is occupied from 5:30 am to 12:00 am in the winter and 7:00 am to 12:00 am in the summer. The ice plant operates between the months of September and March, each year.

Queens Park Arena is conditioned by two RTUs, three MUAs, and two dehumidifiers. The RTUs provide gas heating and ventilation to the second-floor meeting spaces, the Powerplay room and Breakout room. One MUA provides gas heating and ventilation to the arena entry area and offices. The other two gas MUAs ventilate the change rooms along the perimeter of the arena. One MUA serves changes room on the west side of the arena while the other serves the east side change rooms. The ice rink is served by 2 dehumidifiers to control humidity levels, while the spectator area is heated by gas fired infrared heaters. The ice plant

comprises of three compressors, two cooling towers and a brine chiller. The ice plant is also connected to a de-superheater which recovers heat from the refrigerant and transfers it to the west DHW systems. There are three DHW systems: one located in the west arena mechanical room, another in the east arena mechanical room, and an electric water heater for the concession area. The west DHW systems is composed of a gas fired boiler and three storage tanks that serve the west change rooms and the Zamboni fill station. The east DHW system is composed of a gas fired boiler and two storage tanks serving the east change rooms. All of the equipment is controlled locally as this building is not equipped with a BAS.



Figure 15: Queens Park Arena Building

2.12.1 Recommended Measures

A summary of the analysis for the all recommended measures for the Queens Park Arena building is presented in Table 27. The financial analysis of all recommended measures is presented in Table 28. Detailed descriptions for each project are presented below.

Table 27: Queens Park Arena Recommended Measures Summary

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
2.12.1.1	LED Replacements for Interior Lights	$5,500	6.5	$850		30	11,100	0.1
2.12.1.2	BAS Installation	$100,000	8.9	$11,200	380		96,700	20.0
2.12.1.3	MUA Heat Pumps	$65,000	9.8	$6,600	780	(189)	(59,700)	38.3
2.12.1.4	Refrigeration - Compressor Upgrade	$28,000	9.3	$3,000			50,900	0.5
2.12.1.5	Realice - Zamboni Cold Water Conversion	$34,000	10.3	$3,300	120		25,500	6.3
2.12.1.6	Low Emissivity Ceiling Retrofit	$45,000	19.6	$2,300			38,900	0.4
Total		**$277,500**	**10.2**	**$27,250**	**1,280**	**-159**	**163,400**	**65.6**

Table 28: Queens Park Arena Financial Analysis

Item	Description	Cost	Payback	Annual Savings	Life Expectancy	NPV	IRR
2.12.1.1	LED Replacements for Interior Lights	$5,500	6.5	$850	10	$1,000	11%
2.12.1.2	BAS Installation	$100,000	8.9	$11,200	20	$36,200	12%
2.12.1.3	MUA Heat Pumps	$65,000	9.8	$6,600	15	$2,200	8%
2.12.1.4	Refrigeration - Compressor Upgrade	$28,000	9.3	$3,000	15	$2,500	9%
2.12.1.5	Realice - Zamboni Cold Water Conversion	$34,000	10.3	$3,300	15	($400)	7%
2.12.1.6	Low Emissivity Ceiling Retrofit	$45,000	19.6	$2,300	15	($21,600)	(1%)
Total		**$277,500**	**10.2**	**$27,250**	**16.7**	**$11,800**	**8%**

2.12.1.1 LED Replacement for Interior Lights

While the ice rink lighting has been replaced with LED lamps, a number of areas remain lit with T8 fluorescents. We recommend retrofitting all T8 fixtures with longer-life LED Lamps. Energy consumption, demand and maintenance costs for these lamps are lower. As lighting measures were considered outside of scope for this report, the presented analysis is based on estimated lighting counts for the change rooms, hallways and offices. The savings analysis assumes the existing lamps wattage in these areas is 32 Watts. Accurate lighting counts must be done before implementing this opportunity.

