NATIONAL CARBON - NEUTRAL PORTFOLIO PLAN

Version 1.0

PUBLIC SERVICES AND PROCUREMENT CANADA

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INTRODUCTION

Public Services and Procurement Canada (PSPC) has committed to achieve carbon neutrality across its Crown-owned real property portfolio by 2050.

To assist in achieving this goal, PSPC has retained a consultant, WSP, to help develop a plan outlining a path towards achieving carbon neutrality and the feasibility of achieving a National Carbon Neutral Portfolio earlier than 2050, by 2030. The purpose of this report is to inform next steps in PSPC's overall sustainability strategy and specifically its strategy for implementing actions with the goal of portfolio carbon neutrality.

This document represents an initial Plan. Further steps must be completed before the Plan can be implemented. While some Plan elements are already underway, others are beginning to be explored. The Plan can continue to evolve as further steps are taken towards implementing carbon neutrality.

The following report has been structured into 3 parts:

PART 1 – PROPOSED PSPC NATIONAL CARBON NEUTRAL PORTFOLIO PLAN

This part outlines the plan developed to date and includes:

1. Waterfall diagram that graphically illustrates the plan elements and the anticipated carbon reduction for each element on the path to carbon neutrality.
2. An introduction to the individual plan elements being proposed with a description of the initiative; recommendations for implementation; benefits; assumptions; applicable buildings; and order of magnitude emissions reductions and incremental costs.
3. A breakdown of the Plan by Region identifying the unique traits and plan elements for each Region. This includes characteristics, grid intensity data and initiatives by province for each Region.

PART 2 – PLAN DEVELOPMENT

This part outlines the process followed in developing the plan and includes:

1. Background Information
2. Regional Context
3. Plan development process

PART 3 – NEXT STEPS

This part outlines the next steps:

1. Feasibility of achieving carbon neutrality by 2030
2. Next steps in advancing the plan.

This report also include a number of appendices containing detailed supporting documentation.

PART 1 – PROPOSED PSPC NATIONAL CARBON NEUTRAL PORTFOLIO PLAN

The PSPC National Carbon Neutral Portfolio Plan identifies initiatives, referred to as elements within the plan, that PSPC can use to achieve the goal of carbon neutrality across its portfolio of owned buildings and provides high-level evaluations of associated energy savings, greenhouse gas (GHG) emissions reductions, and incremental capital and operational costs.

For the intent of this plan, *PSPC defines carbon neutrality as the efficient operation of its buildings and portfolio to conserve energy and reduce GHG emissions internally, complemented with fuel switching and installation of renewable energy generation to further reduce the GHG impact of its operations. Any remaining carbon-emitting energy consumption will be neutralized through procurement of renewable electricity, renewable electricity certificates (RECs), or carbon offset credits.*

PSPC's national portfolio of owned real estate assets includes 286 facilities as well as other assets such as bridges, dams and properties. Between 2005 and 2015/2016 fiscal year, PSPC's national portfolio emissions reduced from 273,000 tonnes to approximately 181,500 tonnes of carbon dioxide equivalent emissions (tCO_2e). The 2015/2016 fiscal year represents the starting point on our path to carbon neutrality. PSPC's leased facilities are outside of the scope of this Plan, and so are not considered in reduction opportunities (see section 4.3 for details).

This part of the report outlines the suggested path to zero carbon and does not take costs, budget limitations or execution timelines into consideration. These constraints will be factored into the equations later in the report when discussing the feasibility of achieving carbon neutrality by 2030.

Key statistics on the path to carbon neutral:

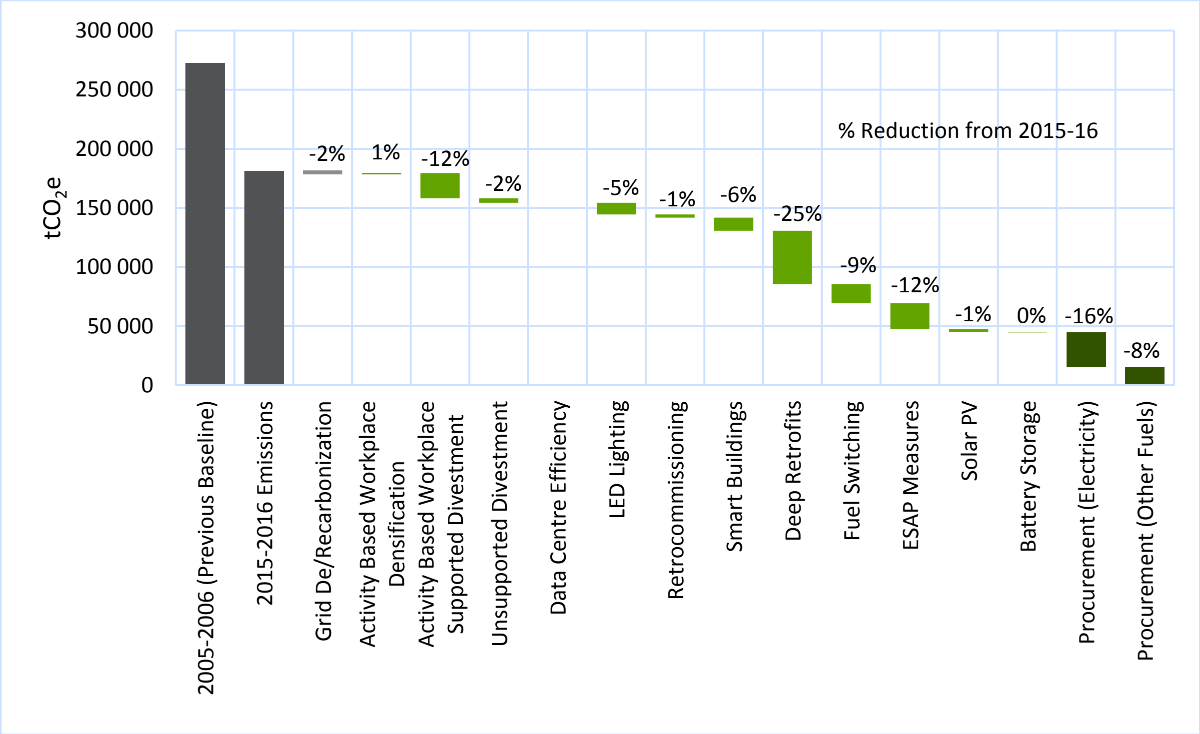
- A total of 1,332 projects implemented across 286 properties
- Upon completion, a total of 133,500 tCO_2e will be avoided each year
- A portfolio-wide incremental capital investment of $3 billion, reflecting the additional investment required beyond that necessary to carry out PSPC's already planned property upkeep and renewal.
- A portfolio-wide incremental 25-year lifecycle cost of $1.2 billion, considering upfront investments as well as ongoing costs avoided due to improved system operation and reduced energy costs.
- An estimated $1.1 billion in avoided carbon costs, assuming escalation from $10/$tCO_2e$ in 2017 to $400/$tCO_2e$ by 2050[1]
- An average incremental lifecycle cost per tonne of $353/ tCO_2e

1 $10/$tCO_2e$ is based on an average of requirements currently in place across the provinces. $400/$tCO_2e$ is based on the predicted requirement for pricing as outlined in the recent Science article: "A Roadmap for Rapid Decarbonization" available at http://science.sciencemag.org/content/sci/355/6331/1269.full.pdf

1 THE NATIONAL CARBON NEUTRAL PORTFOLIO PLAN

The following waterfall chart depicts the individual plan elements and their associated carbon reduction (or in a few cases increase). At this stage, individual plan elements have not been prioritized and have simply order (left to right) following the PSPC stated approach of 1) internal efficiency efforts; 2) renewables; and 3) procurement. Emissions incrementally decrease (or increase) from left to right, starting at the baseline for fiscal 2015/2016 towards zero at the extreme right.

Figure 1: National Carbon Neutral Portfolio Plan



The following table summarizes the number of projects and other key statistics per plan element (prior to procurement), including:

Incremental Capital Costs: The upfront cost to implement a given measure, including only costs not already budgeted.

Annual Operations and Maintenance (O&M) Cost Change: The difference in operations and maintenance costs each year as a result of implementing an element. Some elements increase O&M

costs by introducing equipment or processes that require additional maintenance and oversight, while other elements decrease O&M costs by reducing these requirements.

Life Cycle Cost (LCC): The total net cost over a 25-year period considering incremental capital costs as well as annual O&M cost increases or decreases, adjusted to net present value.

Average LCC per GHG Emissions Reduction: The average lifecycle cost to reduce one tonne of GHG emissions.

Table 1: National Carbon Neutral Portfolio Plan Summary

Plan Element	Number of Assets Affected	Anticipated GHG Reduction (tCO_2e)	Incremental Capital Costs ($ million)	Annual O&M Cost Change ($ million)	Life Cycle Cost ($ million)	Average 25-Year LCC per GHG Emissions Reduction ($/$tCO_2e$)
Grid De/Re-Carbonization	285	2,977	$0	$0	$0	$0
Activity-Based Workplaces (Densification)	197	1,082 (increase)	$251	$4.8	$416	-$398 (including divestment)
Asset Divestment	61	25,233	$0	-$19	-$656	Included above
Data Centre Consolidation	0	N/A	N/A	N/A	N/A	N/A
LED Lighting	224	9,885	$11	-$14	-$429	-$1,734
ReCx, Audit, No and Low-Cost ECM Implementation	75	2,695	$4.8	-$2.1	-$40	-$589
Smart Buildings	80	11,085	$3.8	-$8.8	-$172	-$619
Deep Energy/ GHG Retrofit	127	45,123	10% over base cost	-$31	-$66	-$58
Fuel Switching	56	16,083	$145	$6.3	$399	$993
ESAP Efficiency and Smart Plants	55	7,477	$0	-$2.9	-$99	-$530
Connect to ESAP	7	1,287	$35	$0.7	$59	$1,832
ESAP Uses Quebec Electricity	62	1,385	$464	-$0.4	$449	$12,956

Plan Element	Number of Assets Affected	Anticipated GHG Reduction (tCO_2e)	Incremental Capital Costs ($ million)	Annual O&M Cost Change ($ million)	Life Cycle Cost ($ million)	Average 25-Year LCC per GHG Emissions Reduction ($/$tCO_2e$)
ESAP Biomass/Waste to Energy	62	11,836	$1,043	$7.8	$1,309	$4,422
Solar PV	13	2,222	$16	-$0.6	-$2.7	-$48
Battery Storage	28	628	$41	-$4.4	$9.0	$574
TOTAL		**136,835**	**$3,000**	**-$64**	**$1,200**	**$344**

Note: Totals may appear different from the sum of preceding rows, due to rounding of those values. The total average 25-year LCC per GHG emissions reduction is the sum of total lifecycle costs divided by the sum of total anticipated GHG reduction over 25 years, rather than the sum or the average of values for each plan element.

See section 2.13 for information on procurement to address remaining emissions once emissions are reduced as much as possible through the above elements.

2 PLAN ELEMENTS

The following elements have been identified for inclusion in PSPC's National Carbon Neutral Portfolio Plan:

1. Grid Decarbonisation/Re-carbonization (external influence)
2. Workplace Densification
3. Asset Divestment
4. Data Centre Consolidation and Efficiency
5. LED Lighting Upgrades
6. Recommissioning (ReCx) Energy Investigations and Energy Conservation Measure (ECM) Implementation
7. Smart Building Technology
8. Deep Energy and GHG Retrofits
9. Fuel Switching
10. Energy Services Acquisition Program (ESAP) Plant Efficiency

11. Connecting to ESAP Plants
12. Relocating ESAP Cooling & Pre-Heating to Quebec
13. Converting ESAP to Biomass or Waste to Energy Generation
14. On-Site Solar Photo-Voltaic (PV) Generation
15. On-Site Battery Storage

It should be noted that not every element is applicable at every building or in every region of the portfolio. Some sites may have opportunities to implement additional GHG reduction measures not explored in detail in this Plan. The intention of this Plan is to outline a broadly-applicable, portfolio-wide reduction strategy. Specific implementation details, including site-level strategies, will be developed at a later stage.

The Plan elements are based on best practices and available technologies at the time this Plan was created. Future technologies and strategies not yet identified may offer significant carbon savings and ability to achieve carbon neutrality. The Plan may be augmented in the future as new technologies emerge and are found to be suitable additions to the Plan's goals.

PSPC would benefit from working with partners to test new technology as part of pilot programs, demonstrating leadership while helping PSPC quickly adopt valuable technologies. The Project GHG Options Analysis Methodology approved in 2017 is one tool that will enable PSPC to evaluate benefits of new technologies that emerge over time, by considering carbon benefits in addition to capital costs.

Plan elements with high-level costs and savings assumptions are described below. See Appendix C for more detailed descriptions of assumptions, and references.

The Plan analysis has been set up to avoid double-counting of potential savings. For example, individual sites should not achieve savings from both energy investigations and deep energy/GHG retrofits, as there will be overlap between these activities over the course of the Plan lifetime. Similarly, deep retrofit savings are scaled to remove the savings associated with LED retrofits, as those are already analyzed separately.

The analysis has been completed in a step-wise manner, applying elements in their listed order. Elements are ordered to align with PSPC's objective to achieve efficiency internally first prior to investing in external elements. Later elements may have less incremental impact, as they tend to achieve savings on buildings which have already reduced energy consumption from earlier activities.

2.1 GRID DECARBONIZATION/RECARBONIZATION (EXTERNAL INFLUENCE)

While this plan focuses on activities undertaken by PSPC to improve portfolio efficiency and reduce GHG emissions, PSPC must also consider the external influence of changes to the electricity grids that supply the assets. For example, between 2005 and 2013, provincial electricity emissions factors (the amount of GHG emitted per kilowatt hour of electricity consumed) decreased regionally by between 1% and 92%, resulting in a 20% emissions decrease across PSPC's portfolio during that time.

Between 2013 and 2030, grid intensity is projected to decease further in most provinces and territories, due to the addition of more renewable power and cleaner power generators supplying electric grids. However, grid emissions intensity is projected to increase in Quebec and British Columbia where growth in fossil fuel generation is planned to outpace growth in renewable energy generation[2], and in Ontario where fossil-fuel generators are planned to support the grid while nuclear power plants are taken off line for refurbishment.[3] A comparison of 2013 actual grid GHG intensity and 2030 projected intensity is shown below.

Table 2: 2005, 2013 and Anticipated 2030 Electricity Emissions Factors by Province/Territory[4]

gCO_2e/kWh	2005	2013	2030	2013-2030 Change	% Contribution to Portfolio Electricity Emissions in 2015-16
AB	900	820	600	-27%	7%
BC	24	8.2	11	**37%**	**<1%**
MN	9.1	3.4	0	-95%	<1%
NB	400	420	280	-33%	14%
NL	21	20	9	-54%	1%
NS	870	700	546	-22%	13%
NT	460	330	267	-19%	1%
NU	460	330	230	-30%	<1%
ON	220	96	129	**34%**	**55%**
PE	100	22	9	-61%	<1%
QC	3.7	2.9	5	**65%**	**1%**
SA	780	750	503	-33%	5%
YT	67	40	0	-100%	<1%

2 National Energy Board, 2016, Canada's Energy Future 2016: Energy Supply and Demand Projections to 2040, https://apps.neb-one.gc.ca/ftrppndc4/dflt.aspx?GoCTemplateCulture=en-CA

3 Government of Ontario, 2013, Achieving Balance: Ontario's Long-Term Energy Plan, http://www.energy.gov.on.ca/en/files/2014/10/LTEP_2013_English_WEB.pdf

4 2005 Emissions Factors: Environment Canada, 2013, Canada's National Inventory Report 1990-2011: Greenhouse gas sources and sinks in Canada, Part 3; 2013 Emissions Factors: Environment Canada, 2014, Canada's National Inventory Report, Part 3 (2012 emissions factors used); anticipated 2030 emissions factors calculated from 2013 factors and change in grid mix from: National Energy Board, 2016, Canada's Energy Future 2016: Energy Supply and Demand Projections to 2040, https://apps.neb-one.gc.ca/ftrppndc/, Reference Case

Figure 2: 2005, 2013 and Anticipated Grid Intensity by Province/Territory (MN, YT, QC, PE, NL, BC)

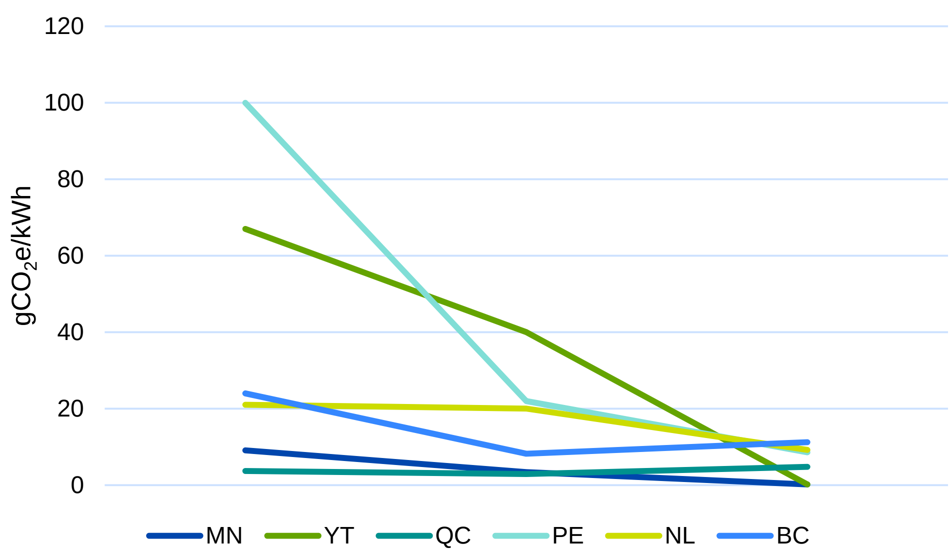
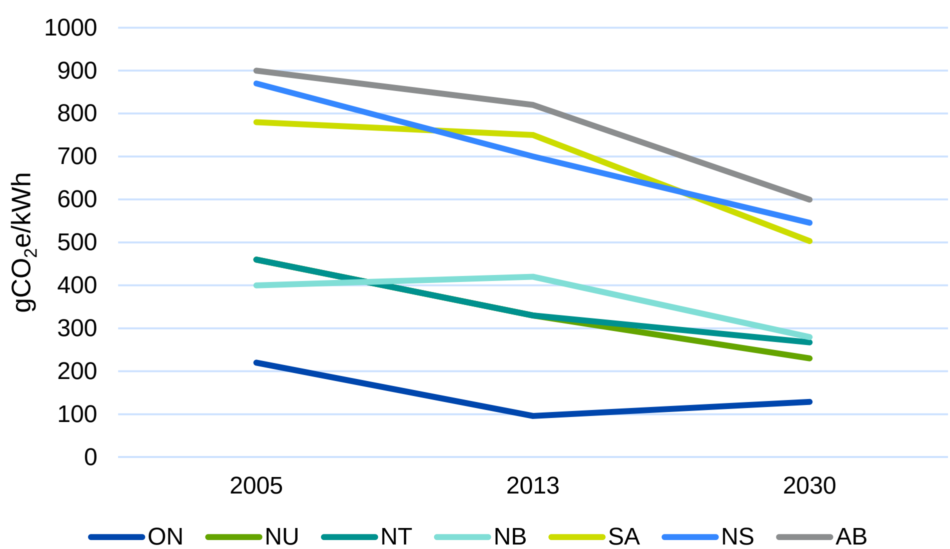


Figure 3: 2005, 2013 and Anticipated Grid Intensity by Province/Territory (ON, NU, NT, NB, SA, NS, AB)



As a result of anticipated grid intensity changes by 2030, all else being equal, PSPC emissions could increase by approximately 5,000 tCO_2e per year, with the majority of this increase occurring in Ontario.

There would be no direct cost to PSPC for this external influence on the portfolio. However, there is an indirect cost in the form of annual utility rates. The magnitude of this cost is poorly understood, because it cannot be easily isolated from other rate effects. For example, in Ontario, electricity rates have doubled in the past 10 year. This cost increase has been attributed to a combination of nuclear refurbishment, transmission grid improvement, financing charges, and green power installation. Various sources suggest between 10% and 20% of current day billed costs were attributed to wind, solar and biofuel generation. These sources have not identified the cost of avoided non-renewable generation that would have been required if renewable power had not been installed.

Grid decarbonisation/recarbonization poses a potentially significant risk as PSPC has no control over this element and actual grid intensities could differ from current projections for better or worse. Projections of grid carbon changes should be monitored regularly and factored into the on-going plan. While PSPC may not have any influence over grid changes, it can encourage the Government of Canada to advocate and support provincial efforts to decarbonize their grids.

2.2 ACTIVITY-BASED WORKPLACE DENSIFICATION & PROPORTIONAL DIVESTMENT

PSPC has focused on modernizing its workplaces by converting assets to Activity-Based Workplaces (ABW). ABW are an evolution of Workplace 2.0, which was focused on providing flexible space that can be used by multiple occupants at different intervals, adaptive collaboration spaces and support remote working. Key carbon-related benefits of Workplace 2.0 included:

- Less office area and more meeting space allowing for more total area to be turned off by occupancy sensors and other occupant-based controls
- Laptops used for computing, which provides a significant (20-40%) reduction in desk-level power consumption vs. desktop computing (even with increased monitor counts)[5].
- Lower lighting density in open office environments, especially if appropriate task lighting provided as part of a holistic fit-up & tenant education approach.[6]

One focus of ABW is to achieve an occupant density of 0.8 work stations for every full-time equivalent occupant.

While denser workspaces consume more energy and emit more GHGs per square meter (m^2) of real-estate, they also allow a decrease in overall workspace as consolidation leads to vacated areas which can then be divested by sale, transfer or demolition. An ABW program supports this carbon neutrality plan so long as areas are vacated and divested proportionally to the densified areas. If vacated spaces are instead kept or repurposed within the PSPC portfolio, ABW will not support PSPC's carbon neutrality plan. Divestment therefore is a necessary element of the ABW program.

ABW densification is recommended for all assets that are being retained in the portfolio (identified as tier 1, 2 or 3) while proportional divestment of tier 4 assets occurs. ABW densification has not been included for PPB assets considering the unique nature and vocation of Parliamentary Precinct buildings. While ABW may be appropriate for portions of the PPB portfolio, this decision is being left to the discretion of PPB.

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5 Useful data for estimating power benefits of laptops taken from ASHRAE journal article: "Plug Load Design Factors", May 2011 and from WSP experience with direct measurement in our own offices.

6 Task lighting is client funded under Workplace 2.0. Further LPD reductions can be achieve if the client is willing to use task lighting. Given the benefits and overlap with other program measures discussed (LED lighting, Deep Retrofits) it may be prudent to include some portion of task lighting costs in PSPC budgets.

PSPC would benefit from a standardized approach to lighting retrofit applied during workplace fit-out, new building construction and deep building half-life retrofit, and is described further in the LED lighting section.

Assumptions

- Energy Use Change: 1.2% savings to densified building's heating energy use, 3.3% increase to densified building's non-heating energy (based on energy model reporting in-space savings of 2.3% heating, 6.5% cooling, and PSPC projection that usable office spaces available for densification represent about half of the portfolio).[7] 100% reduction to divested building's heating and non-heating energy use.
- GHG Emission Change: proportionate to heating savings and non-heating energy increase, considering regional grid emissions intensity and 100% reduction to divested building's GHG emissions.
- Utility Cost Change: proportionate to heating savings and non-heating energy increase at densified buildings, considering regional energy costs. 100% reduction to divested building's cost.
- Cost: $646 total cost per square meter of renovated office space ($323/m^2 of building area, since usable office spaces represent half of the portfolio) including necessary activities (e.g. equipment renewal) which must necessarily be budgeted and completed, separately from this Plan ($108 incremental cost of this Plan above business-as-usual activity per square meter of renovated office space, or $54/m^2 of building area, where usable office spaces represent half of the portfolio)
- Heritage adjustment: 25% cost increase, 0% savings increase
- Maintenance Cost Change: $0.54/m^2 increase
- Longevity of investment: 25 year life

Applicable PSPC Buildings

- ABW retrofit at all Tier 1,2,3 PSPC properties
- Associated divestment of Tier 4 properties totaling an equal floor area vacated as occupants are absorbed into ABW densification of nearby spaces.

It is anticipated that ABW densification in this way will increase portfolio emissions by 1,300 tCO_2e per year, while proportional divestment of identified Tier 4 properties will decrease portfolio emissions by 22,500 tCO_2e per year. The net impact of ABW densification and proportional divestment therefore is a decrease in portfolio emissions of 21,200 tCO_2e per year. If densification is more successful than expected, additional divestment could be considered for further portfolio emissions reductions.

Implementing ABW and proportional divestment would have an order of magnitude incremental capital cost to PSPC of $251 million across the portfolio (lifecycle benefit of $241 million over 25 years, including unsupported divestment). The lifecycle analysis shows a benefit regardless of a building's heritage status.

Other considerations for this measure include occupant buy-in, occupant satisfaction and allowing for departments and program activities requiring more space than targeted. The program would need to successfully accommodate periodic changes to space use which are typical due to government cycles and changes

7 Public Works and Government Services Canada, 2013, Workplace 2.0 Impact Study on Green House Gas Emissions

Capital financing from divestment was estimated at $1,615/m^2$. While this could present a method of financing other elements of this plan, this has not been factored into the Plan presented. Lifecycle costs and benefits are based purely on the avoided operational cost of buildings that have been divested (but do not consider their sale value).

Smart Buildings

PSPC plans to implement Smart Buildings technology (see section 2.7). In addition to monitoring and managing energy use, Smart Buildings technology will be used to monitor building occupancy and utilization, helping ensure the success of ABW in achieving densification and occupant accommodation goals.

PSPC would need to:

- Engage Workplace Solutions Group to understand space utilization opportunity
- Track space utilization
- Regularly review the cost-benefit of this program
- Identify assets to divest/vacate, and carrying out this divestment at a comparable speed to that of densification/utilization

As of March 2017, PSPC has issued a Request for Standing Offer (RFSO) to retail Smart Building services to track space utilization.

2.3 UNSUPPORTED DIVESTMENT

PSPC has identified a number of assets for divestment or transfer to other departments in the near term. By divesting of space, PSPC will reduce its overall GHG emissions footprint, reducing the amount of emissions that must be reduced or neutralized through other means. While divested properties are removed from the GHG inventory baseline and cannot be used to effectively show a percentage reduction in emissions over time, divestment supports the carbon neutral goal of achieving absolute emissions reductions.

While ABW densification is expected to accommodate occupants displaced by most of this divestment, an estimated 75,000 m^2 of additional assets are identified for possible divestment which is unsupported by ABW.

Removing additional buildings from PSPC's portfolio will yield an emissions reduction of 4,000 tCO_2e from PSPC's baseline. Occupants from these divested assets will still require workspaces following divestment. The need for accommodation may cause new building construction, purchasing of another asset, or leasing space, all of which have associated carbon emissions that would balance out the reduction from divestment. As such, it is not appropriate to plan for any carbon emissions reductions to be achieved from unsupported divestment in PSPC's carbon neutrality plan.

PSPC must also consider the impact of selling an asset which has a high carbon footprint, as the new owner will be burdened with a responsibility that PSPC, by divesting, is choosing not to bear. In keeping with the Mandate Letter to the Minister, PSPC could be considering repurposing assets intended for divestment for community housing or other social/community projects. As such, PSPC may decide that, as a first step to any property sale or transfer, the building should be brought up to an achievable and reasonable level of carbon emissions performance. This has the added benefit of increasing building valuation and sale price in some cases.

Applicable PSPC Buildings

- Properties listed as “Tier 4” for sale or demolition, which will require new development, construction, or leased space for displaced occupants (for which occupants cannot be absorbed by ABW densification)

2.4 DATA CENTRE CONSOLIDATION AND RELOCATION

Data Centres are one of the most significant new consumers of electricity in recent years, using 10 to 100 times more energy per square meter than a typical office space. Even data centres that occupy a small footprint within an office building (for example, the size of two or three conference rooms together) can be responsible for a large portion of the building’s energy use. Smaller data centres tend to be more inefficient than larger ones, with less access to efficient heating, ventilation and air conditioning (HVAC) and optimized system layout strategies.

Data centres can easily be located off-site, even in another region from where they serve, while still delivering expected performance.

An opportunity exists to consolidate small and large data centres in PSPC’s portfolio, implement high-efficiency data centre strategies, and relocate them to a region with an electric grid which has a low carbon intensity (as well as lower cost of electricity), like Quebec.

Data centre energy efficiency strategies include:

- Server consolidation, clustering, downsizing, virtualization
- Specifying Energy Star certified new equipment
- Optimizing temperature and humidity setpoints according to Data Centre industry standards
- Occupancy-controlled lighting
- Hot/cold deck configuration with air pathway sealing
- Ultrasonic humidification
- Variable speed demand-based air circulation
- Free cooling, heat recovery, and cooling systems designed for low-differential operating temperatures

PG&E’s Data Centre Best Practices Guide presents a good overview of these opportunities, and suggests savings opportunities in the range of 30% to 50%.

According to PSPC, Government of Canada’s data centre assets are generally separate from PSPC’s portfolio. PSPC must confirm the party responsible for data centre operations and associated emissions before committing to carbon conservation activities within them. For this reason, costs and savings from data centre efficiency, consolidation and relocation have not yet been reflected in this Plan.

Our analysis noted some data centres exist in PSPC’s portfolio asset list:

- One Data Centre flagged by PSPC (350 King Edward Ave., NCR)
- One property labelled as “DND Data Ctr. Ottawa Building” in the PSPC portfolio data, which has a very high energy intensity (kWh/m^2) and is therefore very likely to contain a large data centre;

- Forty buildings across the portfolio which are heated by non-electric fuels, yet have a non-heating EUI higher than 215 kWh/m^2, at least some of which are suspected to contain a data centre;

If these data centres are found to be the responsibility of PSPC, a significant opportunity exists. Otherwise, the responsibility for their carbon emissions (and costs) should be transferred to the appropriate party and removed from PSPC's carbon accounting portfolio. That party should be made aware of this opportunity.

Assumptions

- Energy Use Change: 50% savings to data centre portion of building non-heating energy use
- GHG Emission Change: proportionate to non-heating energy savings, plus impact of migrating to Quebec grid
- Utility Cost Change: proportionate to non-heating energy savings, plus impact of migrating to Quebec grid
- Cost: $10,000/$m^2$ of data centre space (all cost is incremental above business-as-usual activity)
- Heritage adjustment: no impact
- Maintenance Cost Change: none
- Longevity of investment: 50 year life (once moved, no further investment beyond business-as-usual activity is expected)

Applicable PSPC Buildings

- All Tier 1,2,3 properties which contain data centre and high-intensity computer service areas (savings have not yet been projected in this Plan)

We estimate that each of the two identified data centres located in Ottawa are responsible for an estimated 75% of each building's total electricity use. Consolidation and relocation of these two data centres alone could yield emissions reductions of 2,400 tCO_2e, reducing the entire PSPC portfolio's footprint by 1%, which is as impactful as removing three entire buildings from the portfolio's footprint. This would have an order of magnitude incremental capital cost to PSPC of $25 million across the portfolio (lifecycle benefit of $39 million over 25 years due to Quebec's low electricity rates). These values are shown here for illustrative purpose and are not yet incorporated into this Plan for the reasons described above.

If other data centre or computer room spaces also remain in the PSPC portfolio, consolidation and relocation could be even more impactful across the portfolio. While we anticipate that some of these data centre belong to other Departments and are not within the purview of PSPC, the GHG impact and benefits of relocation should be discussed with the client Departments in the overall interest of the Government of Canada.

2.5 LED LIGHTING UPGRADES

LED lighting offers attractive energy savings and GHG emissions reductions with a short-term payback, while also improving the quality of the space. PSPC has begun undertaking a portfolio-wide initiative to retrofit all building lighting to LED lighting over the next 5 years.

The scope of a lighting upgrade can include some or all lights in a building. The costs and savings projected in this plan reflect a full building lamp retrofit (e.g. including lighting for office space, corridors, elevator and entry lobbies, washrooms, exterior and interior parking, and accent lighting).

The scope of a lighting upgrade may involve simple bulb and possibly ballast replacement (lowest cost), or may include full fixture replacement including occupancy control, daylight control, and even addressable fixture dimming with light level calibration. Each of these elements increases cost, but also further decreases energy used by the new system. The costs and savings projected in this plan reflect simple LED bulb replacement (including ballast retrofit where required).

PSPC would benefit from a standardized portfolio-wide approach to lighting retrofit, and which design elements to incorporate. This is most appropriately applied during workplace fit-out, new building construction and deep building half-life retrofit, and is considered in those measures instead of as part of the LED retrofit program.

The portfolio-wide LED strategy must specifically consider heritage buildings which represent a significant portion of the portfolio. Many lights in these buildings will not be subject to heritage designation limitations. Heritage lighting fixtures may require particular consideration. The rapidly evolving LED lighting industry now offers LED retrofit bulbs that are virtually indistinguishable from incandescent bulbs, fitting a variety of sockets. While some heritage lighting may have no appropriate retrofit product available, it is likely that most fixtures can be accommodated.

A standard performance specification or guideline should address lighting fixtures, bulb retrofits, and lighting control, advise design teams on preferred or required scope elements (e.g. digital addressable LED lighting with daylight and occupancy control for full-fixture retrofits).

Lowering illuminance levels can also contribute to significant savings. Illuminance levels in federal government office spaces are mandated by the Canada Labor Act (and by association, Canada Occupational Health and Safety Regulations). These are based on outdated requirements of average 500 lux based on pre-computer, paper based work environments. PSPC‘s draft Technical Reference for Office Building Design proposes a minimum average Illumination of 425 lux for general office space, and providing task lighting where higher illumination is required.

However, while some occupants may prefer higher (or lower) light levels at their workspace via task lighting, in today’s modern computer based workplace an average office-wide illumination of 425 lux is excessive. Industry accepted lighting standards recommend general illuminance levels in the range of 250-300 lux, with task lighting used to satisfy higher workspace illumination requirements. Updates to the Canada Labor Act, COHSR, Workplace 2.0 standards and PSPC’s Technical Reference would be highly recommended.

Over-illumination can lead to glare issues, employee discomfort, and health and productivity issues. For example, several studies have attributed over-illumination as the cause or contributor to migraines, headaches, fatigue, stress and anxiety (*Cambridge Handbook of Psychology, Health and Medicine, 1997; Managing your Migraine, Humana Press, New Jersey, 1994*).

Assumptions

- Energy Use Change: 14% savings to building’s non-heating energy
- GHG Emission Change: proportionate to non-heating energy savings, considering regional grid emissions intensity
- Utility Cost Change: proportionate to non-heating energy savings, considering regional energy costs
- Cost: $22/m^2 (incremental capital cost $2.15)
- Heritage adjustment: 25% cost increase, no change to savings

- Maintenance Cost Change: $0.22/m^2/year savings from avoided relamping activities
- Longevity of investment: 10 year life (average of fixtures, bulbs/drivers, and control devices)

Applicable PSPC Buildings

- All Tier 1,2,3 properties and all PPB properties

Upgrading all portfolio buildings to LED lighting is anticipated to yield emissions reductions of 10,800 tCO_2e each year once complete.

This would have an order of magnitude incremental capital cost to PSPC of $11 million across the portfolio (lifecycle benefit of $429 million over 25 years). The lifecycle analysis shows a benefit regardless of a building's heritage status.

There is relatively low risk to this activity, as reliable and cost effective LED technology has become widely established in recent years.

2.6 DEDICATED ENERGY INVESTIGATIONS AND CONSERVATION MEASURE IMPLEMENTATION

A program of re-commissioning and energy audit investigations will help identify energy saving opportunities in properties that are not scheduled for upcoming deep retrofit. The Smart Buildings program will act as a form of ongoing commissioning undertaken on a recurring basis to ensure that energy reduction persists over time.

Energy Audits will take place at buildings which are smaller and have limited automated controls in place (though the audit may recommend installation of automated controls to improve efficiency, which would then benefit from continuous commissioning).

Re-commissioning will take place at buildings which are larger or have automated controls in place, and which are not scheduled for the Smart Buildings program.

Energy Audits

An Energy Audit identifies equipment and systems which can be retrofitted or replaced to reduce energy use, cost, and carbon emissions. The process begins with an investigation of existing system design and current condition. Recommendations typically involve capital renewal of equipment, and are best suited to aging infrastructure. The resulting recommendations are then implemented.

The achievable energy savings, cost, and payback depend on existing system efficiency, and readiness to invest capital costs in conservation.

Re-commissioning

How a building is controlled, operated and maintained has a big impact on how much energy it uses. Even buildings with energy efficient systems fall out-of-tune as buildings age and adjustments are made without fully considering energy impact. Optimizing the performance and operation of a building's system is known as re-commissioning (ReCx).

Re-commissioning begins with an in-depth investigation of existing system design, controls and as-operated performance. The resulting optimization recommendations (typically related to control adjustments, maintenance, and minor equipment retrofits) are then implemented. After initial optimization, if systems are not optimally maintained, then performance will again begin to drift.

A multi-year Lawrence Berkeley National Labs (LBNL) survey of re-commissioning at 643 buildings identified over 10,000 energy-related opportunities. On existing buildings, correcting problems led to an average 16% energy savings with an average payback of 13 months.

A similar LBNL survey reported similar results for an existing building sample with a median construction date of 1978. Natural Resources Canada's ecoENERGY Efficiency for Buildings primer (2012) highlights a ReCx effort at a 1965 era property that achieved 25% energy savings. This supports a belief that ReCx and control system improvements are effective at energy and carbon savings, regardless of building age and thus also any heritage status.

Re-commissioning is becoming more well-established in the buildings industry. ReCx activities and deliverables are expected to qualify for any available incentive funding from local electricity distribution companies. A strong ReCx report outlines existing systems and suggests improvements to both facility equipment and operations. Resulting savings, costs and simple payback are typically presented. A sound ReCx project outlines whether a measure is feasible and orients the project team towards a workable implementation strategy.

PSPC has shared their anecdotal experience that re-commissioning service providers vary notably in quality of service, and have identified that the lack of experienced high quality providers limits the ability to implement ReCx at scale across PSPC's portfolio. Improved vendor RFPs were recommended as a way to better qualify the professionals who provide this service to PSPC.

Leveraging Existing PSPC Programs

PSPC's Federal Buildings Initiative (FBI) program is intended to optimize capital investments at large (>5,000 m^2) tier 1 buildings and new or recently retrofitted PPB sites for energy investigations and conservation measure implementation. However, anecdotal reports and examples at specific properties suggest that opportunities are often identified and agreed to be feasible yet are not implemented for various reasons. Because of this, we have assumed that achievable savings remain available at PSPC's sites.

PSPC's existing re-commissioning, Energy Audit and FBI activities must be enhanced to complement and support the purpose of this National Carbon Neutral Portfolio Plan:

- Terms of Reference must include GHG goals and communicate a desire to implement GHG reduction strategies as an equal or even higher priority than energy savings. Requirement must be communicated to go beyond a typical ASHRAE energy audit standard and ensure consistency in delivery across all regions and service providers.
- Carry an asset-level budget for, and tie internal PSPC performance to, the successful implementation of no- and low-cost ECMs within a reasonable timeline (e.g. 1 year from issuance of the Audit/ReCx recommendations report)
- Continue to embed ReCx/EA outcomes in capital plans
- Continue leveraging incentive programs where available

As noted in the section above, Lawrence Berkeley National Laboratories as well as Natural Resources Canada have presented research which supports a belief that ReCx and the ensuing control system improvements (which are also the focus of the Smart Buildings program) are effective at energy and carbon savings regardless of building age and thus heritage status, where it exists.

Assumptions

- Energy Use Change: 16% savings to building's heating and non-heating energy use
- GHG Emission Change: proportionate to heating and non-heating energy savings, considering regional grid emissions intensity

- Utility Cost Change: proportionate to heating and non-heating energy savings, considering regional energy costs
- Cost: $5.38/m^2 (increased by 50% for buildings smaller than 20,000 m^2 to reflect economy of scale, or increased by 150% for buildings smaller than 5,000 m^2 which are expected to undertake Energy Audit measures which have higher capital costs than Re-commissioning measures)
- Heritage adjustment: No change to anticipated cost or savings.
- Maintenance Cost Change: $0.54/m^2 savings due to reduced maintenance as equipment operates more effectively
- Longevity of investment: 5 year cycle of audit / re-commissioning investigations and associated upgrades

Applicable PSPC Buildings

- All Tier 1, 2 properties (those not scheduled for upcoming Smart Building program implementation, deep retrofit or divestment), as well as newly constructed or retrofitted PPB sites.
- Buildings larger than 5,000 m^2 are expected to undertake ReCx; buildings between 500 and 5,000 m^2 are expected to undertake Energy Audits; buildings smaller than 500 m^2 are expected to undertake Energy Audits in groups as opposed to individually.

Energy investigations and conservation measure implementation is anticipated to yield emissions reductions of 2,800 tCO_2e each year once complete.

This would have an order of magnitude incremental capital cost to PSPC of $4.8 million across the portfolio (lifecycle benefit of $40 million over 25 years).

2.7 SMART BUILDING TECHNOLOGY

The Government of Canada and PSPC are evaluating Smart Building technologies including building energy performance analytics and off-site monitoring in order to realize operational efficiencies, reductions in GHG emissions, and energy savings.

Smart Building technology consists of the combination of software, hardware, Application Programming Interfaces (APIs), data analytics, fault detection and diagnostics, investigation and troubleshooting to monitor and manage performance, and operations and maintenance (O&M actions to resolve issues.

Dedicated Smart Buildings experts will analyze energy information on an ongoing basis; issue reports, alarms and alerts on consumption; monitor peaks; track energy projects; support continuous energy improvements and identify energy efficiency opportunities. PSPC operations and maintenance (O&M staff or contractors will then act to resolve issues that are identified.

PSPC has observed Smart Building pilot projects achieving measurable results at several facilities. While an increase in O&M effort is necessary to quickly resolve identified issues, this is coupled with an O&M decrease as equipment is operated more optimally, extending its longevity and reducing frequency of faults or failures.

A Smart Buildings program helps maintain savings achieved by implementing findings from Re-commissioning and Energy Audit investigations. It can also identify new savings opportunities and additional conservation measures over time.

Assumptions

- → Energy Use Change: 10% savings to building's heating and non-heating energy use
- → GHG Emission Change: proportionate to heating and non-heating energy savings, considering regional grid emissions intensity
- → Utility Cost Change: proportionate to heating and non-heating energy savings, considering regional energy costs
- → Cost: $1.08/m^2$ annually
- → Heritage adjustment: No change to cost or achievable savings
- → Maintenance Cost Change: $0.22/m^2$ maintenance savings
- → Longevity of investment: Costs are ongoing (annual)

Applicable PSPC Buildings

- → 80 properties identified in Smart Building Services Request for Standing Offer dated October 2016

Smart Building technology is anticipated to yield emissions reductions of 11,600 tCO_2e each year once implemented.

This would have an order of magnitude incremental capital cost to PSPC of $3.8 million across the portfolio (lifecycle benefit of $172 million over 25 years).

The Smart Building program will be a highly valuable ongoing element of PSPC's Carbon Neutral program, beyond the savings anticipated from it alone. The Smart Building program will form the backstop of ongoing monitoring, troubleshooting and reporting that will support persistence of savings over time from all activities.

2.8 DEEP ENERGY AND GHG RETROFITS

As stated in the U.S. Department of Energy's Advanced Energy Retrofit Guide:

> *"A deep retrofit project provides an opportunity for a building owner to reduce energy consumption significantly. […] Deep retrofit projects combine many O&M and standard retrofit measures in an integrated whole-building design approach. […] These projects affect multiple building systems and assemblies (e.g., envelope, lighting, and HVAC) and the retrofit of each system and assembly must be designed in close consideration of the other retrofits. […] The upfront cost of a deep retrofit may be difficult to justify on the basis of energy and maintenance cost savings alone. However, the business case is much easier to make when planned upgrades and the avoided cost of equipment and assembly replacements are taken into account."*

The Guide identifies specific events in a building lifecycle which create opportunities to perform a deep retrofit, including:

- → Roof, window and siding replacement
- → End of life major equipment replacement
- → New owner or refinancing
- → Major occupancy change

- Building greening
- Large utility incentives

PSPC's "Guideline – Project GHG Options Analysis Methodology" provides a framework to assess three levels (options) of deep energy and GHG reduction in planned major retrofits:

Table 3: Deep Energy/GHG Retrofit Options

Option	Description	May Include
1) Minimum Performance, Least Upfront Cost	Energy/GHG savings obtained from bringing building up to minimum department requirement (e.g. NECB-2011, LEED v4 EAp2) Target energy intensity of 165 kWh/m^2/yr (74 kWh/m^2 heating, 91 kWh/m^2 non-heating)	→ Measures typically addressed during re-commissioning (controls, BAS upgrade, VFDs on fans and pumps, some occupancy and daylighting controls) → Benefits of Work place 2.0 and similar standards (e.g. laptops vs. desktops, increase in meeting spaces using occupancy-based control to reduce loads, open office areas achieving comparable lighting levels with less lighting power) → DALI lighting controls and customized lighting by area → New mid-efficiency windows with lower solar gain → Rework HVAC systems for more effective distribution → New boiler systems → New chilled water equipment, some heat recovery if cost-effective
2) Net-Present Value Neutral	Energy/GHG savings obtained from additional measures that have no additional life-cycle cost over option 1; upfront capital costs will be higher Target energy intensity* of 105 kWh/m^2/yr (37 kWh/m^2 heating, 68 kWh/m^2 non-heating)	Option 1 elements, plus: → Cost-effective enclosure improvements (e.g. air-tightness, insulation from inside where appropriate, new roofing) → Better windows (e.g. double low-e coating) → Replace majority of HVAC with new low-energy schemes, but with maximum reuse of existing systems → Heat recovery on ventilation, or deeper recovery using heat-pump systems → Some on-site renewable energy should also be considered (See item 4.1 below)
3) Maximum Site Carbon Neutral	Energy/GHG savings obtained from all feasible on-site measures to reduce GHG emissions Target energy intensity* of 75 kWh/m^2/yr (15 kWh/m^2 heating, 45 kWh/m^2 non-heating)	Option 1 and 2 elements, plus: → Best-in-class for all enclosure improvements, including reskinning where feasible → Innovative enclosure options, including electro/thermo-chromic glass to reduce cooling loads → Innovative low-fan-power HVAC delivery options (e.g. radiant systems) with dedicated outdoor air → Using heat-pumps to share heating / cooling loads throughout the building → Geo-exchange, possibly with solar hot water to balance heating & cooling loads

Option	Description	May Include
		→ As much on-site renewable energy as is economically feasible and respecting desire to target renewable purchase in carbon-intensive grids (see item 4.1 below)

* - energy use intensities exclude on-site renewables

As part of the feasibility study guidance for Deep Retrofit projects developed by PSPC, the study team is also to recommend a possible hybrid approach that combines individual energy conservation measures into a recommended package which offers best value to the crown. This option may, for example, fall somewhere between Option 2 and Option 3 by maximize the life-cycle-cost per ton, instead of matching the life cycle cost of Option 1. This recommended approach is referred to in the guiding document as *Option 4*.

Many properties connected to ESAP will undergo deep retrofit, and these properties can benefit from the efficiency improvements currently underway at ESAP plants. At these properties, collaboration with ESAP will be critical to achieving the energy, cost, and carbon savings reflected in this Plan.

Assumptions

- Energy Use Change: Building energy intensity reduced to the values shown in the above table (15-74 kWh/m^2 heating, 45-91 kWh/m^2 non-heating).
- GHG Emission Change: proportionate to heating and non-heating energy reduction, considering regional grid emissions intensity
- Utility Cost Change: proportionate to heating and non-heating energy reduction, considering regional grid emissions intensity
- Cost: 10% incremental cost per m^2 above business-as-usual retrofit of building at a time of natural mid-life renewal
- Heritage adjustment: 25% cost increase, 10% savings decrease
- Maintenance Cost Change: none
- Longevity of investment: 40 year life

Applicable PSPC Buildings

- All Tier 3 and 2 properties (that is - those scheduled for upcoming deep retrofit) and PPB sites scheduled for deep retrofits

Deep retrofits are applicable first to tier 3 buildings that have been identified for a major retrofit in the next 5 years, as well as high profile or flagship buildings, and other significant GHG emitters. Subsequently, it is applicable to tier 2 buildings that are scheduled to undergo a deep retrofit in the future. Tier 4 buildings that are identified for divestment may instead be identified for rehabilitation or retention; however, the current analysis treats all tier 4 buildings as being divested.

Option 2 is designed to have close to the same incremental life-cycle cost as option 1, while maximizing achievable carbon reductions through higher up-front capital investment.

Therefore, the plan analysis assumes all such buildings will undergo at least a level 2 deep retrofit, to align with PSPC's emphasis on incremental life-cycle cost as a key metric informing investment in GHG reduction activities.

Exceptions to this rule will occur. For example, 25-55 St Clair Ave E in the Ontario Region has recently decided to pursue an “Option 3 – Maximum Site Carbon Neutral” deep retrofit. The estimated savings from the feasibility study of this project show a potential 85% reduction in emission without PV and 89% including PV. This reduction (approximately 800 tCO_2e/year) is equivalent to 7% of all Ontario Region emissions from 2015/2016, demonstrating that a small number of significant deep retrofit projects can have a huge impact on overall emissions reductions.

Overall, Deep Energy / GHG Retrofit is anticipated to save approximately 47,000 tCO_2e per year.

This effort would have an order of magnitude incremental capital cost to PSPC of 10% above base deep retrofit costs across the portfolio, but a lifecycle benefit of $66 million over 25 years due to the near life-cycle neutral nature of the retrofit program.

Since heritage assets represent 40% of PSPC’s portfolio (19% “recognized” assets and 21% “classified” assets), deep retrofits in these assets are critical to achieving the Carbon Neutral goal. While specific heritage features (insulation, windows, light fixtures, security vs natural ventilation) can provide an extra challenge during a deep retrofit activity, the high energy use of some heritage assets can in fact make them ideally suited for deep retrofit. In addition, it should be noted that the architecture of many Heritage buildings have inherent sustainability features – lower window-to-wall ratios, shading of windows, thermal mass – less prevalent in today’s modern buildings providing opportunities that other assets may not have. Conserving these character-defining elements supports both heritage values and sustainability values.

Since heritage buildings are aligned with Canadian identity, they also represent a clear and visible demonstration of government action. Deep retrofits at heritage assets send a message to Canadians, tourists, visitors and global partners that Canada is committed to sustainability.

2.9 FUEL SWITCHING

Facilities consume energy in many forms. Most facilities consume multiple fuels such as electricity, natural gas, or district heating/cooling. Fossil fuels such as natural gas emit GHGs as they are consumed. Other fuels such as electricity and district heating/cooling can be generated from multiple sources.

In provinces with low-carbon electricity grids (where hydro, nuclear, solar and wind power are common), facilities can reduce carbon emissions by converting an existing facility’s HVAC systems to efficiently consume electricity (either principally, or altogether) rather than natural gas or other carbon-intensive fuels.