2.12.1.2 BAS Installation

The HVAC systems and ice plant equipment are controlled locally as no BAS is present. This measure would install a BAS and connect it to a majority of the HVAC systems and ice plant equipment. The BAS would allow for advanced control strategies to be implemented such as:

- Schedule and Optimal Start
- Night Time Setback
- Demand controlled ventilation
- Reduce Minimum Damper Positions
- Cooling OAT Lockout
- Heating OAT Lockout
- Weather Predictor

The savings analysis assumes a scope for the BAS installation and estimates the number of BAS end devices needed to control a majority of the systems. The scope of the new BAS should be further discussed and refined before implementing this measure. Focusing the scope to equipment with higher savings potential will improve the financial payback.

2.12.1.3 MUA Heat Pump

The MUAs are planned for replacement within 5 years. This measure would upgrade the current MUAs with a heat pump option that displaces a majority of the current natural gas usage.

The savings analysis uses an incremental cost as it assumes the unit will be replaced at the end of its service life. This recommendation should be considered with high caution as limited information is available for the MUAs serving the change rooms. Further investigation of these units must be done before proceeding to implementation.

2.12.1.4 Refrigeration - Compressor Upgrade

The ice plant is currently undergoing upgrades to replace the chiller with a plate heat exchanger and reduce the refrigerant charge of the system. However, the existing compressors are not being upgraded as part of this scope of work.

This measure would install a new high efficiency motor and VSD on one compressor. This would run as the main compressor with the other only operating when necessary.

This recommendation should be considered with high caution due to the uncertainty regarding the operation of the ice plant post upgrade. Once the upgrades are complete, further investigation is recommended to understand the new ice plant operation and the savings analysis revised.

2.12.1.5 Realice - Zamboni Cold Water Conversion

The Zamboni uses hot water for ice resurfacing. This increases the load on the ice plant to compensate for the increased temperature of the ice.

This project involves installing a special device for vortex generated resurfacing water which removes air bubbles and filaments from the resurfacing water. This eliminates the need to heat the resurfacing water before application. It also generates thermal and electricity savings through reducing the need to heat up resurfacing water and reducing electricity on the ice rink refrigeration plant.

The savings analysis assumes similar results to the 2014 Fortis Pilot Project that installed this system on 10 ice rinks and reported on the results of a 2-month measurement & verification (M&V) period. Results will verify based on the arena specific operations, for example the ice resurfacing frequency.

2.12.2 Measures Analyzed, but not Recommended

The following projects presented in Table 29 were evaluated but we do not recommend proceeding with these options at this time for a variety of reasons. These may be worth considering at a later date, but are not considered a priority at this time.

Table 29: Measures Analyzed, but not Recommended for Queens Park Arena

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
2.12.2.1	Dehumidifier Upgrade	$60,000	63.8	$940			15,900	0.2

2.13 Queens Park Gardeners Building

The Queens Park Gardeners Building located in New Westminster has undergone multiple renovations over the years and suited different purposes that the original year of construction is unknown. The total square footage of the building is 2,950 ft^2 (274 m^2). The building is composed of a boardroom and the gardener's lunch room, both of which are intermittently occupied.

The building is not mechanically ventilated. A gas-fired boiler provides HW to perimeter radiators. An electric point of use DHW heater serves the washroom. The equipment is controlled locally as this building is not equipped with a BAS.



Figure 16: Queens Park Gardeners Building

2.13.1 Recommended Measures

A summary of the analysis for the all recommended measures for the Queens Park Gardeners building is presented in Table 30. The financial analysis of all recommended measures is presented in Table 31. Detailed descriptions for each project are presented below.

Table 30: Queens Park Gardeners Building Recommended Measures Summary

Item	Description	Cost	Simple Payback	Annual Savings				
				$	GJ	kW	kWh	GHG
2.13.1.1	Zone Control Optimization	$1,800	5.0	$360	20			1.0

Table 31: Queens Park Gardeners Building Financial Analysis

Item	Description	Cost	Payback	Annual Savings	Life Expectancy	NPV	IRR
2.13.1.1	Zone Control Optimization	$1,800	5.0	$360	10	$900	18%

2.13.1.1 Zone Control Optimization

The Boardroom heat is controlled by a Honeywell thermostat set to 18.5°C. The Gardener's lunch room has digital thermostat set to 20.5°C. These thermostats are believed to control the HW temperature to the perimeter radiators.