Fuel switching can involve the replacement of gas-fired heating furnaces, boilers, and distributed equipment with high-efficiency electric heat pump alternatives, predominantly ground-sourced heat pumps, air-sourced heat pumps, variable refrigerant flow (VRF) heat pumps, etc. Switching to non-electric low-carbon fuels, such as biomass and low-carbon district heating/cooling systems, can be similarly beneficial.

Highly efficient electric heat pump operation is effective at most times of year, but must be supplemented either with conventional electric resistance or combustion-based heating during hours of extreme cold weather. Such hybrid systems are becoming relatively common. Even when supplemented, heat pump application can achieve significant energy and carbon savings, since the majority of heating is still delivered by the high-efficiency system, not the supplemental system, even in colder climate regions. Cold climate heat pumps that do not require back-up are beginning to be developed, although they are not yet widely commercially available.

Equipment may be located centrally or distributed throughout the building in enclosed ceiling and crawl spaces and within occupied spaces. Fuel switching can be particularly complicated and costly in the latter case. Often, a space must be vacated to accomplish an effective full building fuel switching retrofit.

Assumptions

- Energy Use Change: 73% savings to building's heating energy use, and conversion from combustion fuel (gas, oil, propane) to electricity as a fuel source
- GHG Emission Change: proportionate to heating energy savings, plus savings from converting to electricity fuel source, considering regional grid emissions intensity
- Utility Cost Change: proportionate to heating energy savings, plus additional cost of (typically more expensive) electricity as new heating fuel source, considering regional energy costs
- Cost: $140/m^2 total cost including necessary activities (e.g. equipment renewal) which must necessarily be budgeted and completed, separately from this Plan ($108/m^2 incremental cost of this Plan above business-as-usual activity)
- Heritage adjustment: 25% cost increase, no change to anticipated savings
- Maintenance Cost Change: $1.08/m^2 (1% of incremental capital cost)
- Longevity of investment: 20 year life

Applicable PSPC Buildings

- All Tier 1, 2, 3 properties (that is – those not scheduled for upcoming divestment) and PPB sites which:
  - currently burn natural gas, oil, propane, or district energy as a primary heating fuel source and
  - Are in a low carbon intensity electric grid region (excludes Alberta, Nova Scotia and Saskatchewan); and
  - Are not scheduled for deep retrofit, or are only scheduled for an 'Option 1' deep retrofit, as this level of deep retrofit typically does not include fuel switching while deeper Option 2 or 3 retrofits often already include some form of fuel switching.

Fuel Switching is anticipated to yield emissions reductions of 16,000 tCO_2e each year once complete.

Fuel switching would have an order of magnitude incremental capital cost to PSPC of $145 million across the portfolio (lifecycle cost of $399 million over 25 years). The results show a lifecycle cost (not benefit) exists regardless of a building's heritage status.

Fuel switching on a mass scale will increase regional electricity use. Electricity generation and distribution infrastructure may need to be added. Government entities responsible for power generation decisions must commit to installing only low-carbon generation, if fuel switching is to result in national carbon reductions.

Despite recent advances in technology including heat pump quality and efficiency, the economics of fuel switching retrofits remain variable from region to region. The low cost of natural gas relative to electricity in some regions has historically led building owners to fuel switch from electricity to natural gas – the reverse of the carbon-saving strategy proposed herein. The financial viability of fuel switching will need to be effectively proven and widely communicated if it is to be adopted as common practice. Measures to decrease the capital costs of switching away from fossil fuels and/or raise the long term costs of using fossil fuels (such as carbon pricing[8]) may be required.

2.10 ESAP PLAN ELEMENTS

Assets located in the NCR that are currently connected or have the ability to connect to one of the six operating district energy plants can benefit from emissions reductions provided by planned modifications to this system and interconnection of all plants within the system.

ESAP improvement was one of the key components of the 2014 Greenhouse Gas Action Plan, with the system modernization actions targeting a 25% reduction in plant emissions by 2025.[9] To achieve carbon neutrality in the portfolio, actions identified in the 2014 GHG Action Plan plus several others identified by the ESAP team have been analyzed and are discussed below.

Part of the broader initiative to modernize the system is to interconnect the six plants located in the NCR, with four plants – National Research Council (NRC), National Printing Bureau, Cliff and Tunney's – already in discussion. Including all six plants will allow for proper citing of the low-emissions options discussed below as well as improving the reliability and resiliency of the system over the long-term.

Heating and cooling load reductions within buildings in the NCR will also help to reduce the cost of ESAP initiatives. For example, the cost to convert all facilities to lower temperature water (as discussed below) could be significantly reduced if individual building heating loads are first reduced, possibly allowing the existing heating coils and piping infrastructure to be retained. This will require coordination, since building load reduction (such as envelope and system upgrades) must come first to achieve cost savings.

In addition to implementing ESAP efficiency measures, emissions factors associated with ESAP energy consumption should be updated in order to inform investment priorities to improve GHG efficiency. Emissions factors for ESAP chilled water, low-temperature hot water, hot water and steam should be calculated or updated.

2.10.1 PLANT EFFICIENCY AND SMART PLANTS

The current funded plan for modernizing the ESAP plant infrastructure has two important sub-projects:

1) ***Transforming the network heating system from steam to low-temperature hot water***. This project will be procured in 2018 and involves a long-term delivery of 70°C supply of hot water and 40°C return with all buildings within the network being required to employ these temperatures by 2025. Initially, some buildings will be permitted to use 90°C, but conversions to 70°C will be ultimately required in all facilities that connect. This conversion requires updates to heat exchange equipment within facilities, as well as network distribution updates.

2) ***Converting the existing steam-driven chilling equipment to electricity***. This project is underway and involves the change-out of steam powered chillers for high-efficiency

8 A price on carbon can help send the right market signals, making the economic case for efficiency, renewables and fuel switching stronger. It can also serve to generate some of the funds necessary to successfully implement the measures described in this report required,

9 Public Works and Government Services Canada, 2014, PWGSC Greenhouse Gas Action Plan

electricity-driven chillers with appropriate refrigerants (e.g. R-410A). This project is expected to be completed by 2020.

ESAP representatives have shared their general energy and GHG savings estimates for these activities.

In addition to major renovations of equipment and piping infrastructure, ESAP is implementing a Smart Plants program which is analogous to the Smart Buildings initiative discussed above. A minimum set of building-level and plant-level metering equipment will be installed, including interval energy metering for all buildings. A common system for providing fault detection and load analysis will give operators the tools they need to maintain the most efficient plant and plan future growth/changes to the system. Plant operators will be trained to use these tools and encouraged to work together to troubleshoot problems and support planning for the entire system of plants.

PSPC's "inside out" approach prioritizes conservation and efficiency end-uses like building loads ahead of energy supply improvements, because this tends to result in the most cost-effective long-term operation of facilities. As individual buildings are retrofitted to reduce heating and cooling loads, ESAP plants will supply less heating and cooling to those buildings. In this Plan, GHG, energy and cost savings are attributed to the prioritized end-use efficiency activities (energy audits, etc.) first, and remaining savings are then attributed to ESAP supply improvements.

Assumptions

- Energy Use Change: 38% savings to building's heating energy use; no change in building's non-heating energy
- GHG Emission Change: 65% reduction in GHG emissions intensity per unit of energy
- Utility Cost Change: proportionate to heating energy savings, considering regional energy costs
- Heritage adjustment: none
- Maintenance Cost Change: -$0.27/m^2
- Longevity of investment: 40 year life

Applicable PSPC Buildings

- All properties currently connected to an ESAP Plant

ESAP plant efficiency is anticipated to yield emissions reductions of 7,000 tCO_2e each year once complete.

ESAP efficiency has no incremental capital cost to PSPC as this measure has already been accounted for at a cost of approximately $2 billion (lifecycle benefit of $97 million over 25 years).

2.10.2 CONNECTING TO PLANTS

As buildings become more energy-efficient and as distribution infrastructure is being upgraded to low temperature hot water, more buildings can be cost-effectively added to the district energy plants associated with ESAP.

Discussions with stakeholders also indicated that a broader plan to connect other PSPC and non-PSPC facilities to the district system would provide a potential revenue stream and be beneficial for other local stakeholders seeking to achieve low-carbon operations including the City of Ottawa, the developers of Zibi, the developers of LeBreton Flats and the Province of Ontario.

In the long term, as efficiency improves and additional fuel switching away from fossil fuels occurs both at the building and plant level, connection to the ESAP plant may be the most feasible (perhaps only) way for the portfolio to achieve carbon neutral *without the use of RECs and offsets*.

At current ESAP carbon efficiency, district connection is a poorer carbon reduction strategy when compared with on-site fuel switching. Connecting additional sites to ESAP is therefore only justifiable if ESAP plant efficiency improves, and may even require plant relocation or biomass conversion to become the best justifiable approach. ESAP emissions factors should be updated or calculated for chilled water, low-temperature hot water, hot water and steam (identified above as an overarching ESAP strategy) prior to connecting additional sites.

Assumptions

- Energy Use Change: no change in building's heating or non-heating energy use
- GHG Emission Change: 65% reduction in GHG emissions intensity per unit of energy consumed
- Utility Cost Change: proportionate to energy savings
- Cost: $65/m^2
- Heritage adjustment: 25% cost increase, no change to savings
- Maintenance Cost Change: -$1.08/m^2
- Longevity of investment: 40 year life

Applicable PSPC Buildings

- The following buildings in the NCR are identified as potential candidates for connecting to ESAP:
  - 111 Sussex Drive (Diefenbaker Building)
  - 350 King Edward Ave.
  - Constitution Building
  - Graham Spry Building
  - Les Terrasses de la Chaudière
  - Place du Portage I & II
  - Place du Portage III
  - Place du Portage III

Connecting to ESAP plants is anticipated to yield emissions reductions of 1,300 tCO_2e each year once complete. The results show a lifecycle cost (not benefit) exists regardless of a building's heritage status.

Connecting to ESAP plants would have an order of magnitude incremental capital cost to PSPC of $35 million across the portfolio (lifecycle cost of $59 million over 25 years).

2.10.3 RELOCATING ESAP COOLING & PRE-HEATING TO QUEBEC

By interconnecting ESAP plants throughout the NCR, PSPC can ensure a highly reliable and cost-effective thermal energy supply. Interconnection may also permit the opportunity to relocate cooling and pre-heating processes and systems to Quebec to take advantage of significantly lower electricity emissions factors and relatively lower electricity costs in that province, supplying the resulting energy to the entire ESAP system.

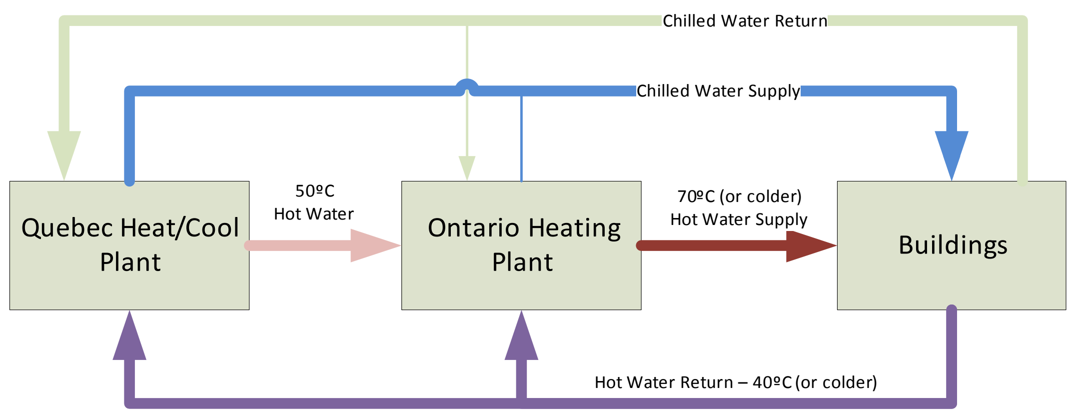
The location of new systems may be at the Printing Bureau Facility or a new facility, for example, in a renovated Place du Portage which would fall along the interconnection lines between Cliff and Printing Bureau.

Both heating and cooling emissions could be reduced by using Quebec electricity for generation. Cooling improvements would be more straight-forward, and involve the relocation of chilling plants to the Quebec side.

It may also be possible to provide lower-temperature hot water (50°C) delivered by heat-pump systems located in Quebec plants. The lower temperature water would be distributed directly to polishing boilers located in larger plants which would then deliver the higher supply water temperature (70°C). The diagram below shows how the system could operate in this mode. This approach would overlap well with delivering cooling from Quebec, since heat-recovery between chilled and hot-water sides could be maximized.

To further improve this approach, controls could be included to reduce the temperature of hot water in the summer when demand is lower, resulting in even less need for polishing energy in the Ontario plants. Maintaining the lowest-possible return water temperature would also maximize the fraction of heating that can be done by heat-pumps.

Figure 4: Quebec chilled water / pre-heating system schematic



Assumptions

- Energy Use Change: 7% reduction to plant heating energy use attributed to heat recovery from chiller plants located in Quebec; no change in building's non-heating energy
- GHG Emission Change: 95% reduction in electricity-related GHG emissions intensity per unit of electricity
- Utility Cost Change: proportionate to energy savings, considering regional energy costs
- Cost: $242/m^2
- Heritage adjustment: none

- Maintenance Cost Change: none
- Longevity of investment: 40 year life

Applicable PSPC Buildings

- All properties currently connected to an ESAP Plant and all those which would be connected in future.

Relocating ESAP cooling and pre-heating to Quebec is anticipated to yield emissions reductions of 1,400 tCO_2e each year once complete.

Relocating ESAP cooling and pre-heating would have an order of magnitude incremental capital cost to PSPC of $464 million across the portfolio (lifecycle cost of $449 million over 25 years).

There is higher risk to this activity, as the implementation of staged system heating is not common across multiple sites, and fewer precedents introduce additional risk. Other considerations include the concern of “outsourcing” energy generation across the border to take advantage of lower costs and emissions factors. Though unlikely, this approach could spur some political controversy.

2.10.4 CONVERTING TO BIOMASS OR WASTE-TO-ENERGY GENERATION

The greatest savings potential offered by ESAP consists of converting fossil fuel use to fuels that emit no net carbon. Biomass and waste-to-energy are two approaches to converting to non-fossil fuel district heat generation.

Biomass boilers, typically pelletized/chipped wood, are growing in popularity in countries with strong emissions reduction goals and significant wood production industries such as Canada. Since wood biomass is considered renewable (with some notable restrictions) and pelletized boilers can operate at similar efficiencies to traditional boilers, switching to wood biomass may be one of the most cost-effective ways to achieve a net-zero emissions plant and heating system.

Compared to wood biomass, waste-to-energy systems are more expensive and complex to implement, though their on-going feedstock costs are much lower. The benefit of overlapping the waste management system for the City of Ottawa with a biomass heating system is appealing from a broader sustainability perspective and warrants further study, especially for the longer-term goal of carbon neutrality without offsets.

ESAP has indicated that they have already conducted a study and believe that a wood biomass system would be the most cost-effective approach resulting in a doubling of the equipment installation cost vs. natural gas and a doubling of the fuel cost. The results of this study are not yet available for incorporation into this report. Cost and benefit should be refined, and further studied if necessary.

Note that biomass and waste-to-energy systems involve more complicated material handling (supply of fuel, and removal of ash) than traditional natural gas based systems. This must be considered and accommodated in evaluation of system feasibility, design and eventually in operation.

Assumptions

- Energy Use Change: no change in building’s heating or non-heating energy use
- GHG Emission Change: 100% reduction in natural-gas-related GHG emissions intensity per unit of heating energy consumed
- Utility Cost Change: 100% increase relative to non-biofuel energy

- Cost: $545/m^2$
- Heritage adjustment: none
- Maintenance Cost Change: +$1.08/m^2$
- Longevity of investment: 40 year life

Applicable PSPC Buildings

- All properties currently connected to an ESAP Plant and all future connected properties.

Converting ESAP to biomass or waste-to-energy is anticipated to yield emissions reductions of 11,800 tCO_2e each year once complete.

Biomass/waste-to-energy conversion would have an order of magnitude incremental capital cost to PSPC of $1.0 billion across the portfolio (lifecycle cost of $1.3 billion over 25 years).

There is moderate risk to a wood biomass implementation given there is no current experience with similar technology in the ESAP portfolio. The risk is higher for waste-to-energy systems given the challenges to site such plants and their interrelationship with municipal and other waste feed stocks.

Other considerations include the following:

Carbon Savings: GHG reductions associated with replacing fuel oil, propane and natural gas represent typical carbon accounting for wood biomass. This Plan assumes biomass fuel is renewable and GHG emissions reductions are based on the capacity and fuel type of the system replaced. This assumption may merit further refinement as best practices on biomass carbon accounting develop.

Fuel Quality: Frozen, wet and/or lower quality biomass requires additional energy to process or support fuels, decreasing efficiency.

Fuel Supply, Transportation and Storage: Biomass fuel requires supply chains and transportation processes that may not yet be established. Considerations include transport, reliability, road traffic, storage etc.

Waste-to-Energy Politics: Political challenges may exist due to opposition to incinerators and misconceptions about waste-to-energy. Projects at the University of British Columbia[10] and in Saint-Hyacinthe, Quebec[11] demonstrate the application of this technology in Canada.

2.11 ON-SITE SOLAR PHOTOVOLTAIC GENERATION

Solar photovoltaic generation (PV) refers to the installation of photovoltaic solar panels and ancillary equipment (inverters, racking, etc.) on site to produce Alternating Current (AC) electricity for use at the facility. Systems are typically grid-connected without battery storage, with net metering available to “balance” hourly differences between facility electricity demand and system generation.

Solar PV systems will always reduce GHG emissions by producing energy and reducing grid electricity consumption requirements, but may not always be financially viable. Projects in areas with particularly low solar availability (global horizontal irradiance - GHI), low grid electricity rates, or high loan rates may not achieve a positive net present value over the lifetime of the project. Performance

10 University of British Columbia, Bioenergy Research Demonstration Facility (BRDF), http://energy.ubc.ca/projects/brdf/

11 Federation of Canadian Municipalities, 2016, How Saint-Hyacinthe turns organic waste into biogas and revenue, https://www.fcm.ca/home/programs/green-municipal-fund/how-saint-hyacinthe-turns-waste-into-biogas-and-revenue.htm

of solar PV systems is very site specific. From one site to another, variables like solar availability, utility rates, shading, and existing roof space and age will all play a role in determining the capital cost and lifetime performance of a system. The site-specific viability of each pre-identified property must be further assessed as a next step.

Some recent reports suggest that direct current power distribution may become preferred (over the existing alternating current distribution in buildings today) as solar power, battery storage, electric vehicles and computer equipment become more common. This may warrant investigation as a future opportunity for PSPC.

Assumptions

- Area equalling 75% of roof area plus 75% of outdoor parking lot area
- Energy Use Change: 183 kWh/m^2 of installed solar panel savings to building's non-heating (electric) energy
- GHG Emission Change: proportionate to energy savings, considering regional grid emissions intensity
- Utility Cost Change: proportionate to energy savings, considering regional energy costs
- Cost: \$565/m^2
- Heritage adjustment: 25% cost increase, no change to savings
- Maintenance Cost Change: none
- Longevity of investment: 25 years, per industry standard for PV panel lifetime. Inverters may require replacement after 15-20 years.

Applicable PSPC Buildings

- All Tier 1, 2, 3 buildings in Alberta, Saskatchewan, and Nova Scotia (where GHG grids have high GHG emissions intensity . Note that net-metering is available in each of these regions).[12]
- All buildings undergoing deep retrofits in New Brunswick and Ontario (where GHG grids have moderate GHG emissions intensity)

On-site solar PV generation is anticipated to yield emissions reductions of 2,700 tCO_2e each year once complete.

On-site solar PV would have an order of magnitude incremental capital cost to PSPC of \$16 million across the portfolio (lifecycle benefit of \$2.7 million over 25 years). The results project a lifecycle cost (as opposed to a benefit) for heritage status buildings, though the lifecycle cost per ton of avoided emissions remains very low. Further assessment of PV installation cost increases in historic sites would help support this plan element at those sites.

There is relatively low risk to this activity, as technology has become widely established in recent years. Site specific challenges will arise at some sites more than others. Further strategic planning may be needed to identify effective strategies for implementation at sites which feel constrained by the existing visual property image. The opportunity to install at adjacent non-PSPC sites should be

12 Government of Alberta, Micro-Generation Protocol, http://www.energy.alberta.ca/Electricity/microgen.asp; http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/cl14883
SaskPower, Net Metering Program, http://www.saskpower.com/efficiency-programs-and-tips/generate-your-own-power/self-generation-programs/net-metering-program/
Nova Scotia Power, Enhanced Net Metering, http://www.nspower.ca/en/home/for-my-home/make-your-own-energy/enhanced-net-metering/default.aspx

evaluated if power can then be provided to PSPC assets. Partnerships should be explored (e.g. ESAP; Ottawa Renewable Energy Co-op; etc.)

2.12 ON-SITE BATTERY STORAGE

Batteries can allow energy to be stored for later use. Modern battery technology has significantly increased reliability while reducing cost of battery storage, and further technology improvement is expected in the near future. Benefits already include:

- Reduced electricity costs, if utility costs are based on time-of-day pricing (Ontario electricity rates include a peak demand cost, and in some cases the Global Adjustment cost).
- Reduced carbon emissions, where provincial electric grid uses ‘dirtier’ fuels during peak hours. In many regions natural gas or fossil fuel generation is used during peak hours while hydro and nuclear provide constant ‘base’ generation. For example, in Ontario, off-peak electricity has been estimated to generate 2/3rds less carbon emissions per kWh than it would during the day
- Backup power availability, except where power has been drained by peak demand reduction use
- Storage for renewable power generation, allowing for greater facility independence (e.g. to store excess solar power for later use when occupant demand increases)

As with all technologies, site conditions such as power distribution layout, available space, maintenance and disposal will affect feasibility, cost, and design/installation strategy.

The cost-benefit of battery storage today depends greatly on the property’s electric rate structure. In Ontario, properties operating at a peak demand of over 1 MW can opt in to Class A ratepayer status, causing about 50% of annual electricity cost to be billed based on peak demand, which can then be offset using battery storage. Other regions may have a similar opportunity to benefit, though at this time in other regions we have assumed that cost benefit is based purely on typical monthly peak demand charges.

The payback period for installation by a large Ontario electricity consumer on a Class A rate plan is expected to be in the range of 7 to 8 years. The payback period in other regions and by other customers is expected to be significantly longer, likely at least double this value.

As this is a relatively new application of battery storage technology, pilot installations should be considered as a next step, to help validate applicability, costs, and anticipated benefits.

Assumptions

- Energy Use Change: 0.1% increase to building’s electricity use, along with a 30% reduction to peak demand for 4 hours daily
- GHG Emission Change: Reduced by 2/3rds for all energy offset from day to overnight hours; quantifying this reduction depends on GHG calculation methodologies that make use of time-of-day emissions factors, whereas the current predominant approach is to use annual average emissions factors
- Utility Cost Change: according to peak demand charges, estimated at $30/kW/mo (Ontario large buildings), $8/kW/mo (Ontario small buildings), or $5.00/kW/mo (non-Ontario buildings)
- Cost: $24/m^2 (100% incremental cost, based on a cost of $1 million per 1.2 MWh installed, shared by Hydro Québec)
- Heritage adjustment: no impact to cost or savings

- Maintenance Cost Change: \$0.24/m^2/yr increased cost to maintain battery systems
- Longevity of investment: 10 year life

Applicable PSPC Buildings

- Large buildings in Ontario (over 300,000 ft^2 in size)

On-site battery storage is anticipated to yield emissions reductions of 700 tCO_2e each year once complete.

This would have an order of magnitude incremental capital cost to PSPC of \$41 million across the portfolio (lifecycle cost of \$9.0 million over 25 years).

There is moderate risk to this activity, as battery technology has recently become widely available, but large commercial real estate peak demand reduction is not yet a well-established application of battery technology in Canada.

There is a common international framework for GHG emissions accounting used by organizations like PSPC. PSPC must consider that this framework does not currently provide a method for PSPC to take credit for emissions reductions achieved as a result of shifting energy use to a different time of day. While Ontario emissions would decrease as a result of this activity, PSPC would not be able to receive the credit for this, meaning it would not reduce the volume of RECs/offsets to be purchased annually.

2.13 PROCUREMENT

PSPC has a mandate to first invest in portfolio improvements such as efficiency measures, before turning to external investments if necessary to address remaining emissions. Once PSPC reduces emissions as much as possible through the above efficiency activities, remaining emissions must be addressed to achieve carbon neutrality. A number of market instruments exist to compensate for the environmental impacts of energy consumption. Two primary instruments fall into the categories of renewable energy and carbon offsets.

2.13.1 RENEWABLE ENERGY CERTIFICATES

Unbundled Renewable Energy Certificates (RECs), power purchase agreements (PPAs) and other renewable power instruments allow the purchaser to claim the environmental benefit of the energy. Depending on the instrument, the RECs may or may not be bundled with the physical energy. Purchasing and retiring RECs that were generated in the same jurisdiction as an organization’s energy consumption allows the organization to claim net-zero emissions from electricity consumption, where the RECs meet key quality standards as defined by the GHG Protocol.

PPAs are long-term contracts to purchase large quantities of energy generated by a specific facility, with the benefit of locking-in a stable energy price. Where power is generated from renewable sources, the PPA may include the purchase of associated RECs. PPAs have the added benefit of encouraging further renewable energy development through long-term investment. True PPAs are only possible in de-regulated electricity markets. Currently, Alberta is the only de-regulated market in Canada. Other options, such as synthetic PPAs, may be available in regulated markets.

True PPAs are a contractual agreement used in the utility power sector for long-term purchase of electricity produced by a particular source of generation. For electricity purchasers, PPAs offer a long-term supply of green power with stability in prices, often at or below current market prices.

True PPAs are restricted to customers located in deregulated electricity markets. However, in some regulated markets like Ontario, agreements with government offer an alternative similar to a PPA, but using the power authority as an intermediary.

Synthetic PPAs facilitate a financial swap that allows an electricity purchaser to provide financial and credit support to a project developer by setting a floor price for electricity sold by the project to the wholesale electricity market. If the wholesale price is below the floor price, the purchaser pays the developer the difference. It the wholesale price exceeds the floor price, the developer pays the purchaser. In return for guaranteeing a floor price, the purchaser receives RECs for the project. This option is a potential solutions for customers that have electricity load distributed over a number of smaller facilities, or with loads in regulated electricity markets.

Other types of renewable and green power procurement strategies include: owned off-site generation, on-site PPA or operating leases, and utility products such as green tariffs.[13]

Once emissions are reduced as much as possible through other plan elements described above, it is anticipated that the portfolio will continue to draw approximately 403,000 megawatt hours (MWh) of electricity from the grid each year, resulting in 32,000 tCO_2e of emissions. These emissions can be addressed by purchasing RECs equivalent to grid electricity consumption, and accounting for these under the GHG Protocol Scope 2 Guidance market-based methodology. Electricity emissions that are not addressed by RECs can be addressed by purchasing carbon offsets.

2025 Clean Energy Commitment

The Canadian Government has committed to procure 100% clean electricity by 2025 as part of the North American Leaders (NAL) Summit.[14] Under this commitment, the federal government will procure RECs to address the portion of its grid consumption that is not from clean sources (i.e. resulting from fossil fuel combustion). Generation from 'clean' sources (i.e. renewable generation, nuclear) does not need to be addressed through procurement for the NALs commitment.

By 2025 it is anticipated that 14% of PSPC's grid electricity consumption will come from non-clean sources.[15] Using baseline electricity consumption of 804,583 MWh to be conservative, given uncertainty about Plan implementation timelines, suggests approximately 109,018 MWh must be addressed with RECs starting in 2025. At recent average costs of $1/MWh[16], this would have an order of magnitude cost to PSPC of $109,000 across the portfolio each year. PSPC has experienced higher contract for RECs in key markets such as Alberta, with prices ranging from $7.50/MWh to $12.50/MWh. At $7.5/MWh procuring RECs could cost PSPC on the order of $818,000 million each year. The portion of electricity consumption for which RECs are not purchased will need to be addressed with the purchase of carbon offsets as it is not possible to preferentially apply RECs to reduce emissions only from the 'non-clean' part of consumption.

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13 WSP, 2016, Green Power Procurement: Understanding the Options, http://cdn.wsp-pb.com/jg8fkm/green-power-procurement-white-paper_can_1.pdf

14 Leaders' Statement on a North American Climate, Clean Energy, and Environmental Partnership, 2016, http://pm.gc.ca/eng/news/2016/06/29/leaders-statement-north-american-climate-clean-energy-and-environment-partnership

15 National Energy Board, 2016, Canada's Energy Future 2016: Energy Supply and Demand Projections to 2040, https://apps.neb-one.gc.ca/ftrppndc/, Reference Case, weighted by PSPC's 2015-16 provincial and territorial electricity consumption

16 WSP has observed costs as low as $1/MWh for RECs generated in Canada and sold by US-based providers.

Alternatively, PSPC could choose to procure RECs covering its entire grid electricity consumption. PSPC could then claim 100% renewable energy generation, going beyond the 100% clean energy commitment. Procuring 100% renewable electricity would also allow PSPC to claim no or very low electricity emissions under the market-based scope 2 approach.[17] Table 4 summarizes the two procurement options for electricity consumption and emissions remaining once the full carbon neutral Plan has been implemented (408,000 MWh of grid electricity consumption, resulting in 32,200 tCO_2e emissions), based on the REC pricing range described above. At recent prices, it is more effective to address remaining electricity emissions with carbon offsets, after procuring RECs to satisfy the NALs commitment.

Table 4: Renewable Energy Procurement Options Beyond 2025

	Option 1: NALS Clean Electricity Commitment	Option 2: 100% Renewable Electricity
REC purchase	55,342	408,441
Offset purchase for remaining electricity emissions	27,860	0
Annual RECs cost at $1/MWh	$55,342	$408,441
Annual RECs cost at $7.5/MWh	$415,068	$3,063,309
Annual Offset cost at $4.5/$tCO_2e$	$125,317	$0
Total Annual Cost Range	**$180,714 - $540,440**	**$408,441 - $3,063,309**

While current Canadian REC capacity is unknown, a 2007 report indicated an annual market of under 1.5 million MWh.[18] Depending on PSPC's strategy to procure RECs only for non-clean electricity or all electricity consumption, PSPC procurement could take up a small or a more significant portion of the Canadian REC market, indicating a potential opportunity to encourage new renewable energy development in Canada.

2.13.2 CARBON OFFSETS

Renewable energy instruments can be used to neutralize emissions associated with electricity consumption. Emissions resulting from other types of energy consumption including fossil fuel combustion must be addressed with carbon offsets to achieve carbon neutrality.

Carbon offsets are a market instrument that represent an achieved GHG emissions reduction that can be applied to compensate for or 'offset' emissions elsewhere. Following strict quality criteria and accounting principles, offsets represent a real, enduring emissions reduction. Some offset projects have additional environmental and social benefits besides GHG emissions reductions. There are many activities that can generate carbon offsets. Renewable energy projects such as wind farms, solar installation, geothermal and biomass energy are among the most popular. (See Appendix D 2.4)

17 World Resources Institute, 2015, GHG Protocol Scope 2 Guidance, http://www.ghgprotocol.org/scope_2_guidance

18 Sustainable Prosperity, 2011, The Potential of Tradeable Renewable Energy Certificates (TRECs) in Canada, http://institute.smartprosperity.ca/sites/default/files/publications/files/The%20Potential%20of%20Tradable%20Renewable%20Energy%20Certificates%20(TRECs)%20in%20Canada.pdf

Once the above plan elements have been applied, it is anticipated that approximately 16,000 tCO_2e of emissions will remain, resulting from combustion of natural gas, fuel oil and propane, and consumption of district heating and cooling. At recent average costs of $4.5/$tCO_2e$, this would have an order of magnitude cost to PSPC of $72,000 across the portfolio each year. Offsets generated outside of Canada can also be applied to neutralize PSPC's emissions. Total costs will be higher where offsets are sold at higher prices; for example recent average prices offsets on the Canadian voluntary market are around $10/$tCO_2e$. Offsets in different voluntary markets, regulatory markets or aligned with certain certification criteria may command higher prices. PSPC's anticipated offset requirements represent 12% of the Canadian voluntary offset market of approximately 124,000 tCO_2e transacted in 2015.[19]

2.13.3 OTHER CONSIDERATIONS

Procurement can be completed at the portfolio level, instead of at the building level. Procurement of RECs and offsets must be done each year to address the emissions that occur that year. While such instruments represent a lower annual investment than many efficiency measures, they require repeated annual procurement while yielding minimal enduring benefit to PSPC's portfolio. While procurement can be used to fill the gap to achieve carbon neutrality, the goal is to continue to further reduce emissions through efficiency, fuel switching as well as on-site generation in order to reduce or eliminate the quantity of RECs and offsets that must be purchased in future years.

See Appendix D for details on implications of federal and provincial carbon pricing initiatives, and information on RECs and offsets pricing and suppliers in Canada.

2.14 ENGAGEMENT

Tenants, occupants, building operators, service providers and other stakeholders' actions and knowledge will contribute to the successful achievement of the carbon neutral Plan, although the impact of this element cannot be readily quantified. Robust education and engagement programming is essential to this Plan. Once efficient systems are in place, human behaviour poses the most significant challenge and opportunity in achieving carbon neutrality. PSPC will need to work closely with key groups to align activities with Greening Government Operational Priorities.

Occupants and Tenants

As Plan elements enhance base building efficiency, occupant plus loads will take on increasing importance in achieving carbon neutrality across the portfolio. Targeting plug load reductions will require occupant and tenant engagement strategies:

- Ensure occupants are following ABW guidance encouraging the procurement of energy-efficient computers and office equipment
- Facilitate behaviour change campaigns to target turning off lighting, computers and office equipment when not in use and/or after-hours

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19 Thompson Reuters, 2016, State of the Voluntary Carbon Markets

- Share energy performance information to provide feedback on occupant conservation efforts, stimulate friendly competition and/or 'gamify' conservation
- Future expansion of Smart Buildings technology to provide floor-by-floor energy consumption information could support occupant engagement
- Design occupant-responsive systems that make it easy for occupants to engage in conservation (e.g. occupancy sensors on lighting, clearly-identified after-hours override switches)
- Clarify which tenants need continuous building access versus full building operation; conservation is enhanced by providing building access with reduced HVAC and lighting operation during evenings and weekends if only a few occupants will be present at those times
- Communicate key information about the carbon neutral Plan including its importance to the sitting government and changes tenants can expect to see in their spaces, to facilitate buy-in

Operators and Service Providers

Operators and external service providers contribute to efficient building operation.

After efficient equipment is in place, emissions reductions are largely dependent on the ability of operators and service providers to efficiently operate this equipment. Strategies to enhance effective operation include:

- Provide operators with training on new technologies and processes; ensure continuous training and feedback opportunities to continually enhance operations
- Engage operators in results of re-commissioning activities and/or Smart Buildings monitoring results to build literacy around outcomes of these processes and enhance implementation of energy conservation measures
- Support continuous learning and provide opportunities for operators to stay abreast of new industry developments
- Structure service providers contracts to define delivery goals and successes based on achieving carbon reduction objectives

2.15 ACTIVITIES TO DISCOURAGE

Some activities appear attractive financially or from an energy-savings perspective, yet increase carbon emissions. Any such activity should be discouraged, so as to protect PSPC from taking any action that moves the portfolio further away from achieving their Carbon Neutral goal. There are many such activities. We have listed a few here:

- While **Combined Heat & Power (CHP)** or cogeneration (cogen) fueled by carbon-neutral sources is aligned with this plan's goals, CHP fueled by natural gas or other fossil fuel sources will result in a net carbon emissions increase, in most cases and provincial regions.
- **Fuel switching from electric heating to natural-gas** boilers or burners, even high-efficiency ones, will result in a net carbon emissions increase, in most cases and provincial regions. Heat pumps fueled by natural gas are a potential exception to this, and must be evaluated on a case by case basis.
- **Expanding PSPC's portfolio of occupied space** (whether owned or leased) will increase carbon emissions, with the exception of occupying space in a building that independently demonstrates net-zero carbon emissions. As such, expansion of PSPC's portfolio should focus on a net-zero carbon space / building.

3 CARBON NEUTRAL PLAN BY REGION

The PSPC National Carbon Neutral Portfolio Plan prioritizes different elements and strategies in each region, province and portfolio segment based on associated grid intensity, feasibility, cost and benefit.

3.1 ATLANTIC REGION

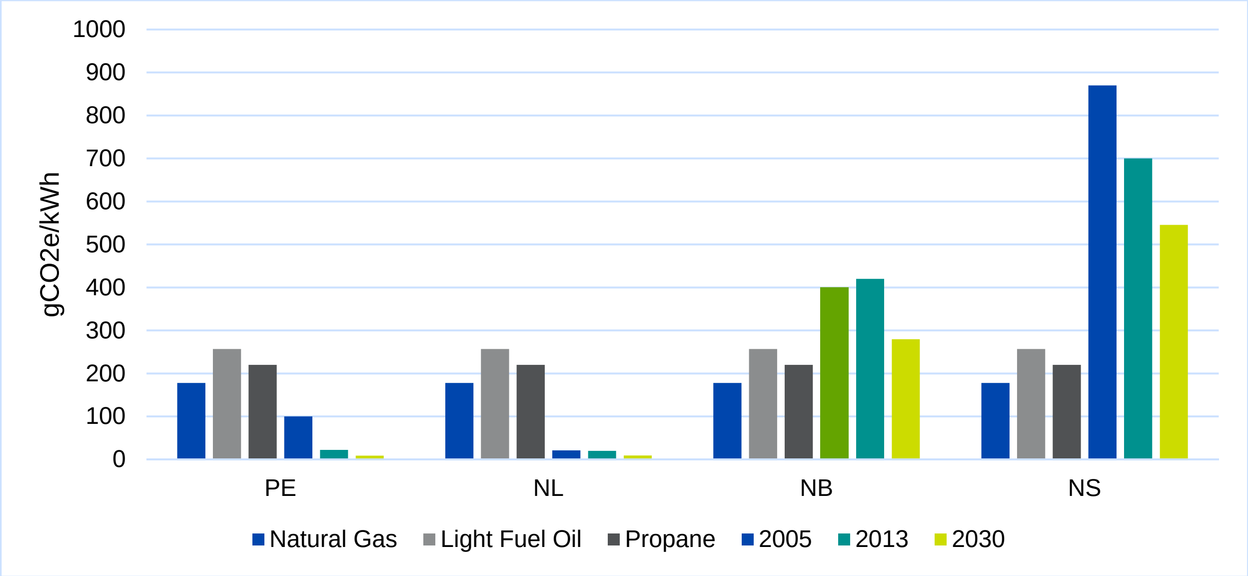
Atlantic Region assets represent approximately 7% of the PSPC portfolio by floor area, 7% of annual energy use and 14% of annual GHG emissions. A breakdown by province is provided below.

Table 5: Atlantic Region Floor Area, Energy Consumption and GHG Emissions

Metric	NB	NL	NS	PE
Floor Area (m^2)	117,588	91,296	97,059	55,535
% of National Total	**2%**	**2%**	**2%**	**1%**
Energy (GJ)				
Natural Gas	8,605	582	19,210	-
Light Fuel Oil	4,623	8,244	11,230	23,071
Propane	3	-	-	-
Electricity	83,735	77,321	47,949	38,425
District Heating	-	-	8,045	4,229
District Cooling	-	-	-	-
Total	96,965	86,148	86,435	65,724
% of National Total	**2%**	**2%**	**2%**	**1%**
GHG (tCO_2e)				
Natural Gas	428	29	955	-
Light Fuel Oil	326	581	792	1,626
Propane	0	-	-	-
Electricity	9,769	430	9,324	235
District Heating	-	-	668	351
District Cooling	-	-	-	-
Total	10,523	1,040	11,738	2,212
% of National Total	**6%**	**1%**	**6%**	**1%**

Atlantic region is characterized by a mix of electric grids with high carbon emissions intensity (New Brunswick, Nova Scotia) and low carbon emissions intensity (Newfoundland, Prince Edward Island).

Figure 5: Atlantic Region Fuel and Electric GHG Intensity



All Atlantic region electric grids are projecting carbon emissions reductions between present and 2030, ranging from a 22% to 61% de-carbonization, though New Brunswick's grid will remain moderately intensive and Nova Scotia's grid will remain high intensity.

When compared to average Canadian energy costs, area-weighted to reflect PSPC's portfolio, Electricity prices are 5 to 25% higher than typical, while natural gas is about double the typical cost. Access to natural gas is limited in some locations.

Plan elements applicable to Atlantic Region include:

Table 6: Atlantic Region Carbon Neutral Plan Elements

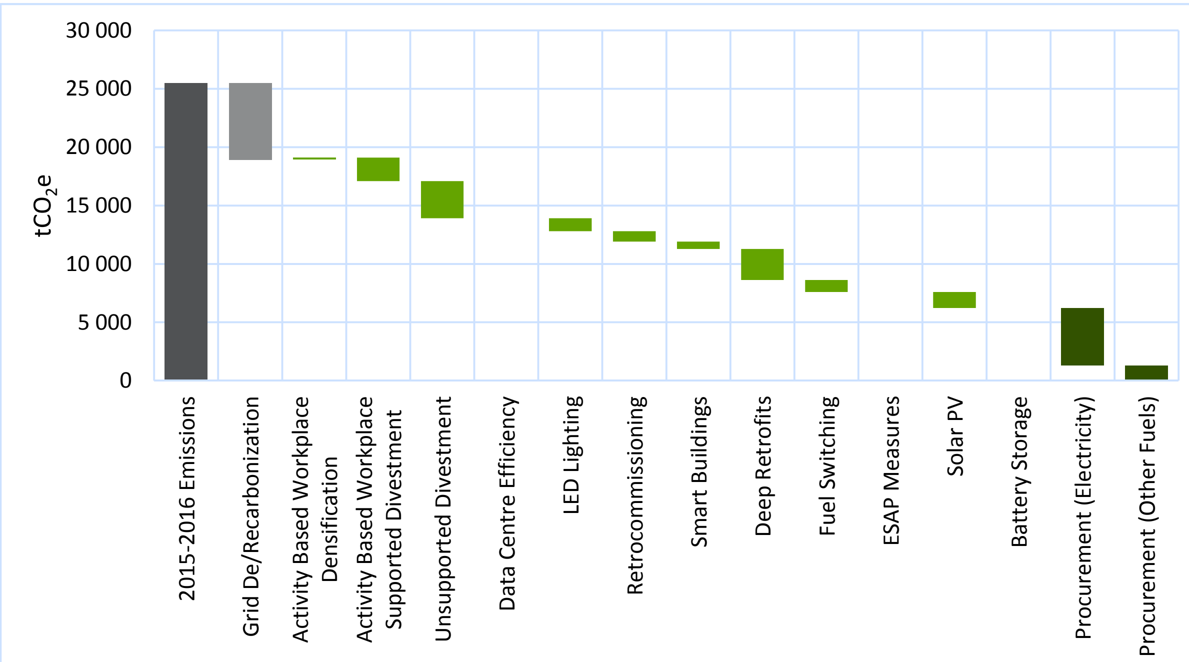
Plan Element	NB	NL	NS	PE	Number Buildings	Floor Area (m^2)
Grid Intensity	Y	Y	Y	Y	60	361,479
Workplace Densification	Y	Y	Y	Y	35	287,164
Divestment	Y	Y	Y	Y	25	74,315
Data Centres	-	-	-	-	-	-
LED Lighting	Y	Y	Y	Y	35	287,164
EA, RCx, ECMs	Y	Y	Y	Y	17	86,268
Smart Buildings	Y	Y	Y	Y	12	190,005
Deep Retrofits	Y	Y	Y	Y	17	180,228
Fuel Switching	Y	-	-	Y	2	22,855
ESAP Efficiency	-	-	-	-	-	-
ESAP Connections	-	-	-	-	-	-
ESAP to Quebec	-	-	-	-	-	-
ESAP Biofuel	-	-	-	-	-	-
Solar PV	-	-	Y	-	8	57,463
Battery Storage	-	-	-	-	-	-

Actions unique to Atlantic Region include:

- Prioritized solar PV generation where feasible to offset carbon-intensive electricity use in Nova Scotia
- De-prioritized solar PV generation in Newfoundland and PEI due to low intensity carbon grid
- Prioritized fuel switching from natural gas to electricity, which is financially attractive due to high natural gas / fuel costs, despite a limited carbon benefit in Nova Scotia where a moderate to highly intensive carbon grid exists

Implementing the Carbon Neutral Plan in Atlantic Region will target carbon emissions reductions as follows:

Figure 6: Atlantic Region Carbon Neutral Plan



Internal actions by Atlantic Region can reduce PSPC's national portfolio carbon emissions by 10% (19,000 tonnes per year).

3.2 NATIONAL CAPITAL REGION (EXCLUDING PARLIAMENTARY PRECINCT)

National Capital Region assets (excluding Parliamentary Precinct assets) represent approximately 58% of the PSPC portfolio by floor area, 60% of annual energy use and 54% of annual GHG emissions. A breakdown by province is provided below.

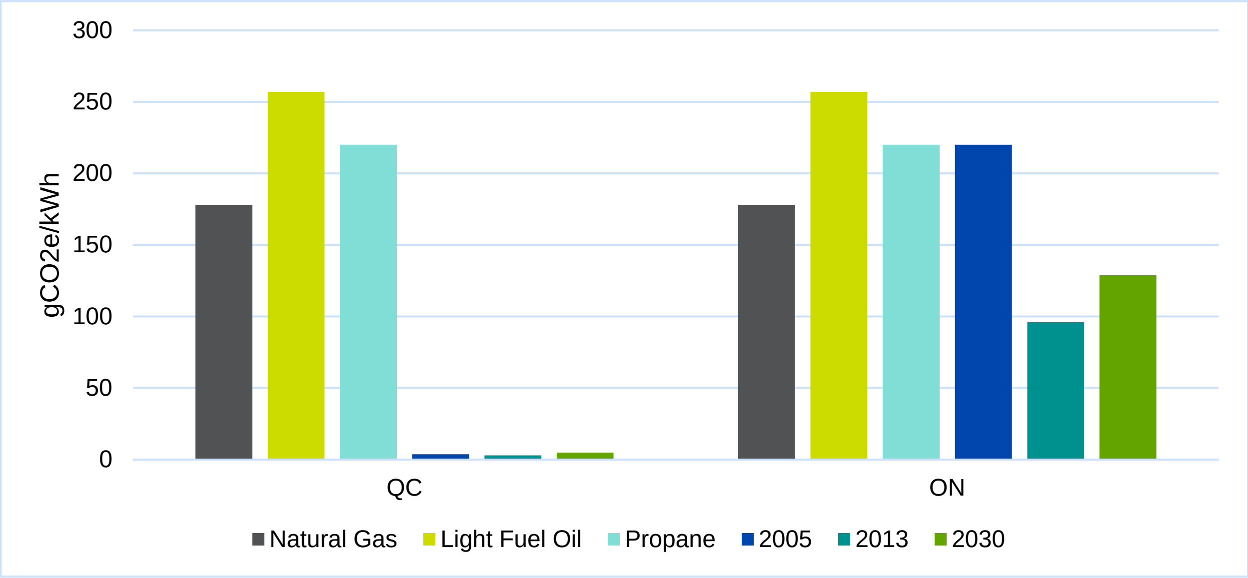
Table 7: NCR Floor Area, Energy Consumption and GHG Emissions

Metric	ON	QC
Floor Area (m^2)	1,884,117	1,049,764
% of National Total	**37%**	**21%**
Energy (GJ)		
Natural Gas	365,215	192,815

Metric	ON	QC
Light Fuel Oil	-	-
Propane	-	-
Electricity	1,113,731	610,114
District Heating	326,519	-
District Cooling	256,572	-
Total	2,062,038	802,929
% of National Total	**43%**	**17%**
GHG (tCO_2e)		
Natural Gas	18,165	9,590
Light Fuel Oil	-	-
Propane	-	-
Electricity	29,700	491
District Heating	28,386	-
District Cooling	11,381	-
Total	87,631	10,082
% of National Total	**48%**	**6%**

The NCR is characterized by two electric grids, one with moderate carbon emissions intensity and the other with extremely low carbon emissions intensity.

Figure 7: NCR Fuel and Electric Grid Intensity



The Ontario electric grid is projecting a carbon emissions intensity increase of 34% between present and 2030 as a result of fossil fuel generation planned to support the grid while nuclear power plants are taken off line for refurbishment, during which Ontario will remain a moderate intensity carbon intensity grid, of about 129 g/kWh. The Quebec electric grid is projecting a carbon emissions intensity increase of 65% between present and 2030, but will remain an extremely low carbon intensity grid, below 5 g/kWh.

When compared to average Canadian energy costs, area-weighted to reflect PSPC's portfolio, Ontario electricity is about 20% higher than typical, while natural gas prices are about 20% lower than typical. Quebec electricity prices are about 30% lower than typical while natural gas prices are about 15% higher than typical.