This measure will replace the existing thermostats with a smart thermostat that has web capabilities for remote access and monitoring. The thermostats will be programmed with a scheduled temperature setback to reduce demand for HW on the boiler. This recommendation should be considered with caution as the payback may be longer if there isn't internet access already available.

3. Available Incentives

There are various incentives available to the City of New Westminster to assist in further identification and implementation of energy reduction measures. There is funding available to support with more detailed energy studies, capital upgrades, replacements and even to hire staff to support you with your energy goals. Some of the incentives and programs that may be relevant for the City of New Westminster are summarized below.

3.1 Electrification and Fuel Switching

The CleanBC Custom Program, administered by BC Hydro, offers energy study funding and capital incentives for fuel switching and other electrification measures. The incentives available as part of this program are summarized below. The eligibility requirements for the incentives along with more information about the program can be found on the CleanBC Better Buildings website[5]. These incentives would be relevant for the heat pump measures recommended as part of this study.

- Energy Study Funding – the Custom Program supports up to 50% of an energy study's cost, up to a maximum of $20,000.
- Custom Capital Funding Incentives – based on a rate of $40/tCO2e of lifetime greenhouse gas savings, BC Hydro will support up to $200,000 per customer. For heat pump rooftop units, the Program offers a rate of $60/tCO2e.

[5] CleanBC Better Buildings Electrification: https://betterbuildingsbc.ca/incentives/cleanbc-custom-program/

3.2 Fortis BC Pipe and Tank Insulation Rebate

FortisBC is offering incentives to encourage customers to install insulation on uninsulated pipes and tanks for hot water and steam that are heated by natural gas. This program would be relevant for the insulation measures recommended as part of this study. More information about the program can be found on the Better Buildings Website under the FortisBC Pipe and Tank Insulation Rebate section[6].

3.3 BC Hydro Energy reduction Incentives for Businesses

BC Hydro is offering financial incentives for commercial customers, small industrial sites, and residential stratas to help shorten the payback period for simple one-to-one lighting, HVAC or refrigeration energy efficiency upgrades. These incentives would be relevant for lighting upgrades, VSD installs and BAS recommissioning measures recommended as part of this study. More information about this program can be found on the Better Buildings Website under the Energy reduction Incentives for Businesses section[7].

3.4 Fortis BC Custom Performance Program

The FortisBC Custom Performance Program provides funding for detailed energy studies and capital upgrades related to natural gas energy-efficiency projects. The available incentives for this program are summarized below. In order to qualify for this program, the project must have the potential to save a minimum of 1,200 GJ of natural gas annually. Since the goal of this study was to reduce GHGs, the projects recommended sought to remove natural gas rather than simply reduce it, as such the majority of these measures will not be eligible for this incentive. However, this should be considered for future energy studies.

- Energy Study Funding – have a detailed engineering analysis of your facility conducted to identify opportunities for cost-effective natural gas savings and/or electricity savings. Maximum funding is 50% of the cost of the energy study, up to $25,000.
- Capital Incentive Funding – funding offered to encourage the implementation of cost-effective natural gas and/or electricity energy efficiency measures that were identified in the energy study.
- Implementation Bonus Funding – funding is offered to participants who successfully implement the approve energy conservation measures. Maximum funding is equivalent to the energy study funding amount, to a maximum of $25,000.

3.5 Energy Specialist and Energy Manager Programs

Both BC Hydro and Fortis BC offer funding for energy managers (or specialists if FortisBC). These Energy Managers [8] and Energy Specialists[9] will help your organization meet their energy goals and objectives by supporting in the identification and implementation of energy reduction projects. This would be a valuable next step for your organization as it will allow you to gain access to training sessions, resources and a network to help improve your overall energy efficiency. More information about both of these positions can be found at the respective utility website, noted in the footnote.