Plan elements applicable to NCR include:

Table 8: NCR Carbon Neutral Plan Elements

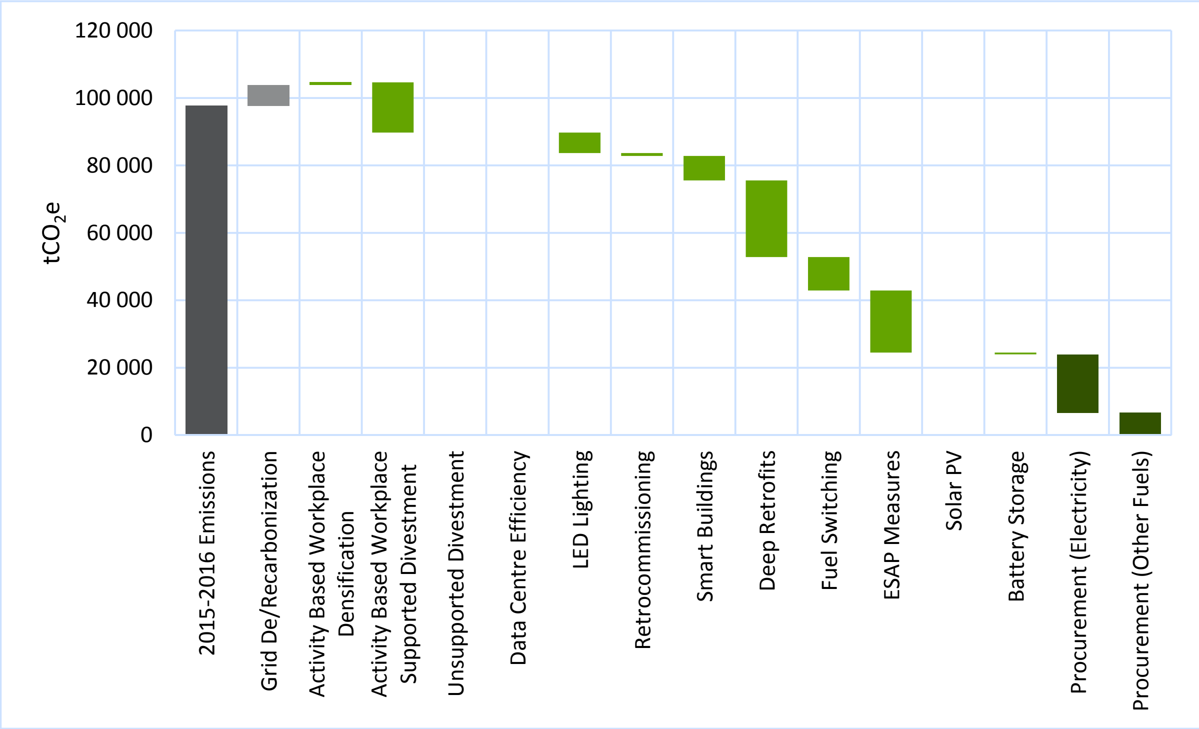
Plan Element	ON	QC	Number Buildings	Floor Area (m^2)
Grid Intensity	Y	Y	62	2,933,882
Workplace Densification	Y	Y	56	2,691,447
Divestment	Y	-	6	242,435
Data Centres	-	-	-	-
LED Lighting	Y	Y	56	2,691,447
EA, RCx, ECMs	Y	Y	12	198,435
Smart Buildings	Y	Y	40	2,394,868
Deep Retrofits	Y	Y	28	1,505,162
Fuel Switching	Y	Y	13	765,332
ESAP Efficiency	Y	-	29	1,106,870
ESAP Connections	Y	Y	7	510,283
ESAP to Quebec	Y	Y	36	1,617,153
ESAP Biofuel	Y	Y	36	1,617,153
Solar PV	-	-	-	-
Battery Storage	Y	-	19	1,332,306

Actions unique to NCR include:

- Upgrading ESAP district heating and energy systems
- De-prioritized solar PV generation due to moderate intensity carbon grid
- Battery storage is financially attractive in Ontario for large electricity consumers that can take advantage of capacity-based global adjustment contracts

Implementing the Carbon Neutral Plan in the NCR will target carbon emissions reductions as follows:

Figure 8: NCR Carbon Neutral Plan



Internal actions by NCR can reduce PSPC's national portfolio carbon emissions by 39% (72,000 tonnes per year).

3.3 PARLIAMENTARY PRECINCT

Parliamentary Precinct assets represent approximately 6% of the PSPC portfolio by floor area, 7% of annual energy use and 10% of annual GHG emissions.

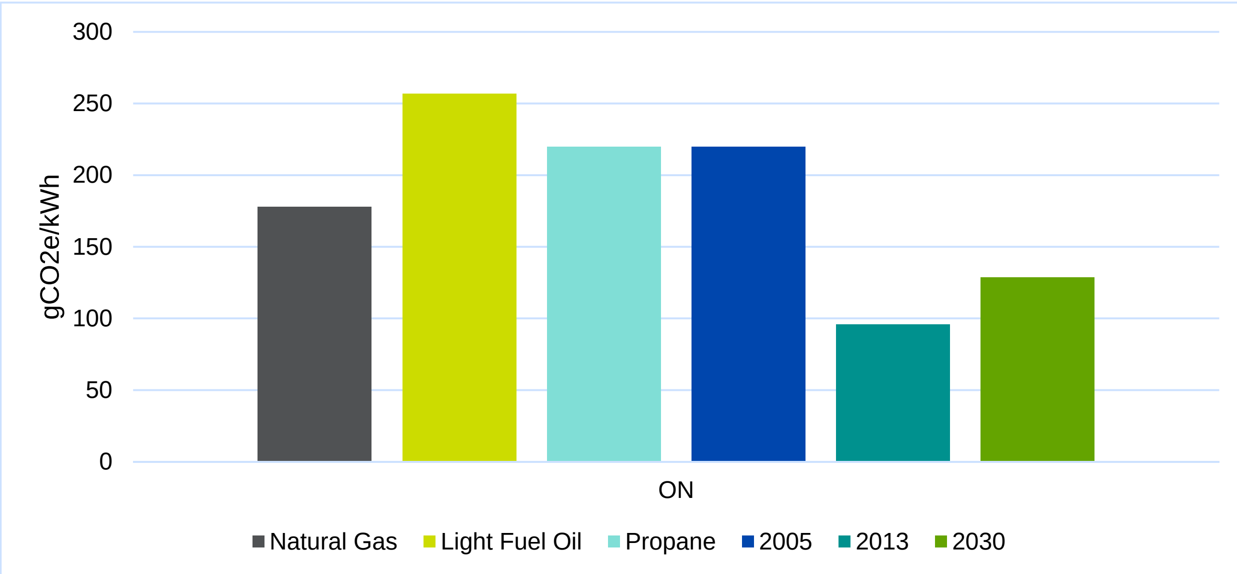
Table 9: Parliamentary Precinct Floor Area, Energy Consumption and GHG Emissions

Metric	ON
Floor Area (m^2)	300,114
% of National Total	**6%**
Energy (GJ)	
Natural Gas	10,112
Light Fuel Oil	-
Propane	-
Electricity	145,385
District Heating	118,732
District Cooling	73,488
Total	347,717
% of National Total	**7%**
GHG (tCO_2e)	
Natural Gas	503
Light Fuel Oil	-
Propane	-

Electricity	3,877
District Heating	10,595
District Cooling	3,513
Total	18,488
% of National Total	**10%**

Parliamentary Precinct is characterized by an electric grid with moderate carbon emissions intensity.

Figure 9: Parliamentary Precinct Fuel and Electric Grid Intensity



The Ontario electric grid is projecting a carbon emissions intensity increase of 34% between present and 2030 as a result of fossil fuel generation planned to support the grid while nuclear power plants are taken off line for refurbishment, during which Ontario will remain a moderate intensity carbon intensity grid, of about 129 g/kWh.

When compared to average Canadian energy costs, area-weighted to reflect PSPC's portfolio, Ontario electricity is about 20% higher than typical, while natural gas prices are about 20% lower than typical.

The Parliamentary Precinct includes 28 buildings. While the remainder of the PSPC portfolio is predominantly office space and can be managed in a similar fashion, the same cannot be said for most of the PPB portfolio due to the vocation of many of the buildings as part of the seat of government. While the elements of the plan put forward are fully applicable to the PPB portfolio, the unique nature of the activities within this portfolio – legislatures the business end of Canada's parliament, committee, Cabinet and conference rooms, great public access, tourism, diplomatic activities, etc. – may require adapting the strategy and implementation of the plan elements. This should not be construed as a limitation on achieving the plan objectives within the PPB portfolio. The opportunity to reduce GHG within the PPB portfolio is as good if not better than other segments of the portfolio.

The parliamentary precinct is responsible for about 10% of the entire portfolio's carbon emissions. This portfolio additionally offers an important opportunity to embed carbon considerations in deep retrofits of landmark federal buildings. The parliamentary buildings – Centre Block, East Block and the Confederation Building are scheduled to undergo deep retrofits over the next 10-15 years. Embedding deep carbon-reducing initiatives in these retrofits will ensure these buildings will perform well over the next century before their next deep retrofit, and will also serve to demonstrate to Canadians and the world, the federal government's action on sustainability.

In addition, a number of these sites are considered heritage assets which will present challenges and opportunities when undertaking retrofits in order to conserve heritage elements.

Since many parliamentary precinct buildings are connected to ESAP plants, their carbon emissions is significantly influenced by ESAP plant efficiency.

Specific decision criteria that are especially applicable to the plan for PPB include:

- Upgrade of existing ESAP plant equipment to improve performance
- Excluded application of ABW as an applicable ABW program remains to address occupant requirements of these properties
- De-prioritized solar PV generation due to moderate intensity carbon grid
- Battery storage is financially attractive in Ontario for large electricity consumers that can take advantage of capacity-based global adjustment contracts

With the exception of ABW, all other plan elements have been equally applied to PPB assets. In the case of heritage assets, costs have been adjusted with a multiplier factor to represent that treatment of heritage assets may be more costly, and savings have been discounted representing that savings achievement may be limited to some degree by the special/heritage nature of these assets.

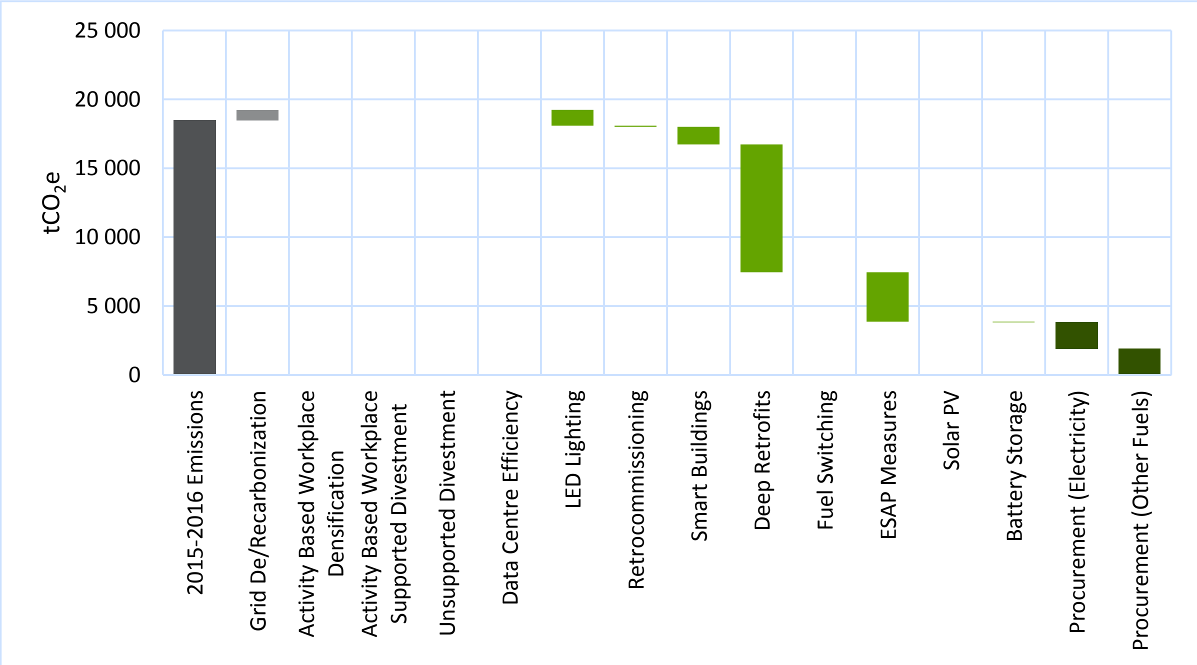
Plan elements applicable to Parliamentary Precinct include:

Table 10: Parliamentary Precinct Carbon Neutral Plan Elements

Plan Element	ON	Number Buildings	Floor Area (m^2)
Grid Intensity	Y	27	300,114
Workplace Densification	-	-	-
Divestment	-	-	-
Data Centres	-	-	-
LED Lighting	Y	27	300,114
EA, RCx, ECMs	Y	1	47,295
Smart Buildings	Y	9	187,639
Deep Retrofits	Y	25	235,466
Fuel Switching	-	-	-
ESAP Efficiency	Y	26	297,601
ESAP Connections	-	-	-
ESAP to Quebec	Y	26	297,601
ESAP Biofuel	Y	26	297,601
Solar PV	-	-	-
Battery Storage	Y	3	137,214

Implementing the Carbon Neutral Plan in Parliamentary Precinct Branch will target carbon emissions reductions as follows:

Figure 10: Parliamentary Precinct Carbon Neutral Plan



Internal actions by Parliamentary Precinct Branch can reduce PSPC's national portfolio carbon emissions by 8% (14,000 tonnes per year).

3.4 ONTARIO REGION

Ontario Region assets represent approximately 9% of the PSPC portfolio by floor area, 7% of annual energy use and 7% of annual GHG emissions.

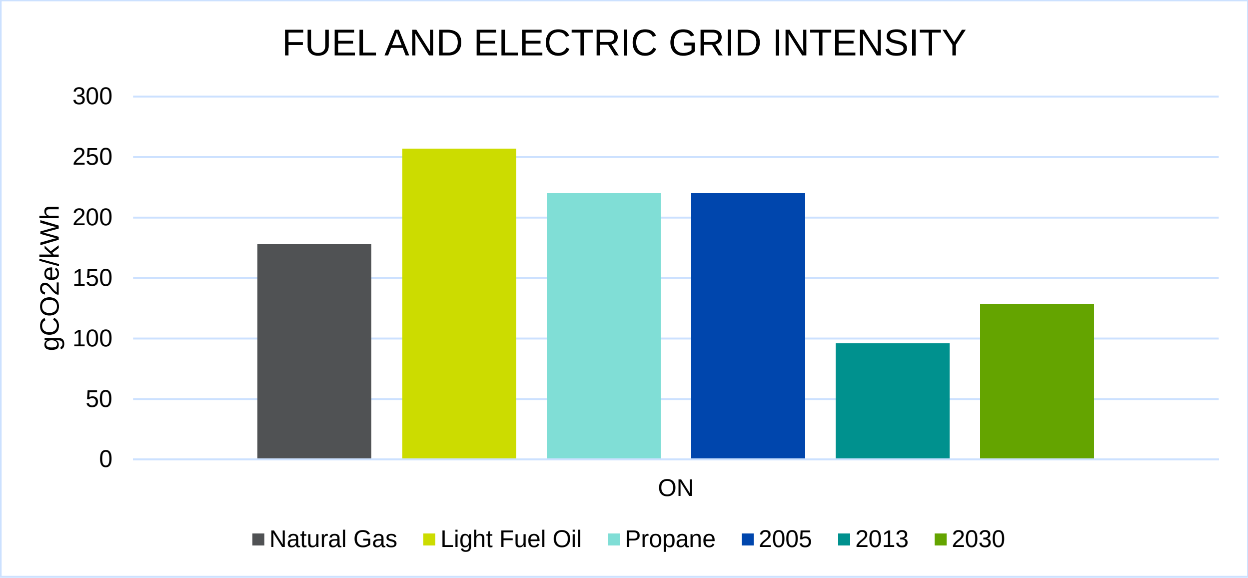
Table 11: Ontario Region Floor Area, Energy Consumption and GHG Emissions

Metric	ON
Floor Area (m^2)	448,639
% of National Total	**9%**
Energy (GJ)	
Natural Gas	140,445
Light Fuel Oil	579
Propane	-
Electricity	180,617
District Heating	20
District Cooling	-
Total	321,660
% of National Total	**7%**
GHG (tCO_2e)	
Natural Gas	6,986
Light Fuel Oil	41
Propane	-

Metric	ON
Electricity	4,816
District Heating	2
District Cooling	-
Total	11,844
% of National Total	**7%**

Ontario Region is characterized by an electric grid with moderate carbon emissions intensity.

Figure 11: Ontario Region Fuel and Electric Grid Intensity



The Ontario electric grid is projecting a carbon emissions intensity increase of 34% between present and 2030 as a result of fossil fuel generation planned to support the grid while nuclear power plants are taken off line for refurbishment, during which Ontario will remain a moderate intensity carbon intensity grid, of about 129 gCO_2e/kWh.

When compared to average Canadian energy costs, area-weighted to reflect PSPC's portfolio, Ontario electricity is about 20% higher than typical, while natural gas prices are about 20% lower than typical.

Plan elements applicable to Ontario Region include:

Table 12: Ontario Region Carbon Neutral Plan Elements

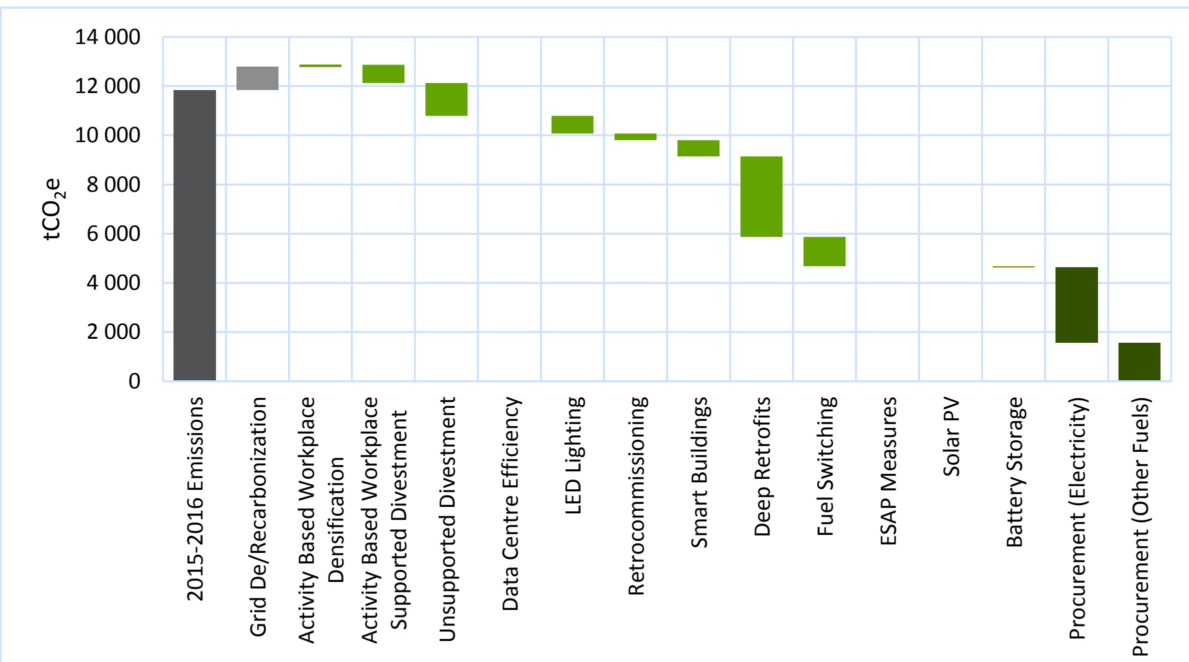
Plan Element	ON	Number Buildings	Floor Area (m^2)
Grid Intensity	Y	41	448,639
Workplace Densification	Y	28	350,317
Divestment	Y	13	98,323
Data Centres	-	-	-
LED Lighting	Y	28	350,317
EA, RCx, ECMs	Y	9	64,663
Smart Buildings	Y	6	227,844
Deep Retrofits	Y	18	244,530
Fuel Switching	Y	10	105,787
ESAP Efficiency	-	-	-
ESAP Connections	-	-	-
ESAP to Quebec	-	-	-
ESAP Biofuel	-	-	-
Solar PV	-	-	-
Battery Storage	Y	6	227,844

Actions unique to Ontario Region include:

- De-prioritized solar PV generation due to moderate intensity carbon grid
- Battery storage is financially attractive in Ontario for large electricity consumers that can take advantage of capacity-based global adjustment contracts

Implementing the Carbon Neutral Plan in Ontario Region will target carbon emissions reductions as follows:

Figure 12: Ontario Region Carbon Neutral Plan



Internal actions by Ontario Region can reduce PSPC's national portfolio carbon emissions by 4% (7,000 tonnes per year).

3.5 PACIFIC REGION

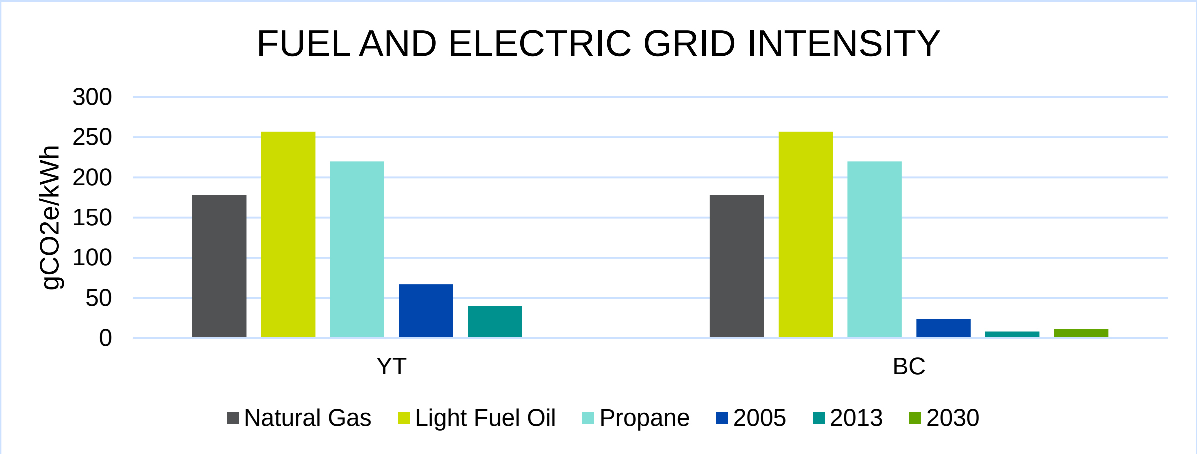
Pacific Region assets represent approximately 6% of the PSPC portfolio by floor area, 4% of annual energy use and 2% of annual GHG emissions. A breakdown by province/territory is provided below.

Table 13: Pacific Region Floor Area, Energy Consumption and GHG Emissions

Metric	BC	YT
Floor Area (m^2)	288,504	16,616
% of National Total	**6%**	**<1%**
Energy (GJ)		
Natural Gas	35,644	-
Light Fuel Oil	42	939
Propane	1,422	2,712
Electricity	136,977	11,330
District Heating	10,845	-
District Cooling	-	-
Total	184,930	14,981
% of National Total	**4%**	**<1%**
GHG (tCO_2e)		
Natural Gas	1,773	-
Light Fuel Oil	3	66
Propane	87	165
Electricity	312	126
District Heating	900	-
District Cooling	-	-
Total	3,075	358
% of National Total	**2%**	**<1%**

Pacific Region is characterized by electric grids in British Columbia and Yukon with extremely low carbon emissions intensities.

Figure 13: Pacific Region Fuel and Electric Grid Intensity



The BC electric grid is projecting a carbon emissions intensity increase of 37% between present and 2030, but will remain an extremely low carbon intensity grid, around 11 g/kWh. Yukon is projecting a 100% reduction in carbon emissions intensity to 0 g/kWh.

When compared to average Canadian energy costs, area-weighted to reflect PSPC's portfolio, BC electricity prices are about 35% less than typical while Yukon electricity prices are about double what is typical. Natural gas prices in BC are about 5% higher than typical, while Yukon gas prices are about double what is typical.

Plan elements applicable to Pacific Region include:

Table 14: Pacific Region Carbon Neutral Plan Elements

Plan Element	BC	YT	Number Buildings	Floor Area (m^2)
Grid Intensity	Y	Y	30	305,120
Workplace Densification	Y	Y	27	298,995
Divestment	Y	Y	3	6,124
Data Centres	-	-	-	-
LED Lighting	Y	Y	27	298,995
EA, RCx, ECMs	Y	Y	13	91,807
Smart Buildings	Y	-	4	175,107
Deep Retrofits	Y	-	13	177,554
Fuel Switching	Y	Y	14	121,441
ESAP Efficiency	-	-	-	-
ESAP Connections	-	-	-	-
ESAP to Quebec	-	-	-	-
ESAP Biofuel	-	-	-	-
Solar PV	-	-	-	-
Battery Storage	-	-	-	-

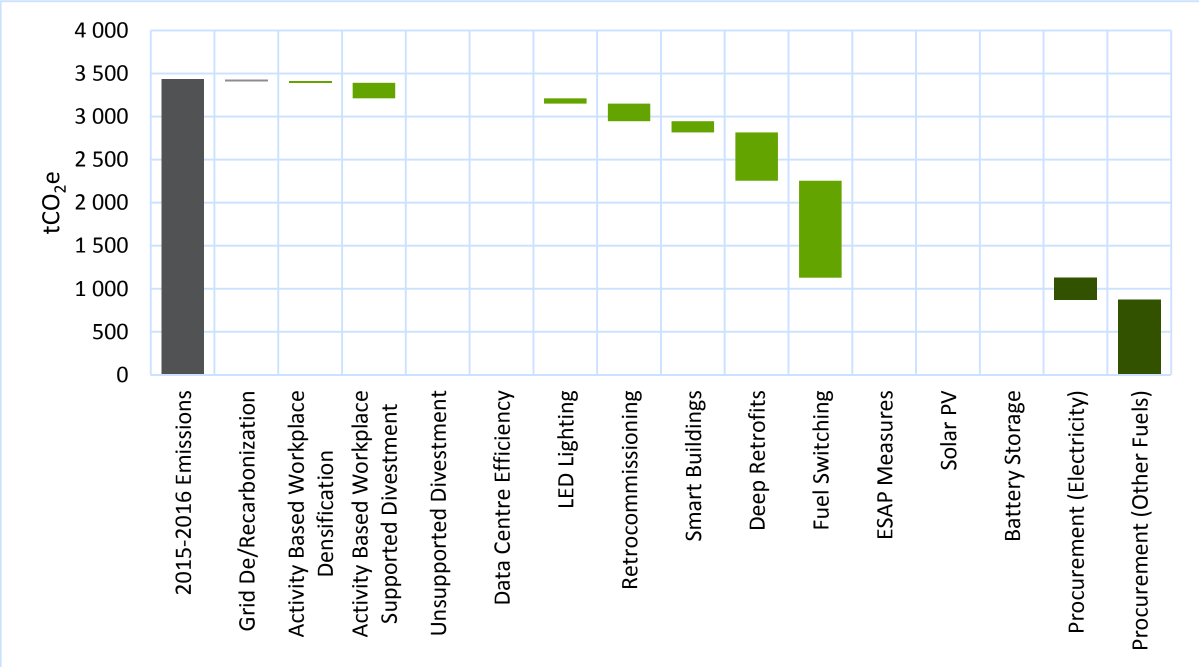
Actions unique to Pacific Region include:

- → De-prioritized solar PV generation due to low intensity carbon grid
- → Prioritized fuel switching in BC which is financially attractive due to low electricity costs

Note that despite the low intensity carbon grid, LED lighting is included as a plan element due to its attractive financial benefit.

Implementing the Carbon Neutral Plan in Pacific Region will target carbon emissions reductions as follows:

Figure 14: Pacific Region Carbon Neutral Plan



Internal actions by Pacific Region can reduce PSPC's national portfolio carbon emissions by 1% (2,300 tonnes per year).

3.6 QUEBEC REGION

Quebec Region assets represent approximately 9% of the PSPC portfolio by floor area, 9% of annual energy use and 4% of annual GHG emissions.

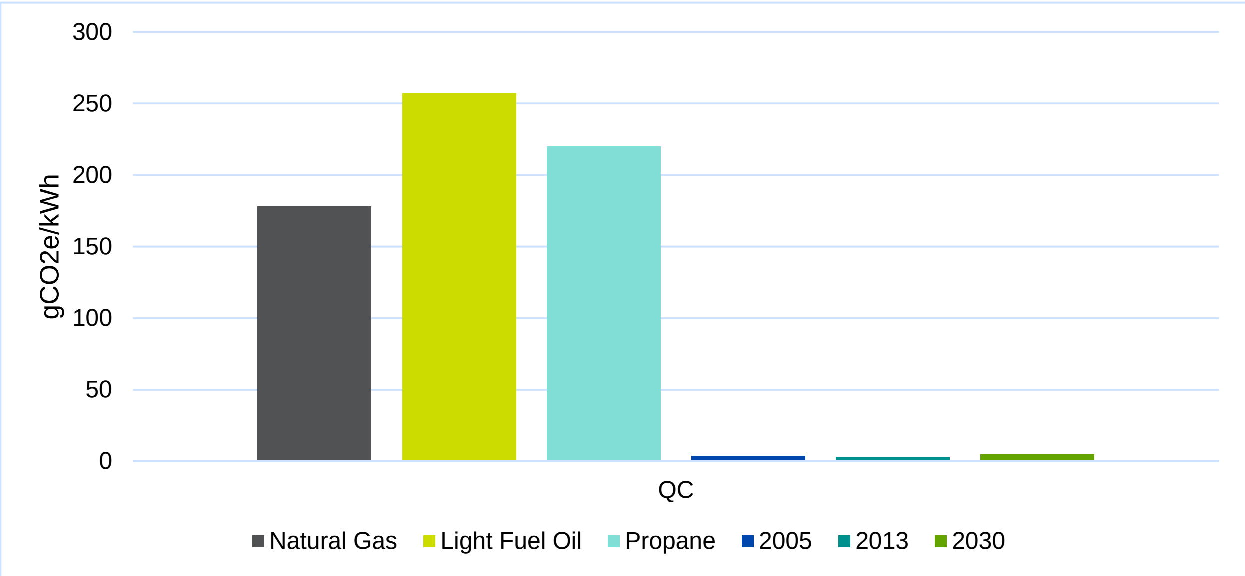
Table 15: Quebec Region Floor Area, Energy Consumption and GHG Emissions

Metric	QC
Floor Area (m^2)	480,494
% of National Total	**9%**
Energy (GJ)	
Natural Gas	135,216
Light Fuel Oil	277
Propane	-
Electricity	313,808
District Heating	-
District Cooling	-
Total	449,301
% of National Total	**9%**
GHG (tCO_2e)	
Natural Gas	6,725
Light Fuel Oil	20
Propane	-

Metric	QC
Electricity	253
District Heating	-
District Cooling	-
Total	6,998
% of National Total	**4%**

Quebec Region is characterized by an electric grid with extremely low carbon emissions intensity.

Figure 15: Quebec Region Fuel and Electric Grid Intensity



The Quebec electric grid is projecting a carbon emissions intensity increase of 65% between present and 2030, but will remain an extremely low carbon intensity grid, below 5 g/kWh.

When compared to average Canadian energy costs, area-weighted to reflect PSPC's portfolio, Quebec electricity prices are about 30% lower than typical while natural gas prices are about 15% higher than typical.

Plan elements applicable to Quebec Region include:

Table 16: Quebec Region Carbon Neutral Plan Elements

Plan Element	QC	Number Buildings	Floor Area (m^2)
Grid Intensity	Y	34	480,494
Workplace Densification	Y	28	421,142
Divestment	Y	6	59,353
Data Centres	-	-	-
LED Lighting	Y	28	421,142
EA, RCx, ECMs	Y	11	131,456
Smart Buildings	Y	5	238,759
Deep Retrofits	Y	15	248,507
Fuel Switching	Y	10	149,535
ESAP Efficiency	-	-	-
ESAP Connections	-	-	-
ESAP to Quebec	-	-	-
ESAP Biofuel	-	-	-
Solar PV	-	-	-
Battery Storage	-	-	-

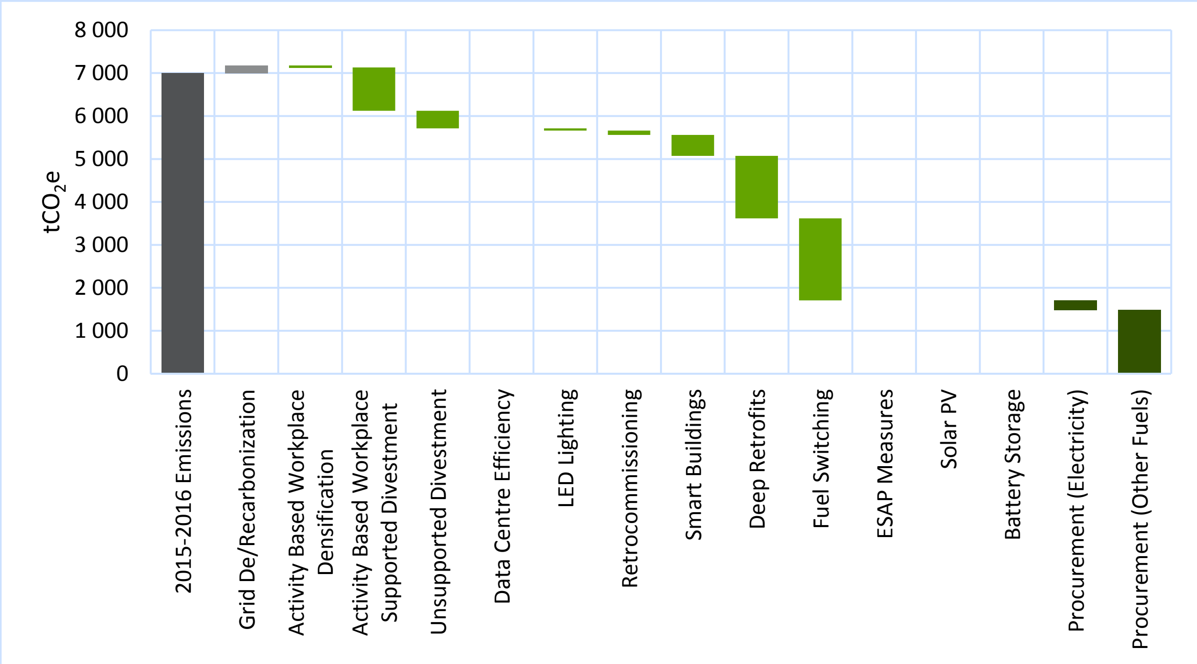
Actions unique to Quebec Region include:

- De-prioritized solar PV generation due to low intensity carbon grid
- Prioritized fuel switching which is financially attractive due to low electricity costs

Note that despite the low intensity carbon grid, LED lighting is included as a plan element due to its attractive financial benefit.

Implementing the Carbon Neutral Plan in Quebec Region will target carbon emissions reductions as follows:

Figure 16: Quebec Region Carbon Neutral Plan



Internal actions by Quebec Region can reduce PSPC's national portfolio carbon emissions by 3% (5,000 tonnes per year).

3.7 WESTERN REGION

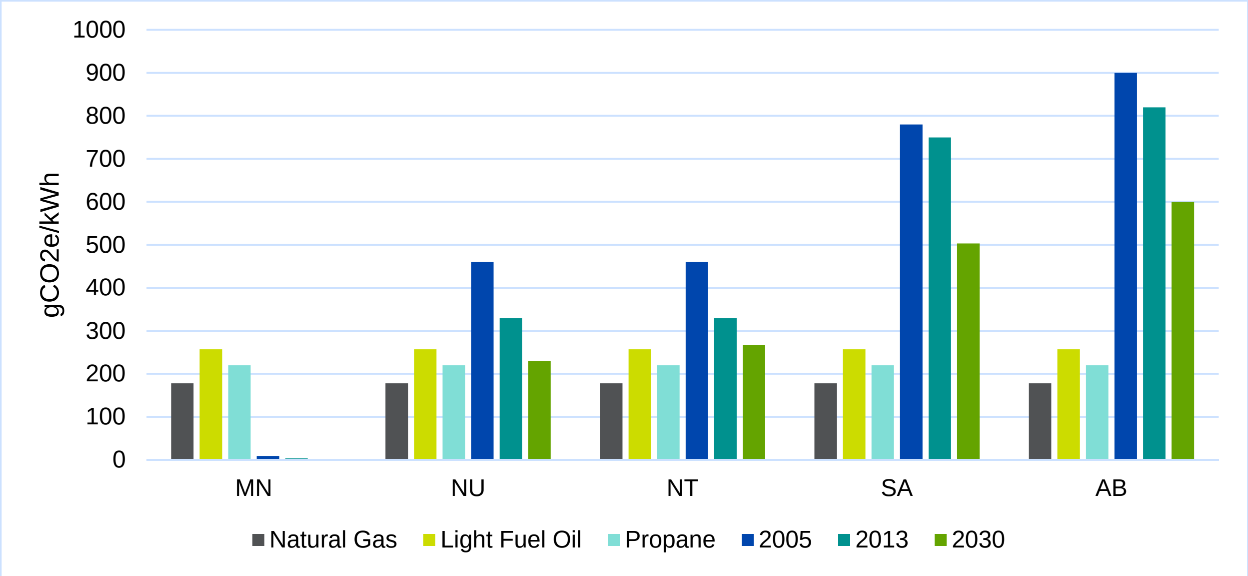
Western Region assets represent approximately 5% of the PSPC portfolio by floor area, 6% of annual energy use and 10% of annual GHG emissions. A breakdown by province/territory is provided below.

Table 17: Western Region Floor Area, Energy Consumption and GHG Emissions

Metric	AB	MN	NT	NU	SA
Floor Area (m^2)	42,830	152,106	21,059	2,742	45,797
% of National Total	**1%**	**3%**	**<1%**	**<1%**	**1%**
Energy (GJ)					
Natural Gas	45,540	62,557	2,643	-	12,820
Light Fuel Oil	-	-	10,025	3,928	-
Propane	-	-	5,567	-	-
Electricity	22,785	85,453	8,272	2,417	18,181
District Heating	-	-	-	-	-
District Cooling	-	-	-	-	-
Total	68,325	148,010	26,507	6,345	31,001
% of National Total	**1%**	**3%**	**1%**	**<1%**	**1%**
GHG (tCO_2e)					
Natural Gas	2,265	3,112	131	-	638
Light Fuel Oil	-	-	707	277	-
Propane	-	-	340	-	-
Electricity	5,190	81	758	222	3,788
District Heating	-	-	-	-	-
District Cooling	-	-	-	-	-
Total	7,455	3,192	1,936	498	4,425
% of National Total	**4%**	**2%**	**1%**	**<1%**	**2%**

Western Region is characterized by a mix of electric grids with high carbon emissions intensity (Alberta, Saskatchewan), moderate intensity (Northwest Territories, Nunavut) and low carbon emissions intensity (Manitoba).

Figure 17: Western Region Fuel and Electric Grid Intensity



All Western Region electric grids are projecting carbon emissions reductions between present and 2030, ranging from a 19% to 95% de-carbonization. Alberta and Saskatchewan grids will remain high intensity over 500 g/kWh, Northwest Territories and Nunavut will remain moderate intensity between

200 and 300 g/kWh. Manitoba is projecting a 95% reduction in carbon emissions intensity to <1 g/kWh.

Electricity prices are 3% to 6% above typical in Alberta and Saskatchewan, while Manitoba electricity prices are about half what is typical. Northern territories electricity prices are about double the typical rate. Natural gas in the northern territories is about double what is typical, while Alberta is half of what is typical, and Manitoba and Saskatchewan are about 30% less than typical.

Plan elements applicable to Western Region include:

Table 18: Western Region Carbon Neutral Plan Elements

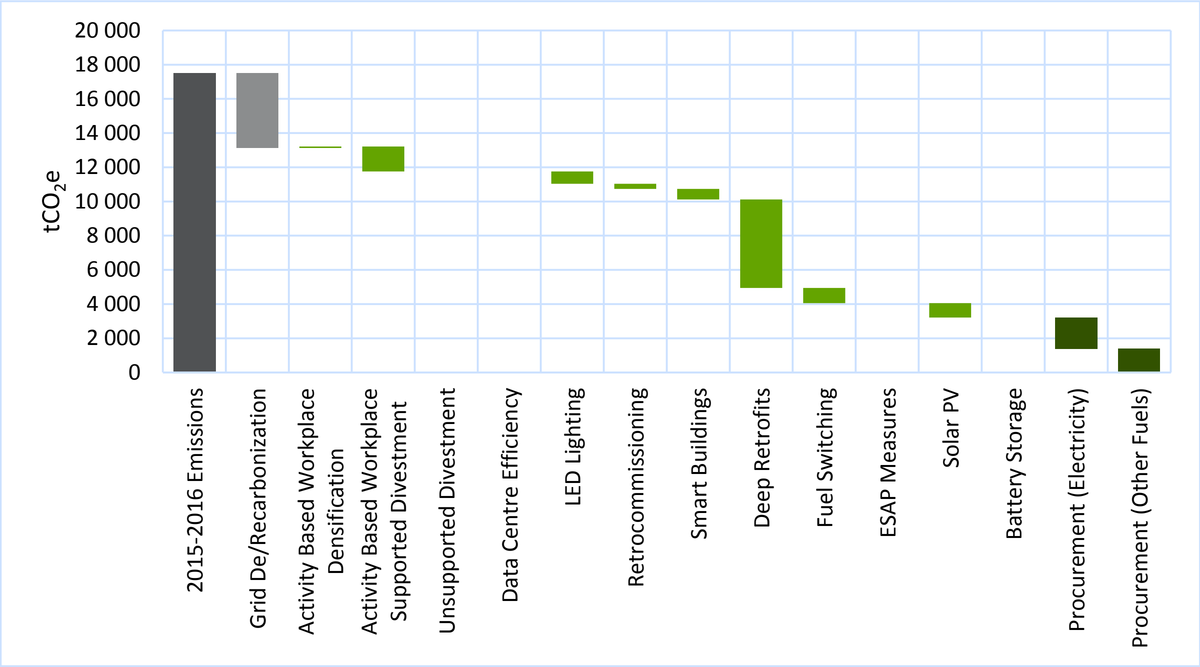
Plan Element	AB	MN	NT	NU	SA	Number Buildings	Floor Area (m^2)
Grid Intensity	Y	Y	Y	Y	Y	31	264,534
Workplace Densification	Y	Y	Y	Y	Y	23	241,194
Divestment	Y	Y	Y	-	-	8	23,341
Data Centres	-	-	-	-	-	-	-
LED Lighting	Y	Y	Y	Y	Y	23	241,194
EA, RCx, ECMs	-	Y	Y	Y	Y	12	50,028
Smart Buildings	Y	Y	Y	-	Y	4	109,854
Deep Retrofits	Y	Y	Y	-	Y	11	165,536
Fuel Switching	-	Y	Y	Y	-	7	63,499
ESAP Efficiency	-	-	-	-	-	-	-
ESAP Connections	-	-	-	-	-	-	-
ESAP to Quebec	-	-	-	-	-	-	-
ESAP Biofuel	-	-	-	-	-	-	-
Solar PV	Y	-	-	-	Y	5	76,473
Battery Storage	-	-	-	-	-	-	-

Actions unique to Western Region include:

- Prioritized solar PV generation to offset carbon-intensive electricity use in Alberta and Saskatchewan
- Prioritized fuel switching which is financially attractive due to low electricity costs in Manitoba.
- Excluded fuel switching in Alberta and Saskatchewan due to high intensity carbon grid

Implementing the Carbon Neutral Plan in Western Region will target carbon emissions reductions as follows:

Figure 18: Western Region Carbon Neutral Plan



Internal actions by Western Region can reduce PSPC's national portfolio carbon emissions by 8% (14,000 tonnes per year).

PART 2 – PLAN DEVELOPMENT

4 BACKGROUND

Public Services and Procurement Canada (PSPC) has a diverse portfolio of over 5 million square metres of Crown-owned real property assets, spread across the country. The majority of this area is office space with most of it concentrated in the Windsor to Quebec City corridor. PSPC has a long history of managing its assets in line with 'green' principles and Federal Sustainable Development Strategy objectives. And while past strategies have primarily focused on operational efficiency and energy management, they did include GHG reduction commitments in support of Canada's overall national GHG reduction goal:

- FSDS 2013-2016:17% reduction below 2005 levels by 2020
- FSDS 2016-2019: 40% reduction below 2005 levels by 2030, aspiring to achieve by 2025

However, in alignment with current Government of Canada priorities a new goal of a Carbon Neutral Portfolio has been introduced.

4.1 CARBON NEUTRAL COMMITMENT

PSPC has committed to achieving carbon neutrality of their owned portfolio by 2050, and further aspires to achieve this milestone earlier, by 2030.

This commitment has been established in line with and to support the current Government priorities, specifically GHG emission reductions and clean technology, following various goals, objectives and commitments announced by Canada both nationally and internationally:

- North American Leaders' Statement on a North American Climate, Clean Energy, and Environment Partnership (June 2016):
- Pan-Canadian Framework on Climate Change (December 2016):
- Mandate Letters to the Ministers
- Speech from the Throne to Open the First Session of the Forty-second Parliament of Canada
- Budget 2016
- TBS requests to PSPC
- Joint Memorandum to Cabinet on Greening Government Operations

In addition, PSPC has made further commitments that align and support this new commitment on Carbon Neutrality, including:

- To use 100% "clean" electricity in all PSPC facilities by 2025

- >$1B in new funding to implement PSPC's Energy Services Acquisition Project which is anticipated to reduce GHG emissions by >65%

4.2 DEFINING CARBON NEUTRAL

While definitions of carbon neutral vary across the globe and industry, they all incorporate, to varying degrees, three aspects:

- Energy efficiency of the building(s)
- Generation of renewable energy
- Procurement of renewable electricity, renewable electricity certificates (RECs) or offsets.

As there is no general consensus on a definition for carbon neutral, it is key that PSPC clearly outline their definition of carbon neutral.

At the outset of this mandate, the definition of Carbon Neutral started as:

Carbon neutral for the Department is defined as a highly energy efficient building and portfolio that produces on-site, or procures, enough carbon-free renewable energy to meet building operations energy consumption annually. The Department will focus on reducing emissions internally to reduce the number of offsets and credits required.

Feedback and comments received during Stakeholder Engagement sessions supported and reiterated that PSPC efforts to reduce GHG emissions should flow from the inside out, prioritizing first and foremost aspects under PSPC direct control, such as improving energy efficiency, fuel switching and construction of renewable energy generation; ensuring the best value for the Canadian public. Then, only after internal efforts have been reasonably exhausted, will procurement options be considered.

As a result, the following revised definition is put forward:

PSPC defines carbon neutrality as the efficient operation of its buildings and portfolio to conserve energy and reduce GHG emissions internally, complemented with fuel switching and installation of renewable energy generation to further reduce the GHG impact of its operations. Any remaining carbon-emitting energy consumption will be neutralized through procurement of renewable electricity, renewable electricity certificates (RECs), or carbon offset credits.

GHG emissions under this definition refer to annual carbon emissions associated to the operation of the buildings.

It should be strongly emphasized that the carbon neutral objective is a portfolio wide objective and as such, individual buildings within the portfolio may not, and some likely will not, achieve carbon neutrality on their own.

4.3 PLAN BOUNDARIES

The boundary of this plan has been drawn to encompass the PSPC portfolio of Crown-owned real property assets managed by PSPC which at present included 286 assets as identified in Appendix A.

This boundary was chosen based on PSPC present ability to properly inventory the GHG emissions of its assets and to affect direct changes in order to manage and reduce GHG emissions.

PSPC also manages a portfolio of leased assets.

Leases were excluded from the plan at this time. The current lease agreements do not permit PSPC to obtain the required data to properly inventory the GHG emissions for the leased spaces. Renegotiating leases may be required in order to readily and easily affect changes to manage or reduce GHG emissions. While the extent still needs to be determined, GHG emissions from leased assets likely represent a significant portion of PSPC's overall GHG footprint and efforts should be made in the near future to expand the Carbon Neutral Plan to include leased assets. It should be noted that certain initiatives put forward in this plan, such as space densification and property divestment, have direct correlations with leased spaces and would likely influence the decision making process. Critical to success of this plan is that both owned and leased spaces be considered together, so total carbon emissions influence is lessened, not merely shifted between owned or leased assets.

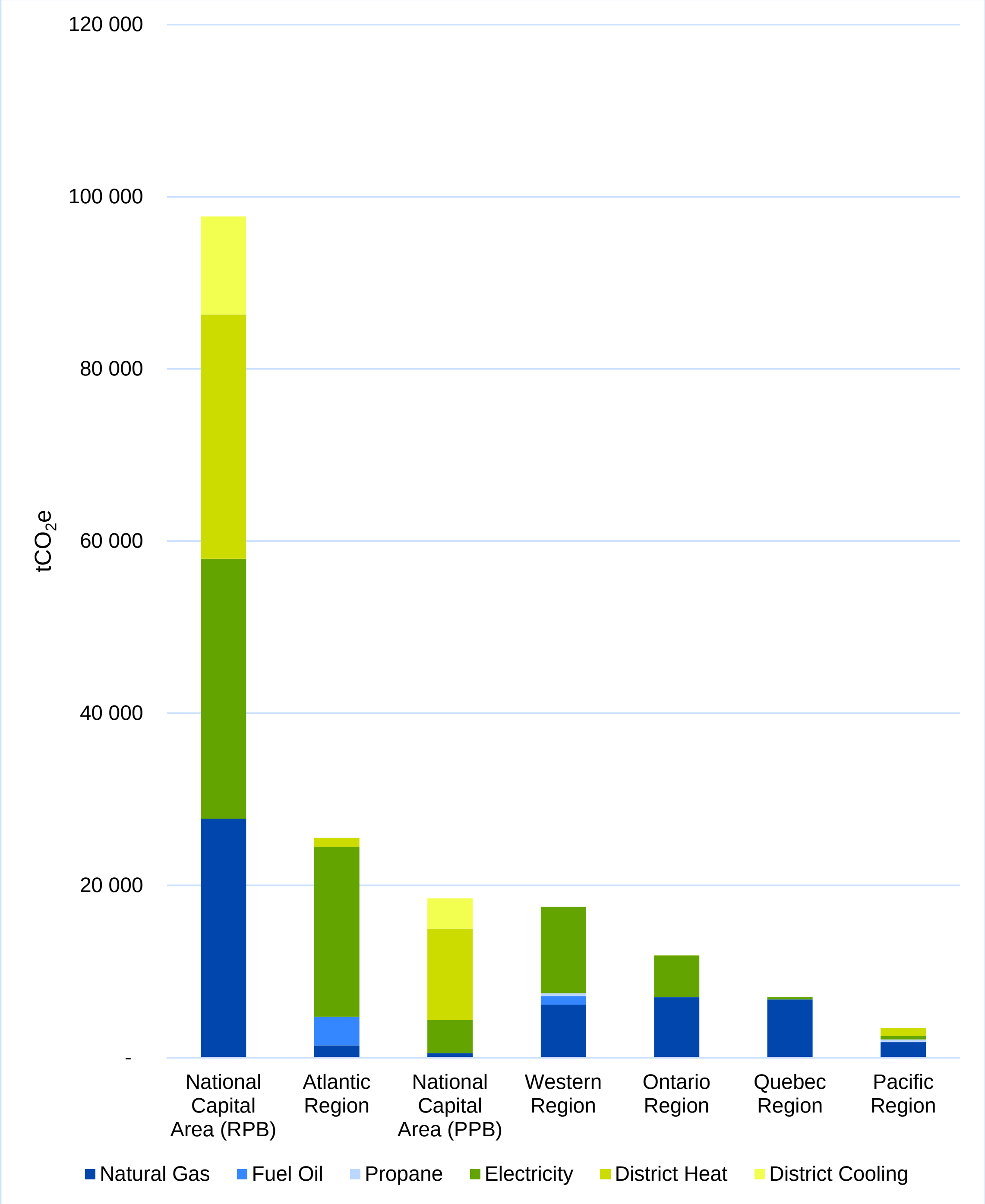
Canada's Real Property GHG footprint also includes assets owned and leased directly by other Departments. While leased assets are not addressed by this plan, the ideas, strategies and lessons learned by PSPC in developing and implementing this plan should be shared with other Departments.