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[6] FortisBC Pipe and Tank Insulation Rebate: https://betterbuildingsbc.ca/incentives/fortisbc-pipe-and-tank-insulation/

[7] Energy reduction Incentives for Businesses section: https://betterbuildingsbc.ca/incentives/energy-saving-incentives-for-businesses/

[8] BC Hydro Energy Manager - https://www.bchydro.com/powersmart/business/programs/energy-manager.html

[9] FortisBC Energy Specialist - https://www.fortisbc.com/rebates/business/energy-specialist-funding

3.6 BC Natural Resources Canada ISO 50001 Implementation Incentive

The BC Natural Resources of Canada ISO 50001 Implementation Incentive provides funds to cover 75% of the total costs up to $80,000 for the implementation or enhancement of an energy management system. This includes the following. This may be a valuable next step for CNW as implementing or improving an energy management system would allow for better identification of energy reduction opportunities, monitoring and trouble shooting of equipment and tracking of savings and overall energy use.

- Development of an energy baseline
- Energy use assessment
- Energy performance monitoring and reporting
- Professional and technical service fees
- Professional training
- Salaries of internal employees for work related to the implementation of energy management projects
- Purchase of instrumentation, software and metering equipment**

4. Conclusion

This report identifies a number of significant energy reduction opportunities as part of the level 1 energy studies. These measures focus on the reduction of natural gas and GHG emissions. If all our recommendations are implemented, we expect the following energy and greenhouse gas reductions.

	kWh	GJ	GHG
Project Portfolio wide consumption	7,590,850	24,358	1,291
Estimated L1 Energy Reduction	722,500	6,295	322
Percent Energy Reduction	10%	26%	25%

The report has identified that the majority of the buildings have excellent opportunities for BAS upgrades and recommissioning. We recommend that these measures are implemented prior to higher cost mechanical upgrades because of their relative low cost and payback. In addition, focusing on controls first increases our overall understanding of the buildings performance and systems, which informs the design of any additional measures planned for implementation.

5. Acknowledgments

SES Consulting Inc. would like to acknowledge the valuable assistance of the following personnel in providing the necessary information for this report. This report was created and written by Brad White and Justin Blanchfield with the assistance of Stephanie Poole and Sheldon Boyce. In addition, this report was prepared with the assistance of Monty Peters, Tobi May and all the building specific operators and facilities managers. Their cooperation and contributions to the project are greatly appreciated.

6. Disclaimer

This document was prepared by SES Consulting Inc. for the City of New Westminster (CNW). The scope was to provide a benchmarking study for 24 buildings and level 1 energy studies for the buildings that were identified as good candidates. Using the criteria identified in this report, 13 buildings were selected for level 1 energy studies. Investigation work for these studies has been performed to estimate the probable costs and savings associated with each project. Further detailed design work will be required for project implementation. Any estimates of probable cost are made on the basis of SES's judgment and experience. SES makes no warranty, express or implied, that cost of the work will not vary from the SES's estimate of probable cost. SES accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Appendix A - Recommissioning Project Descriptions

Bay Door Heating Lockout

Heating does not lock out when bay doors are open, resulting in unnecessary heating of large flow rates of outdoor air infiltration. Often, this heating does not lead to any improvement in space comfort since the outdoor air flow is cold and creates significant drafts.

Install bay door sensors and lock out space heating or reduce room temperature setpoint when the doors are open. If heating is required for specific areas in the work space when the bay doors are open, consider installing radiant heaters which are an efficient and effective form of heating for these types of spaces.

Chilled Water Supply Temperature Reset

Chilled water supply temperature (CHWST) does not reset based on actual demand to optimize chiller efficiency.

Reset CHWST based on actual demand to improve the efficiency of the chiller. Operating the chiller at its best efficiency will also increase the lifespan of the equipment and reduce maintenance costs.

Cooling Plant Recommissioning

The buildings cooling plant consists of a chiller and cooling tower that are often operating outside of their best efficiency point.

We recommend a recommissioning of the cooling plant controls to reset chilled water and condensing water setpoints, and modulate pump and fan speeds to optimize efficiency.

Cooling Outdoor Air Temperature Lockout

Cooling systems are enabled during heating and shoulder seasons when there is little or no demand for cooling.