We have excluded from our analysis all assets which did not report GHG emissions in 2015/2016. Excluded sites are primarily Tier 4 assets which have been sold, transferred, or deconstructed. The list of excluded facilities is as follows:

- Bonavista Government of Canada Building (GOCB)
- Arichat GOCB
- Montague GOCB
- Arnprior EMO Storage 44
- Film Storage – 167
- Customs Warehouse
- Oshawa GOCB
- Fairmont Complex
- Victoria GOCB
- Ste-Foy,1141 de l'Église
- Prince Albert GOCB

Note that some properties have been added to PSPC's portfolio since the previous GHG baseline was established. For example, the addition of the Carling Campus led to a net 3% increase in GHG emissions from PSPC's portfolio. Since the goal of the Carbon Neutral Plan is zero carbon, the plan must address all carbon emissions, whether or not they are recent additions to the portfolio. Similarly, any future additions to the portfolio will similarly cause an increase in PSPC's carbon emissions, and require additional action to reach the Carbon Neutral mandate.

Figure 19: 2015-16 Emissions by Region and Fuel

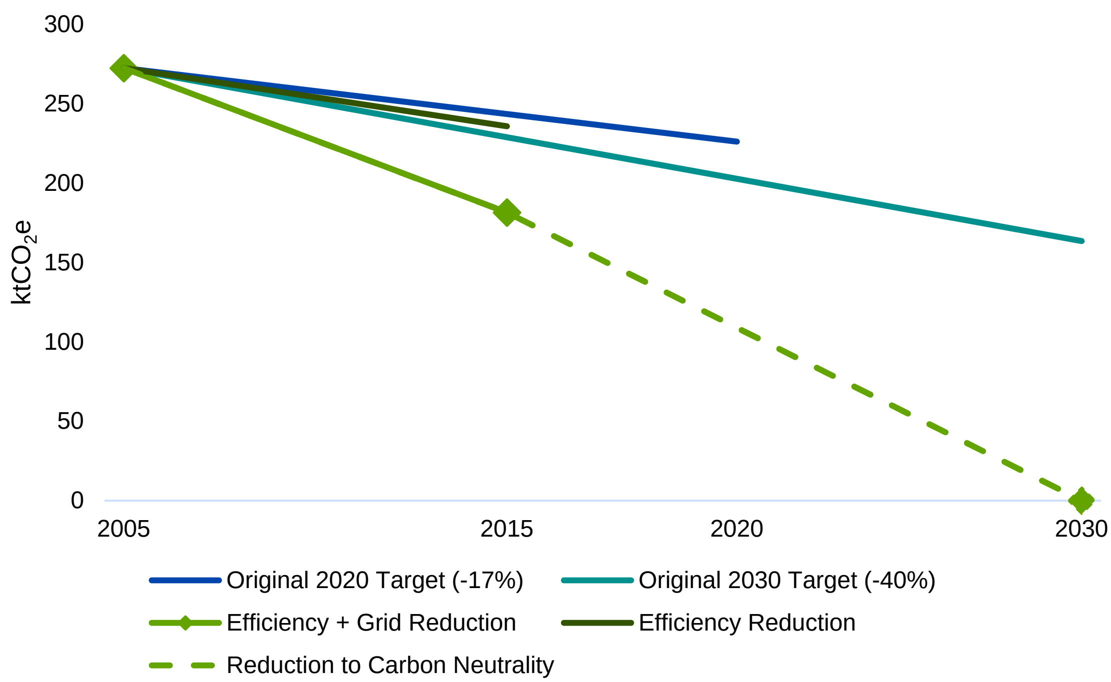


See Appendix A for further details of PSPC's historical GHG emissions footprint.

4.4 PROGRESS TO DATE

As of the 2015-16 fiscal year, PSPC's GHG inventory included 286 assets, which collectively emitted approximately 181,500 tCO_2e. This represents a 33% reduction in emissions from the 2005-06 adjusted baseline of 272,500 tCO_2e.[20] During this time, PSPC has reduced its emissions by 13% considering only efficiency initiatives. Concurrently, electricity generation has become less carbon-intense in many regions of the country through initiatives to add more low-carbon generation (hydro, wind, solar, nuclear) and decommissioning high-carbon generation (coal). This grid decarbonisation has resulted in an additional 20% reduction in PSPC's emissions over the past 10 years.

Figure 20: PSPC GHG Emissions Reduction Trajectory



Emissions result from the combustion of fuels on site including natural gas, light fuel oil and propane, as well as consumption of energy generated off-site, including electricity, district heating and district cooling.

In GHG accounting organizations report their operational boundary. An operational boundary is defined to prevent double counting of reported emissions. The boundaries are separated into the following three emission types:

- Direct GHG emissions (scope 1): emissions released from sources owned or controlled by the organization. They may include fuel combustion, refrigerant emissions, generation of electricity, and/or fuel combusted from owned or leased vehicles.

20 This baseline has not yet been adjusted to include recently acquired assets. For example, the addition of the Carling Campus could increase the baseline by approximately 9,000 tCO_2e or 3%. Under the carbon neutral mandate, eliminating emissions reported in the 2015-16 inventory and future inventories is prioritized over reducing emissions by a percentage relative to the 2005 adjusted baseline.

→ Energy indirect GHG emission (scope 2): indirect emissions from the generation of purchased energy for the organization. They may include the purchase of electricity, steam and/or chilled water.

→ Other indirect GHG emissions (scope 3): emissions that are released from activities outside the organizations direct control (their value chain). They may include business travel, employee commuting, waste, transmission and distribution losses from electricity and more.

4.5 OPPORTUNITIES AND CHALLENGES

Several opportunities and challenges unique to PSPC's portfolio and Carbon Neutral Plan were considered and are summarized as follows:

Opportunities:

- Direct ownership and control of all buildings included in the portfolio
- Long-term hold ownership strategy
- Manage central heating and cooling plants
- Low-carbon fuel access (QC)

Challenges:

- Diverse regional distribution
- Different electricity grids with higher and lower carbon intensity
- Diverse climates
- Different tenant and program needs
- Heritage assets
- Legacy management requirements not in alignment with carbon neutrality objectives

4.6 HOW THE CARBON NEUTRAL PLAN RELATES TO OTHER PSPC PROGRAMS

PSPC's National Carbon Neutral Portfolio Plan is a commitment to reduce carbon emissions across PSPC's portfolio. This is not a replacement of previous sustainability and energy programs, but rather is complementary to existing (and future) initiatives. For example:

- The Leadership in Energy and Environmental Design (LEED) certification system as well as the Building Owners and Managers Association Building Environmental Standards (BOMA BEST) certification program support energy efficient building design, construction, and/or operation. But LEED and BOMA BEST also address additional sustainability factors like water use, waste reduction, site selection, occupant environmental quality etc. An energy efficient building can achieve LEED or BOMA BEST certification yet still generate carbon emissions. However, a carbon neutral building must be very energy efficient. In this way, pursuing the Carbon Neutral Plan will support holistic sustainability programs such as LEED and BOMA BEST.
- Increasingly, certification systems are adding emphasis to recognize properties that provide outstanding occupant health and wellbeing. The Carbon Neutral Plan does not address any mandate of occupant health and wellbeing. However, occupant wellbeing remains a focus of PSPC. The Carbon Neutral Plan must act in collaboration with PSPC wellbeing programs. With the right commitment, collaboration and attention to detail, a healthy carbon neutral building is an achievable goal.

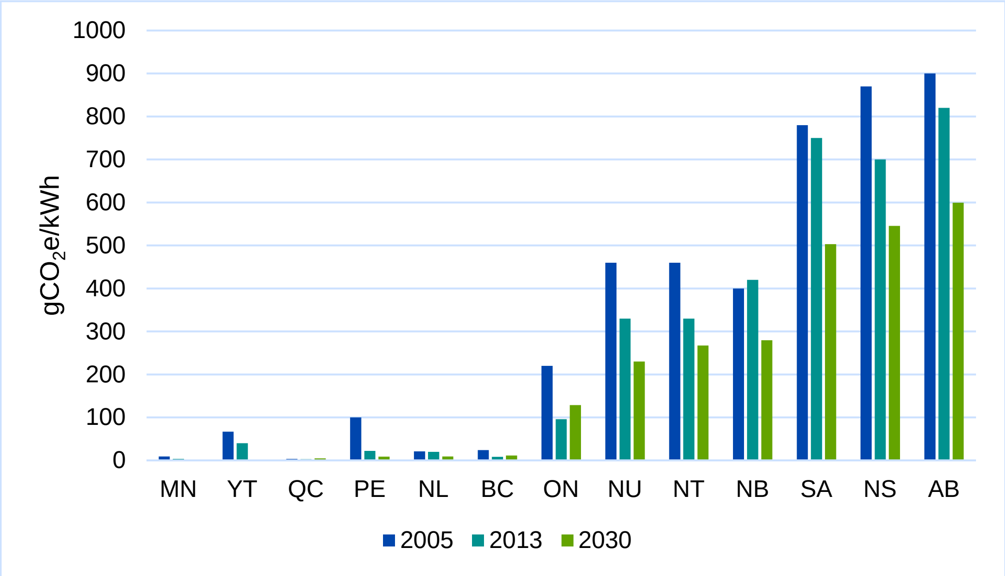
5 REGIONAL CONTEXT

PSPC manages assets in all Canadian provinces and territories. The development of the carbon neutral plan considers regional differences and opportunities, including different electricity grid carbon intensities, utility rates, climates and real estate trends and influences.

Electricity in Canada is generated using fossil fuels (coal, natural gas, and oil), nuclear generation and renewable generation (hydroelectric, wave, tidal, wind, solar, biomass, geothermal). The composition of fuels used to generate electricity varies by region and Province, and impacts the carbon intensity of electricity consumed in each region. For example, Alberta electricity is mostly generated from coal and natural gas, resulting in a current emissions intensity of 820 gCO_2e per kilowatt hour (kWh), while Quebec electricity is mostly from hydroelectric generation resulting in an emissions intensity of 3 gCO_2e/kWh (Figure 21).

Grid intensity changes over time as the fuel mix of electricity generation changes. PSPC does not have direct control over this factor as electricity generation is a provincial responsibility. As a result of shifting away from fossil fuels in some provinces, regional emissions factors for electrical generation decreased by an average of 37% between 2005 and 2013. For example, Ontario’s emissions factor decreased by 70% during this time, as a result of decommissioning coal-fired power plants. Grid intensity is anticipated to continue to decrease in most provinces and territories by 2030 in line with the planned phase-out of coal generation, with increases expected in some areas. For example, Ontario’s emissions factor is projected to increase by 34% as a result of nuclear plant refurbishment, and the temporary replacement of this zero-emissions energy with natural gas generation as well as renewable energy (Figure 21).

Figure 21: 2005, 2013 and Anticipated 2030 Electric Grid GHG Intensity by Province/Territory[21]



5.1 UTILITY RATES

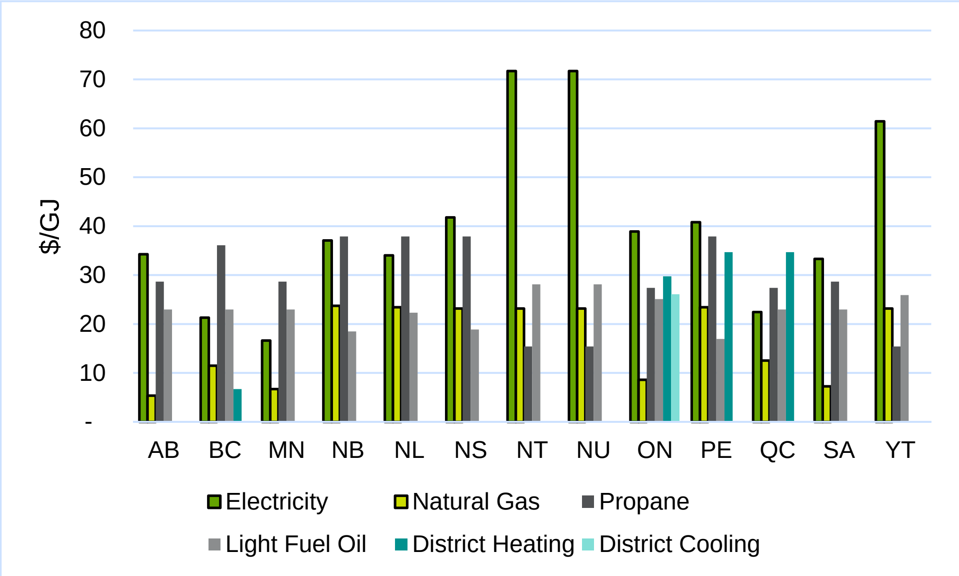
Utility rates drive decisions about conservation activities and fuel types used. Increasing electricity rates in some regions have prioritized electricity conservation over natural gas conservation, as a cost saving measure. Lower natural gas rates per unit of energy may dissuade switching from carbon-emitting gas heating to cleaner electric heat pumps due to the potential utility cost increase.

In addition, not all fuels are available in all regions. Properties in the northern Territories and some Atlantic provinces do not typically have access to a natural gas supply. As a result, building heating in northern and Atlantic regions is often supplied by other fuels such as heating oil or propane.

See Figure 22 for average utility rates by province and territory, based on utility costs paid by PSPC facilities during 2015.

21 2005 Emissions Factors: Environment Canada, 2013, Canada's National Inventory Report 1990-2011: Greenhouse gas sources and sinks in Canada, Part 3; 2013 Emissions Factors: Environment Canada, 2014, Canada's National Inventory Report, Part 3 (2012 emissions factors used); anticipated 2030 emissions factors calculated from 2013 factors and change in grid mix from: National Energy Board, 2016, Canada's Energy Future 2016: Energy Supply and Demand Projections to 2040, https://apps.neb-one.gc.ca/ftrppndc/, Reference Case

Figure 22: Utility Cost by Fuel and Province/Territory



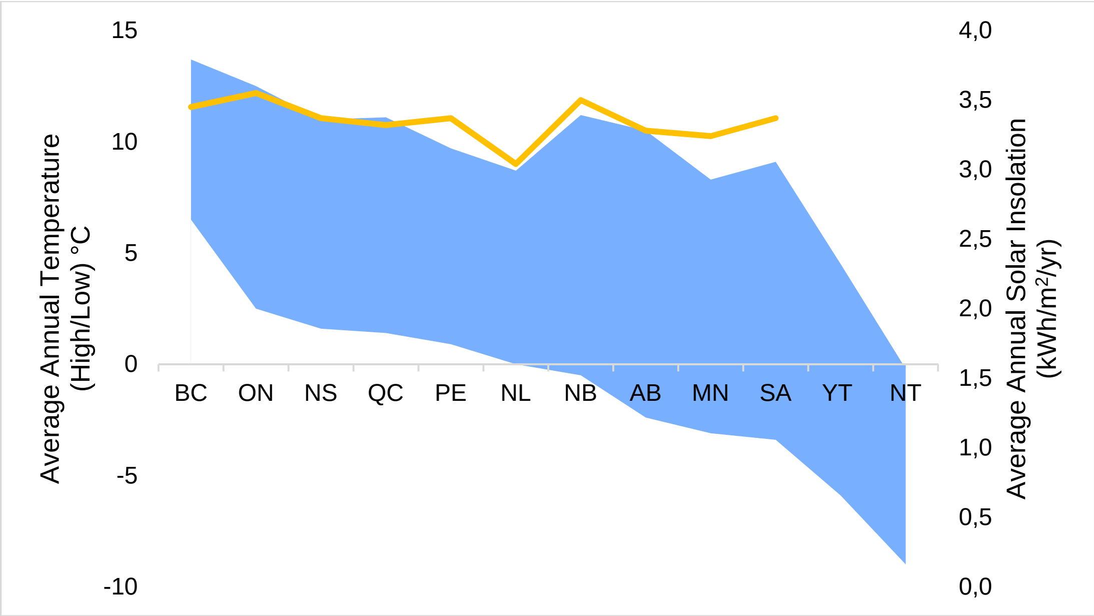
5.2 CLIMATE FACTORS

Building energy use may be impacted by regional climate factors such as temperature, weather and solar irradiance. Buildings in temperate regions may require less energy for heating and cooling than buildings experiencing extremely cold or warm temperatures. While buildings in temperate regions may more easily achieve carbon neutrality, cold climate buildings have the potential to achieve significant GHG emissions reductions and some may eventually achieve carbon neutrality. PSPC's Carbon Neutral Plan should reflect these barriers and opportunities. For example, targeting lower absolute energy use and carbon intensity in temperate regions, and targeting more significant energy and carbon reduction in more extreme regions.

The amount of sunlight a building receives influences how much energy is used for lighting, heating, and cooling. It also determines how much energy can be generated through solar photo-voltaic (PV) generation. Areas of high solar irradiance can generate more electricity through solar PV. However, all Canadian regions have similar average annual solar insolation, supporting the argument that this technology can be used to some degree in any region. While the largest opportunity for carbon neutral buildings exists in temperate climates, there is a significant opportunity for GHG savings in cold climates due to the greater heating needs there.

See Figure 23 for Provincial average annual temperature (from Statistics Canada), and solar insolation (from Atmospheric Science Data Center, NASA Surface Meteorology and Solar Energy).

Figure 23: Average Annual Temperature and Solar Insolation by Province/Territory



6 PLAN DEVELOPMENT

In developing this Plan, PSPC considered past internal initiatives focused on efficiency and sustainability. Recognizing that past initiatives would be insufficient to achieve carbon neutrality, PSPC engaged a consultant – WSP – to assist in the development of a National Carbon Neutral Portfolio Plan.

Steps to develop this plan included

- → Understanding past PSPC initiatives
- → Considering PSPC's asset characteristics (tiers, heritage status, fuels used, and regions)
- → Defining the metrics to be used for decision making
- → Engaging Real Property stakeholders from all regions and relevant groups within PSPC to receive input and feedback on possible plan elements, to understand the current organization and to develop possible organizational approaches to effectively implement a National Carbon Neutral Portfolio Plan.
- → Researching how other real property entities are pursuing carbon neutrality in other jurisdictions and similar climates
- → Selecting plan elements that fit PSPC objectives, opportunities and needs

6.1 UNDERSTANDING PAST PSPC INITIATIVES

PSPC has always had a strong commitment to greening government operations with forward thinking targets established in Federal Sustainable Development Strategies. Emphasis was always on improving operational efficiencies of the National Portfolio through dedicated energy initiatives and environmental assessment tools. PSPC has consistently used dedicated energy efficiency initiatives to advance its objectives through the use of tools such as cyclical energy and re-commissioning audits, Energy Performance Contracts and sub-metering. Environmental assessments use tools such as BOMA BEST for operational evaluations, and LEED and Green Globes for new construction and major renovations. Departmental green building policies also include commitments for energy efficiency thresholds in new construction and newly acquired buildings.

Specific GHG reduction objectives were first introduced in the FSDS for 2012-2013 and were established at 17% reduction below 2005 levels by 2021. The strategies and results of which were reported in the GHG Action Plan. The three major initiatives identified in the action plan included: the Energy Service Acquisition Project (ESAP), Inventory Progression, and Efficiency Initiatives in existing buildings.

Understanding that past methods of achieving energy savings would be insufficient to meet the new objective of Carbon neutrality, PSPC recently initiated a number of new measures:

1. Informal National Office Lighting Update; this entails the replacing of fluorescent lighting fixtures with light-emitting diode (LED) fixtures.
2. The implementation of GHG and sustainability targets in the re-design of 3 flagship buildings, where major asset renewal was already ongoing. PSPC wanted to demonstrate leadership by showcasing high visibility assets immediately, specifically:
   - Lester B. Pearson Building in Ottawa
   - Centre Block on Parliament Hill
   - Arthur Meighen (25 St. Clair) in Toronto
3. Energy Star Portfolio Manager Benchmarking for all PSPC assets
4. Several Energy Performance Contracts for buildings in Ottawa and Montreal
5. National Smart Building Initiative; it is expected that 80 buildings across Canada will be implementing Smart Building technology in the next 5 years.
6. ESAP to modernize PSPC’s district heating and cooling plants.
7. Clean Electricity Commitment; PSPC has committed to purchasing 100% clean electricity for its facilities by 2025.
8. Bulk Natural Gas Initiative; where green natural gas (i.e. produced from organic waste) options have been included in the contract terms and conditions.
9. Workplace Solutions modernisation
10. Build in Canada Innovation Program to leverage innovative technology
11. Project GHG Options Analysis Methodology

Several of the above new initiatives are being integrated into the Carbon Neutral Plan.

6.2 ASSET CHARACTERISTICS

Asset characteristics were considered when deciding which buildings and regions would implement each element. Characteristics have been taken into consideration in developing the plan and are available to inform future implementation decisions. The remainder of this section will describe each element, its applicability to specific types of assets within the portfolio, and expected outcomes and the funding required.

A key feature of this plan is acknowledging that every building is unique – with its own set of opportunities, challenges, system design, and occupant expectations. It is not appropriate, nor even possible, to implement every element of this plan at every building in PSPC's portfolio.

Individual building plans must be developed to ensure appropriate implementation. At this planning stage, PSPC must project cost, benefit, and general strategy by identifying elements which are likely applicable to assets depending on characteristics such as their condition, capital plan (tier), heritage status, fuel type use or location.

6.2.1 ASSET TIERS

Following PSPC's tiering tool, all assets are categorized as tier 1, 2, 3 or 4, based on their current condition and future planned retrofit or disposal activities (Table 19). Some measures are suitable to buildings in a specific tier. For example, tier 3 properties that have been identified for near-term major investments are ideal for concurrent deep energy and GHG retrofits. Tier 4 properties that are slated for disposal may merit minimal retrofits to improve their condition and performance, but may be omitted from some longer-term initiatives.

Parliamentary Precinct uses a different system to describe asset condition. In this Plan, the majority of PPB sites are recognized to require deep retrofits in the near term and are targeting similar activities to tier 3 facilities, where appropriate. New and recently renovated PPB sites including the Wellington Building and West Block are targeted for similar activities as tier 1 facilities, where appropriate.

Table 19: Tier Descriptions

Tier	1	2	3	4
Goal	**Plan & establish next life cycle**	**Identify short & long term funding needs**	**Renovations to support improved performance**	**Repairs only to support disposed value**
Financial Performance	Excellent	Good	Good to Poor	Poorest
Non-Financial Characteristics Supporting Portfolio Objectives	High	Above Average	Moderate to Poor	Poorest
Satisfy Long-Term Tenant Needs	Yes	Yes	N/A	No, Short-Term Only
Require Major Capital Investments/ Renovations/ Disposals in Next 10-15 Years	No	No	Yes, in Next 5 Years	Disposal (or major recapitalization) in Next 5-10 Years

Tier	1	2	3	4
Comments		Second wave of major portfolio recapitalization	First wave of major portfolio recapitalization; requires greatest scrutiny in assessing investment and/or leasing decisions	Investment cannot be justified (but compelling imperatives may require retention or investment)

6.2.2 HERITAGE ASSETS

Heritage designated assets represent 40% of PSPC's portfolio by floor area. This includes 69 "recognized" assets (19% of floor area) and 31 "classified" assets (21% of floor area). PSPC cannot achieve carbon neutrality without taking action at heritage sites.

Table 20: Summary of Heritage Assets

Metric	ATLANTIC	NCR	PPB	ONTARIO	QUEBEC	PACIFIC	WESTERN
Number Properties							
"Recognized"	16	12	13	13	5	5	5
"Classified"	-	13	9	4	3	-	2
Total Heritage	16	25	22	17	8	5	7
Floor Area (m^2)							
"Recognized"	103,297	491,283	113,622	114,880	80,427	18,964	33,636
"Classified"	-	795,686	162,302	54,552	37,937	-	23,579
Total	103,297	1,286,969	275,924	169,432	118,364	18,964	57,215
% of Total Portfolio	**2%**	**25%**	**5%**	**3%**	**2%**	**<1%**	**1%**

Where plan elements are applied to heritage assets, costs and savings may be modified to reflect key differences in implementing efficiency projects at heritage assets.

Heritage assets are recognized as offering a key opportunity to conserve history while enhancing efficiency, and are ideal for innovative solutions that achieve dual objectives.

Other administrations offer illustrative examples of significant energy and GHG reductions achieved at historic buildings while preserving their cultural and architectural value.

The Empire State Building opened in 1931 in New York City. The building underwent a deep energy retrofit in 2008. The project was anticipated to reduce energy consumption by 38% and GHG emissions by 105,000 tCO_2e over 15 years, while also reducing cooling load requirements and peak electricity demand.[22] Project elements included:

- Direct digital controls (DDC)
- Variable air volume (VAV) air handling units (AHU)

22 Empire State Building, Leading Example for Energy Efficiency, http://www.esbnyc.com/esb-sustainability/press-and-resources/empire-state-building-energy-efficiency

- Chiller plant retrofit
- Window retrofits
- A radiative barrier
- Tenant strategies:
- Addressing tenant lighting, daylighting and plug-loads
- Tenant energy management program
- Tenant demand control ventilation (DCV)

As an added benefit, these measures supported improved indoor environmental quality, thermal comfort and lighting conditions for tenants.

The 57,600 m^2 Byron G. Rogers Federal Building and U.S. Courthouse was constructed in 1964. The building underwent a major renovation between 2010 and 2014, targeting LEED Gold certification and a 70% reduction in existing energy use.[23] The interior was completely replaced, with the exception of significant historic interior design elements, and asbestos was abated. The primary structure and historic exterior envelope were maintained. Building upgrades included replacing mechanical, electrical, lighting, fire protection and plumbing systems. Significant energy conservation measures included LED lighting, high-performance lighting controls, solar thermal heating and thermal energy storage.[24]

Looking ahead, a group of UK City Councils has investigated low carbon opportunities for their significant heritage building stock. Kirklees and Leeds Councils in Yorkshire commissioned a Low Carbon Heritage Buildings user guide to provide steps for groups restoring heritage buildings to incorporate carbon reductions.[25] The guide includes a high-level assessment of measures with high, medium and low impact and discusses heritage specific issues to consider for each measure. For example, solar PV requires a roof that is not visible from significant viewpoints to preserve the heritage appearance, and historic roof structures may not support added weight.