Programming an outdoor air lockout will disable non-critical cooling systems when the demand for cooling is low.

Demand Controlled Ventilation

The amount of fresh outdoor air supplied to the spaces does not modulate based on actual air quality in the spaces.

Install CO_2 sensors to monitor indoor air quality and modulate outdoor airflow based on actual demand for fresh outdoor air. CO_2 sensors are typically installed in return air ducts but may also be installed in spaces such as boardrooms or lecture halls since they experience high densities of occupants.

Domestic Hot Water Pump Scheduling

Domestic hot water (DHW) circulation pumps operate continuously.

Scheduling DHW circulation pumps will reduce afterhours heat loss through DHW supply lines.

Dual Maximum Variable Air Volume Box Control

Variable air volume boxes (VAV) modulate airflow between a single minimum and maximum setpoints based on heating and cooling demand. This strategy typically leads to excessive air changes when the spaces are in Deadband.

Reprogram VAV controllers based on a dual maximum control strategy. This strategy allows for lower minimum setpoints when the spaces are in deadband while ensuring flow rates are increased when either heating or cooling is required.

Heat Pump Supply Water Temperature Reset

The heat pump supply loop is not optimized to minimize the boiler and cooling tower runtimes.

By resetting loop temperature based on heat pump demand, the system may be operated at its highest efficiency point and reduce the run times on the boiler and cooling tower.

Heating Water Supply Temperature Reset

Heating water supply temperature (HWST) does not reset based on demand from the zones and / or air handling units.

Reset HWST based on demand to reduce unnecessary heat loss and improve the efficiency of the heating plant. The efficiency of condensing boilers increases by lowering return water temperature (RWT). This strategy aims to lower the RWT as much as possible while maintaining effective heating in the zones. While the efficiency of non-condensing boilers is not very sensitive to RWT, reducing the RWT in both condensing and non-condensing systems results in the following savings:

1. Reduced heat loss from heating water supply and return lines to the spaces
2. Reduced cooling energy associated with removing unwanted heat from the space
3. Reduced boiler room space temperature

Heating Outdoor Air Temperature Lockout

Heating systems are often enabled in the facility when there is little or no demand for heating. Heating demand is typically low when fresh air requirements are minimal and internal heating loads such as occupants, lighting, and solar gain provide sufficient space heating at a given outdoor air temperature (OAT).

Lockout heating systems based on an adjustable OAT setpoint. If the DHW heating system is coupled with the heating water system, the entire heating plant may not be disabled. In this scenario, the heating water devices such as heating water pumps and heating coil valves must be disabled instead.

Hot Water Piping Insulation

Sections of the heating water piping are uninsulated. This results in unnecessary heat loss and often results in uncomfortably hot spaces to work in, including mechanical rooms.

Insulate all exposed heating water pipes, fittings, valves, and motors.

Occupancy Sensors for Zone Control

Zones with intermittent occupancy maintain continuous temperature and ventilation setpoints even when the spaces are empty.

Occupancy sensors may be installed along with an occupancy counter program to setback space temperature and flow setpoints when insufficient occupancy is detected.

Nighttime Setback

Afterhours heating setpoints are higher than necessary.

Reducing the nighttime heating setpoint will reduce unnecessary heat loss. An optimal start routine will ensure that space temperatures are comfortable for the start of the occupied period. During night time setback mode, mixed air dampers on all air handling units shall be set to 100% return air. Where variable speed drives are present, the fans shall operate at a reduced speed. For facilities with perimeter hydronic heating devices such as perimeter radiation, ceiling mounted radiant panels, or unit heaters, the AHUs may be used as a second stage of nighttime heating.

Pump Differential Pressure Reset

Pumps currently have variable speed drives; however, the speed of the pumps does not modulate based on actual demand.

For distribution systems with primarily 2-way valves, reset the pump speed based on the pressure differential between the supply and return water. For 3-way valve systems, the temperature differential between the supply and return water may be used.

Reduce Minimum Damper Position

Minimum outdoor air damper position setpoints are typically set too high and provide more outdoor air than required to meet minimum ventilation standards. This excessive fresh air results in unnecessary heating and cooling demand.

Reducing minimum damper positions, in combination with real-time air quality monitoring, will reduce heating and cooling demand while ensuring adequate indoor air quality.

Run Equipment on Demand

Non-critical equipment is often operating continuously during periods of little to no demand.

Equipment should be programmed to operate based on demand to reduce run-time.

Scheduling and Optimal Start

Many of the existing HVAC systems run longer than required by occupants. This results in unnecessary energy consumption during unoccupied periods.

Occupancy schedules may be updated to reflect actual demand. An optimal start sequence may be programmed to minimize run times while ensuring the spaces are comfortable when occupants arrive in the morning. When afterhours HVAC is intermittently required, override buttons may be installed.

Occupant engagement plays a critical role in successfully implementing a scheduling project, especially in facilities such as labs and mixed-use spaces which have complex HVAC requirements. Occupants should be surveyed to determine actual HVAC requirements.

Supply Air Pressure Reset

Supply air pressure setpoints (SAP SP) do not reset based on actual demand for ventilation.

Resetting SAP SP based on zone demand will reduce air handling unit fan speeds when appropriate.

Supply Air Temperature Reset

Supply air temperature setpoints (SAT SP) do not reset based on actual demand for heating and cooling from the zones.

Resetting SAT SP based on actual demand will reduce simultaneous heating and cooling between the air handling unit and zone reheat systems.

Theatre/Lecture Hall Occupancy Control

Large theatres and lecture spaces have significant ventilation demands yet very intermittent occupancy throughout the year. Typical occupancy control programs enable HVAC equipment for several hours anytime occupancy is detected. This can often lead to a single person enabling an HVAC system that is designed for 100 or more occupants.

Implement a strategy to count the density of occupancy using appropriately positioned ceiling mount occupancy sensors. SES can provide sample code for this occupancy counter which enables HVAC systems only once a user-defined occupant density is detected.

Weather Predictor

During cool mornings in the shoulder season and summer, it is common for the heating systems to be enabled during morning warm-up even though the spaces will often require cooling only hours later as OAT increases. The morning heating loads therefore overheat the spaces and increases the cooling demand.

Program a weather predictor to estimate the daily high temperature early in the morning and lock out the heating systems when the predicted high temperature will be warmer than 20°C (adj.). This project often results in some morning comfort complaints since many spaces may be below room temperature setpoint. It does however reduce cooling demands and can reduce the number of overheating complaints. To minimize comfort complaints, occupants should be engaged and educated on the benefits of the strategy.

Zone Level Scheduling

Several of the zones in the building have varying occupancy demands, however, the whole building is controlled based on a common operating schedule.

Through engagement with occupants, a detailed understanding of zone level HVAC controls and comfort requirements may be determined. Individual occupancy schedules may be implemented for each of the zone. In some cases, low cost control upgrades including new zone air dampers and additional room temperature sensors may be beneficial.

APPENDIX 3
GREEN FLEET ROADMAP

APPENDIX 3: GREEN FLEET ROADMAP

Fuel-Based & Technical Initiatives

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Light Duty Fleet (e.g, Police Patrol)	Prepare infrastructure for electric vehicles – e.g, 4 initial sites (Police, City Hall, Eng Ops, Parks) & DC Level 3; street lights.			Purchase Electric Vehicles (as availability allows)								
	BAU Propane / Gasoline Dual Fuel											
Medium Duty Fleet	Study of charging infrastructure		Provide infrastructure for electric vehicles (incl. DC Level 3; street lights)				Purchase Electric Vehicles (as availability allows)					
	BAU Propane / Gasoline Dual Fuel											
Heavy Duty Fleet (e.g, Sanitation, Fire Services)	BAU Fuel Use (Diesel)		Research use of R100 or other low carbon fuel	Implement R100 or other fuel						Prepare infrastructure for EVs	Purchase Electric Vehicles (as availability allows)	
Other Pool Vehicles / Employee Commute	Investigate enhanced pool vehicle program: including e-bikes / car share (hybrids)											
	Investigate installation of employee charging stations											

Behaviour-Based Initiatives

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Existing Staff & New Hires	Update Manual		Provide Driver Orientation (includes refresher training)									
	Implement staff idling reduction challenges											
	Install instructions on propane pump station		Look for other functions of GPS system to reduce fuel use / behaviour									

Policy-Based Initiatives

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Low Carbon Fleet Policy	Update policy to support CEERS goals & new structure around purchasing process and present to EMC / SMT		Implement updated Low Carbon Fleet Policy									
Take Home Policy		Investigate the need to separate out personal vs at work Kms	Revise Take Home Policy to align with low carbon fleet policy	Implement the revised Take Home Policy								
		Investigate leasing vehicles										

APPENDIX 4
CARBON PRICING AND MULTIPLE ACCOUNTS EVALUATION

APPENDIX 4: CARBON PRICING AND MULTIPLE ACCOUNTS EVALUATION

Category	Evaluation Criteria	Impact
Environment	GHG Reduction	The impact of the action on reducing CO_2e as compared to the existing or alternative options.
	Other Emissions	The impact of the action on reducing other harmful emissions compared to the existing or alternative options.
	Other Environmental Benefits	The impact of the action on reducing other environmental impacts compared to the existing or alternative options.
Financial Implications	Carbon Pricing	The cost of the investment is inclusive of carbon pricing and achieves effective cost-performance on this basis. There is consistent, long-term price of carbon accounted for.
	Lifecycle Costs	The costs of capital expenditure, operating expenditure (cost of fuel, gas and electricity), planned maintenance, controls and system optimization
	Simple Payback	The project payback period based on expected energy costs saved. Presented in years and months.
	Return on Investment (ROI) – GHG Reductions	The reduction in GHGs (tonnes) per dollar of investment.
	External Funding	Does the opportunity intersect with potential funding available from Fortis, BC Hydro, Metro Vancouver, Federal Government, Federation of Canadian Municipalities, etc.?
	Carbon Offsets	Does the opportunity qualify as a Carbon Offsets for payments from the Pacific Carbon Trust or other third party offsetting organizations?
Policy	Policy Alignment	Does the action fit in with existing policies, plans and strategic initiatives?
Feasibility	Work Plan Synergies	Does the action fit with existing work plans for buildings e.g. roof maintenance, vehicle replacement and planned upgrades to services?
	Risk	Does the proposed action use proven technology or is it relatively new technology with a limited track record?
	Capacity	Do we have the knowledge, skills and resources to carry out the project in-house or are external consultants and specialists required?
	Staff Resources	Can the action be included within existing work plans or are new staff / roles required to realize this opportunity?
Other	Innovation	Does this project show innovation which will be recognized. Are we able to manage the impact of operating with new technology?
	Social	Does the action have a visible positive impact on community livability?
	Leadership	Do the actions show leadership from the City to reflect well on our residents and the Lower Mainland?

APPENDIX 5
APPLICATION OF CARBON PRICE TO VEHICLE PURCHASE (EXAMPLE)

APPENDIX 5: APPLICATION OF CARBON PRICE TO VEHICLE PURCHASE (EXAMPLE)

Table A. Sedan Comparison (8 year life cycle cost) for vehicles driven 15,000 km / year

	Conventional Gasoline	Electric	Plug-in Hybrid
			
8-Year Life Cycle Cost (Net Present Value)			
Expenditures			
	Nissan Sentra	**Nissan Leaf**	**Chevy Volt**
Capital Cost (2018 est.)	**$22,361**	**$33,998**	**$35,889**
Fuel / Electricity	$10,900	$2,800	$4,000
Maintenance	$7,700	$4,700	$6,600
Resale Value	– $2,800	– $4,700	– $4,700
NPV Lifecycle Cost	$38,161	$36,798	$41,789
Per Year Lifecycle Cost	$4,770	$4,600	$5,224
Carbon Price Actuals	$4,320	$0	$576
Total	**$42,481**	**$36,798**	**$42,365**

Example: Applying a $150 / tonne Carbon Price to Vehicle Purchases.