6.2.3 FUELS USED AT THE ASSET

GHG emissions vary by fuel type.

Table 21: GHG Intensity by Fuel Type

Fuel Type	Emissions Factor (gCO_2e/kWh)
Light Fuel Oil	257
Propane	220
Natural Gas	178
Electricity	3 to 820 Refer to provincial grid intensity (Table 2).

23 Rocky Mountain Institute, Byron G. Rogers Federal Office Building, http://www.rmi.org/Content/Files/ByronRogersCaseStudy.pdf

24 Bartels, M.C., Swanson, M.L., Summer 2016, From Retro to Retrofit, High Performing Buildings, http://www.hpbmagazine.org/attachments/article/12423/Byron%20Rogers%20Building.pdf

25 Low carbon heritage buildings: A user guide, http://yourclimate.github.io/system/files/documents/Low%20carbon%20heritage%20buildings...%20guide%20(Final%2014-11-2011)%20(2).pdf

Fuel switching can offer an opportunity to reduce GHG emissions by converting a building from a carbon-intense fuel to a low-carbon alternative. Examples of fuel switching are converting from light fuel oil, propane or natural gas heating to electric heat pumps, or connecting to a district heat plant instead of maintaining an on-site gas boiler. The type of fuel currently used, as well as its relative carbon intensity compared to available alternatives, informs whether a building will undertake fuel switching measures.

6.2.4 REGION

Some elements of the Carbon Neutral Plan are more applicable or less applicable depending on the province, territory or region in which an asset is located, and the specific energy carbon intensity and costs there.

For the purposes of this plan, the Parliamentary Precinct assets have separated from the National Capital Region (NCR) assets in order to allow Parliamentary Precinct Branch (PPB) to better understand and manage how GHG affects their assets.

NCR assets have opportunities related to improving efficiency at the ESAP district heating and cooling plants, or connecting to ESAP.

6.3 DEFINING METRICS FOR DECISION MAKING

Defining appropriate metrics is key to proper planning, decisions making, and achieving of goals. With the objective of achieving carbon neutrality, defining and implementing the proper and relevant metrics is essential to attaining the goal. A number of metrics were discuss and explored though the stakeholder engagement sessions and in the elaboration of this plan. The metrics identified were used to inform which elements of the plan are most beneficial, to identify which elements represent the greatest impact, and to help establish the priority of implementation. Moving on from the plan to implementation, these same metrics will need to be used in the analysis and decision making process to determine the best course of action to take for each project, and determining the priority of projects across the portfolio.

PSPC suggested initial metrics of:

- → GHG emissions reduction impact (tCO_2e)
- → Implementation cost ($)
- → Value ($/tCO_2e$)

The above metrics were presented to stakeholders for discussion and validation, and to elicit further potential metrics.

Incremental lifecycle cost per tonne emissions reduced (LCC $/tCO_2e$) emerged as the primary metric. This aligns with PSPC's objective to reduce GHG emissions as much as possible at the best financial value over the project lifetime. A 25-year net present value (NPV) was used to calculate lifecycle cost, as directed by PSPC to align with the lifecycle duration commonly used in PSPC financial decisions. Secondary metrics include grid carbon intensity, heating fuel and building condition. These metrics serve to prioritize activities for buildings that use more carbon intense electricity and fuels, to maximize carbon reductions per dollar invested, and that are planned to undergo deep retrofits in the near term to capture synergies and achieve greater carbon reductions through additional, incremental investments.

Table 22: Metrics Definitions

Criterion	Units or Categories	Definition	Rationale
Lifecycle cost per emissions reduction	LCC $/tCO_2e$	25-year NPV lifecycle cost per tonne of carbon reduced	Maximum GHG reduction at minimum lifecycle cost
Grid Carbon Intensity	gCO2e/kWh	Carbon emitted per kWh electricity consumed	Prioritizes certain activities (e.g. solar PV generation) in grids with greatest carbon reduction potential
Heating Fuel	Electricity, Natural Gas, Propane, Fuel Oil or District Heat	Type of fuel used to heat the building	Prioritizes certain activities (e.g. fuel switching; ESAP plant measures) in buildings with greatest carbon reduction potential
Building Condition	Tier 1, 2, 3 or 4	Current condition of building and near-term planned upgrades, maintenance or disposal	Aligns carbon-reduction activities with planned capital upgrades to capture cost synergies
Total Energy Use Intensity & Total Thermal Energy Demand	GJ/m^2	Total energy or thermal energy used per building area in gigajoules (GJ) Note that although “demand” often refers to a peak instantaneous use (GJ/s), the increasingly popular term “Thermal Energy Demand” refers to energy consumed over a period of time (GJ).	Ensures that, even in areas with low grid carbon intensity, energy conservation is prioritized and implemented

See Table 23 for a list of decision criteria metrics suggested by stakeholders. Those metrics may be used for future implementation decisions.

6.4 BUILDING ON STAKEHOLDER INSIGHTS

In developing this plan, PSPC engaged with staff, consultants and other stakeholders from all Regions and significant Branches including:

- NCR
- Ontario Region
- Atlantic Region
- Western Region
- PPB
- ESAP, which operates PSPC-owned district heating and cooling plants in the NCR
- Technical Services

- Treasury Board Secretariat (formerly Centre for Greening Government)
- Brookfield Global Integrated Solutions (BGIS)

Stakeholders were engaged through in-person and web conference discussions. They were presented with the plan context & background, regional context, market research, a possible plan framework, plan elements and decision criteria, and given the opportunity to provide feedback on the following questions, in addition to general feedback:

- What GHG reduction strategies are already working in this region?
- What challenges might exist to meeting the GHG reduction target in this region?
- What actions would you propose to meet the GHG reduction target?
- What do you think about the possible plan framework?
- What do you think about the possible decision criteria? Are these the right criteria? Are there other criteria you would use?

Stakeholder engagement sessions were conducted in the National Capital Region on January 18th and 19th, 2017. The sessions were with ESAP on the morning of the 18th, PPB on the afternoon of the 18th and NCR/TBS/BGIS all day on the 19th. A small follow up session for certain members of PPB who were unable to attend the original session was conducted on February 1st, 2017.

Ontario Region stakeholders were engaged at a general session on January 26th, 2017, focused on Greening Government Operations, a larger initiative that encompasses the Carbon Neutral Plan initiative. Atlantic Region stakeholders were engaged via web conference on January 31st, 2017. Western Region Stakeholders were engaged via web conference on February 14th, 2017.

The sessions were generally well attended and interaction with those in attendance was high and very constructive. The sessions provide a lot of valuable insight into structure, teams, operations, concerns and ideas of the various groups in attendance. Feedback from participants was positive and they looked forward to the next steps.

Results of stakeholder engagement sessions confirmed key plan elements, opportunities, challenges and decision criteria (Table 23).

Table 23: Summary of Stakeholder Feedback

Opportunities
→ Low-carbon fuels (e.g. biomass)
→ Stakeholder relationships
→ Low-cost activities (e.g. operations)
→ New technologies
→ Consolidate underutilized space
→ Include energy and carbon efficiency in planned major rehabilitations and deep retrofits
→ Enterprise solutions
→ Identify carbon objectives early in project planning to inform scope and budget
Challenges
→ Funding

- → Behaviour change (occupants)
- → Achieving carbon neutrality on-site
- → Training
- → Satisfying tenant needs alongside carbon neutral goals
- → Delayed information on energy performance
- → Aligning heritage and carbon reduction objectives
- → Access to low-carbon energy and fuels
- → Potential operational cost increases

Decision Criteria

GHG Value	→ **Net Present Value (LCC $/tCO_2e$)** → Incremental Net Present Value (Incremental LCC $/tCO_2e$) → Simple Value ($/tCO_2e$)
GHG Reduction	→ **Regional Grid Carbon Intensity (gCO_2e/kWh)** → GHG Reduction (tCO_2e) → GHG Intensity (tCO_2e/m^2) → Magnitude of GHG Reduction (% of portfolio emissions) → GHG Savings Per Full-Time Equivalent Occupant (tCO_2e/FTE)
Cost and Savings	→ Implementation Cost ($) → Cost per Area ($\$/m^2$) → Cost per Occupant ($/FTE) → Incremental Cost ($) → Incremental Cost (% increase relative to base costs) → Life Cycle Cost (25-year NPV $) → Avoided Future Capital Cost ($) → Avoided Operational and Maintenance Costs ($) → Energy Cost Savings ($) → Asset Value Improvement ($) → Return on Investment ($/year) → Payback Period (years)
Energy	→ **Energy Intensity (GJ/m^2)** → **Thermal Energy Demand (GJ/m^2)** → Avoided Future Energy Demand (kilowatt or KW)
Utilization	→ Occupant Density (FTE/m^2) → Building Utilization (%)

Building-Specific Criteria	→ **Heating Fuel** → **Building Condition** → Planned Disposal
Activity-Specific Criteria	→ Scalability → Speed of Implementation and Results → Technology Type: Demonstration Projects → Confidence in Performance and Timeline → Long-Term Maintenance of Reductions
Other Qualitative Criteria	→ Alignment with Other Scheduled Activities, Visions, Plans → Political Capital: Marketability, Leadership, Visibility, Demonstrated Value → Partnership Opportunity

Bold = Selected as primary or secondary metric for the carbon neutral plan.

Key messages from specific sessions included:

ESAP

- Extensive discussion about the future plans for District Plants
- Potential financial models (Public Private Partnership – P3, Design/Build/Finance/Maintain/Operate – DBFMO) and pros and cons
- Strategy already analyzed for GHG reduction
- Other initiatives that could assist with carbon neutrality goal

PPB

- Challenges presented by the unique tenants
- Heritage aspect
- The impact of ESAP on their buildings
- Desire and potential of being a beacon for change on the national and international scene. High profile and visibility of the buildings, particularly Centre Block.
- Integration with Long Term Vision Plan

NCR

- Anticipated challenge in engaging all PMs, need to clearly articulate the objective and direction
- Buy-in at all levels will be critical
- In depth discussion on potential strategies (floor area reduction, Workplace 2.0/3.0, leveraging clean electricity from Quebec, ESAP)
- Need for data collection to better inform decision making
- Questions about financing of carbon neutral initiatives

- Need to intervene quickly on certain projects already in the planning stages (875 Riverside Dr, Centre Block, Place du Portage III, and others)

Further details of stakeholder feedback are presented in Appendix B.

6.5 UNDERSTANDING CARBON NEUTRAL PLANS IN OTHER JURISDICTIONS

At an early stage of Plan development, we completed a review of carbon neutral plans in other jurisdictions, to inform PSPC's approach. Real property entities are increasingly committing to deep carbon reductions, including energy efficiency, renewable energy and/or carbon neutral objectives. While no other jurisdiction has yet achieved carbon neutrality through wide-spread deep reductions in building-level carbon emissions, committed governments and businesses offer illustrative examples of the kinds of elements considered for carbon neutral and deep carbon reduction plans.

New York City is pursuing an ambitious GHG reduction target of 80% from 2005 by 2050, based on all emissions within the city, not just those resulting from municipal operations.[26] Building stock constitutes 68% of the City's GHG emissions footprint, offering a significant opportunity for GHG reductions. NYC is targeting a reduction of 26 to 27 million tCO_2e in building emissions through efficiency and renewable energy generation, including the following strategies:

- Low- and medium-effort energy conservation measures
- Deep energy retrofits in existing buildings
- Transitioning away from fossil fuels in buildings through high-efficiency electric technologies (e.g. air-source heat pumps)
- Biofuels for heating
- Managing energy capacity demand to reduce peak loads
- A performance-based energy code for new buildings and major renovations
- Installation of 1,000 MW of solar PV by 2030
- Leading by example in City-owned buildings
- Programs, regulatory processes and workforce development to support energy efficiency in the private sector

Copenhagen, Denmark is targeting carbon neutrality by 2025 in city operations, and has already achieved significant reductions.[27] Key plan elements include:

- Installing 60,000 m2 of solar panels, on all new and existing municipal buildings
- Mapping building energy consumption and centralizing energy management
- Piloting innovative technologies
- Converting combined heat and power plants from coal to biomass

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26 New York City's Roadmap to 80 x 50, http://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/New%20York%20City's%20Roadmap%20to%2080%20x%2050_20160926_FOR%20WEB.pdf

27 Copenhagen 2025 Climate Plan, http://kk.sites.itera.dk/apps/kk_pub2/pdf/983_jkP0ekKMyD.pdf

- Adding to national renewable energy wind generation capacity
- Mandating energy conservation targets for utility companies, and stricter fuel efficiency regulations

Stockholm, Sweden is committed to a 20% absolute emissions reduction from 1990 by 2020 as well as an intensity target of 3 tCO_2e per resident by 2015.[28] Stockholm has further targeted zero fossil fuel use by 2050. Strategies to support these objectives are anticipated to reduce emissions by 100,000 tCO_2e between 2015 and 2020, and include the following activities:

- Converting the city district energy plant from coal to biofuel with carbon capture and storage
- Converting buildings from oil, naphtha and electric heating to natural gas and district heating
- Phasing out energy-efficient lightbulbs as part of a European Union directive
- Energy efficiency improvement programs for existing buildings
- Heat exchange ventilation
- Optimized lighting design
- Boiler conversions to district biofuel heating or electric heat pumps

The Carbon Neutral Cities Alliance (CNCA) Framework for Long Term Deep Carbon Reduction Planning provides processes, strategies, practices, tools and institutional structures used by leading global cities to plan long-term, deep reductions in carbon emissions with the goal of reducing emissions by 80% from 1990 to 2050.[29]

The CNCA Framework focuses exclusively on deep reductions, which typically require transformative rather than incremental approaches and take years to achieve. Several large city centers are using the framework to achieve their carbon reduction goals, such as Berlin, Boston, Copenhagen, London, Melbourne, Minneapolis, New York, Oslo, Portland, San Francisco, Seattle, Stockholm, Sydney, Vancouver, Washington DC, and Yokohama, though many of these cities have set goals that are more aggressive than those outlined in the Framework.

The province of British Columbia has achieved carbon neutrality of its operations since 2010 through its Carbon Neutral Government program.[30] The program relies heavily on carbon offsets, supported by decentralized efficiency projects that achieved a 5% weather-normalized emissions reduction between 2010 and 2015. BC Public Service Organizations are responsible for achieving the carbon neutral target independently.

The private sector likewise offers illustrative examples of deep carbon reduction strategies.

Google has been pursuing carbon neutrality of their global operations since 2009 and anticipates achieving neutrality in 2017, including investments in sustainable buildings, infrastructure and operations. Renewable energy procurement forms a significant portion of this strategy. Google is one

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28 Stockholm action plan for climate and energy 2010-2020, http://projects.centralbaltic.eu/images/files/result_pdf/COMBAT_result2_Stockholm.pdf

29 Carbon Neutral Cities Alliance, Framework for Long-Term Deep Carbon Reduction Planning, https://www.usdn.org/uploads/cms/documents/cncaframework_deepdecarb.pdf

30 British Columbia, Carbon Neutral Action Planning, http://www2.gov.bc.ca/gov/content/environment/climate-change/reports-data/carbon-neutral-action-reports

of the first companies to enter into large-scale, long-term PPAs to directly procure renewable energy to reduce emissions from global corporate offices and data centres. At present, Google is the largest purchaser of renewable power, with commitments for 2,600 MW of wind and solar generation annually. The scale of these purchases significantly influences the renewable energy generation market, and offers economic benefits to local communities where generation projects are located.

Bentall Kennedy is a Canadian real-estate sustainability leader, regularly at the top of industry indices such as the Global Real Estate Sustainability Benchmark (GRESB). Bentall Kennedy has been committed to carbon neutrality since 2015 and achieves this goal through a combination of energy efficiency projects and procurement of RECs and carbon offsets. Building efficiency strategies include:

- → Building energy efficiency targets
- → LEED Volume and BOMA BEST green building certification programs
- → Efficient building system operations
- → Lighting retrofits and controls
- → Fit-out and operations guides for tenants
- → Innovative technology pilots including solar-powered rooftop HVAC equipment and fuel cells

The Carbon Neutral Plan developed for PSPC contains many of the same elements used by other jurisdictions and real property enterprises pursuing deep carbon reductions and carbon neutrality.

Not all strategies applied globally are suitable to PSPC. For example, unlike Copenhagen, the NCA does not yet have combined-heat and power plants to convert to biofuels. Rather, a similar strategy may be applied to NCA's district heating and cooling plants, which will decarbonize connected building heating and cooling, but will not decarbonize connected building electricity use.

In contrast to other real property entities heavily reliant on RECs and offsets to achieve neutrality (e.g. Government of BC, Bentall Kennedy), PSPC's intention is to invest first in its own portfolio as part of a robust carbon reduction program. This 'inside-out' strategy prepares PSPC to achieve significant cost as well as internal reductions in carbon emissions and limit ongoing carbon credit/offset procurement costs.

6.6 SELECTING PLAN ELEMENTS

A long list of ideas and opportunities emerged from the ideas proposed by past PSPC initiatives, stakeholder insight, metric selection, jurisdictional research and expert insights. The list was filtered to combine complementary ideas.

Many Specific energy conservation technologies were proposed, which have associated carbon reduction benefit. These were agreed to best be evaluated on a building-by-building basis. Depending on the building characteristics, these would be carried out as part of an energy audit, re-commissioning exercise, smart building program, deep retrofit, and/or a fuel switching project. Thus, these activities became plan elements.

Several portfolio activities were proposed which must be enacted strategically by portfolio leaders, and would not achieve the desired carbon reduction if considered only in an individual building's context. Plan elements were added for workplace densification, asset divestment, Data Centre consolidation, and ESAP Plant changes. Similarly, LED retrofits are now sufficiently commonplace to be best delivered at scale.

On-site solar photovoltaic generation was the only power generation element identified, and was therefore listed separately.

On-site battery storage is a newer opportunity, suitable to only a small subset of the portfolio. It is not energy conservation nor energy generation, and is seldom considered in context of individual building assessments, so it was listed separately.

The list was finally organized to begin with activities that are likely to take place in the near future, and end with activities that have longer timelines, less proven technology, or less attractive co-benefits (like cost savings).

The final list of unique plan elements is:

1. Grid Decarbonisation/Re-carbonization (an external influence)
2. Workplace Densification
3. Asset Divestment
4. Data Centre Consolidation and Efficiency
5. LED Lighting Upgrades
6. Energy Investigations and Conservation Measure Implementation
7. Smart Building Technology
8. Deep Energy and GHG Retrofits
9. Fuel Switching
10. ESAP Plant Efficiency
11. Connecting to ESAP Plants
12. Relocating ESAP Cooling & Pre-Heating to Quebec
13. Converting ESAP to Biomass or Waste to Energy Generation
14. On-Site Solar Photo-Voltaic Generation
15. On-Site Battery Storage

PART 3 – NEXT STEPS

7 FORECASTING CARBON REDUCTION SCENARIOS

The plan described in Part 1 outlines possible actions and estimates the magnitude of GHG emissions reductions available by implementing each element across PSPC's portfolio. It does not evaluate key components that will be required to facilitate implementation. Following the development of this plan, the next step is to identify more specifically the cost/funding and timing in which the plan can realistically be achieved. This section outlines known factors that will influence timing and funding and identifies next steps to further refine these variables in order to carry the plan forward.

The portion of the Plan that can be implemented by 2030 (PSPC's aspirational target) will be limited by available annual funding and, to a lesser extent, project team capacity and the speed at which major projects can be proposed, approved and completed.

PSPC anticipates the following elements will be completed entirely in the near term, even before 2030:

- LED lighting retrofits
- Retrocommissioning, energy audits and energy conservation measure implementation
- Smart Buildings
- ESAP efficiency measures

Implementing ABW and deep retrofits across the portfolio, as identified in the Plan, will not be completed by 2030. The following assumptions are used to scale back the number of these projects that may be implemented by 2030. The 2030 scenario assumes the following:

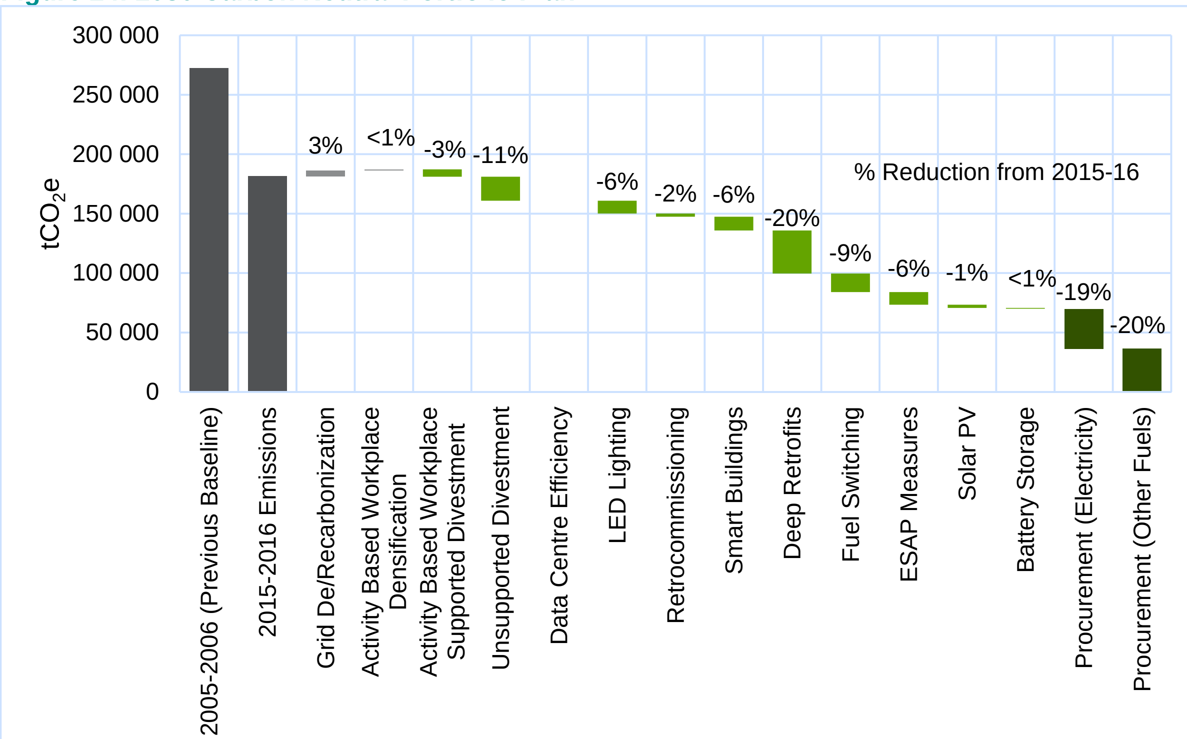
- Deep Retrofits for all tier 2 and 3 facilities (excluding Parliamentary Precinct facilities) with 2015-16 GHG emissions intensity greater than 32 $kgCO_2e/m^2$, plus Centre Block
- Activity Based Workplace (ABW) only for facilities undertaking deep retrofits as identified above (as well as other exceptions to ABW implementation previously described)

It is further anticipated that the following will <u>not</u> take place by 2030:

- Fuel switching for all facilities previously identified with 2015-16 GHG emissions intensity greater than > 22 $kgCO_2e/m^2$ could occur by 2030
- Consolidating ESAP pre-heating and cooling in Quebec, and
- Converting ESAP to biofuel or waste to energy

Implementing elements of the Carbon Neutral Plan by 2030 based on the above assumptions will target carbon emissions reductions as follows:

Figure 24: 2030 Carbon Neutral Portfolio Plan



As a result of partial efficiency project implementation, achieving carbon neutrality by 2030 will rely more heavily on a procurement strategy. Incomplete reductions by 2030 from ABW, deep retrofits, fuel switching and ESAP measures will leave approximately 34,000 tCO_2e of emissions from electricity consumption (490,000 MWh) and 36,000 tCO_2e of emissions from other energy and fuel combustion that need to be addressed. By 2030 it is anticipated that 13% of PSPC's grid electricity consumption will come from non-clean sources.[31] Procuring an equivalent quantity of RECs could cost approximately $480,000 per year at $7.50/MWh. Procuring offsets for the remaining emissions from electricity as well as other fuel and energy use could cost $295,000 for offsets at $4.50/$tCO_2e$. The scale of procurement could take up a more significant portion of the annual Canadian market for these products.

See Appendix G for a summary of 2030 Carbon Neutral Plan details. See Appendix E for a summary of plan results by province/territory. See Appendix F for a list of plan elements applied to each site.

31 National Energy Board, 2016, Canada's Energy Future 2016: Energy Supply and Demand Projections to 2040, https://apps.neb-one.gc.ca/ftrppndc/, Reference Case, weighted by PSPC's 2015-16 provincial and territorial electricity consumption

8 NEXT STEPS: IMPLEMENTING THE CARBON NEUTRAL PLAN

Implementing the Carbon Neutral Plan across PSPC's portfolio will require coordinated effort including management and leadership to institutionalize programmatic elements.

The next step for PSPC is to design the processes by which this plan will be delivered.

A detailed process will require significant effort. Based on our plan development to-date, we note that the following list of activities will be useful or even necessary to accomplish successful plan roll-out. While this is not an exhaustive list, these activities will include:

- Plan Refinement
  - Review this Plan with key stakeholders to refine assumptions and strategies, and prepare for implementation.
  - Refine assumptions used in analysis, to reflect PSPC's goals
  - Refine timing and implementation decisions for plan elements
  - Continue to evaluate emerging technologies and strategies for potential additions to the Plan. The Plan is based on best practices and available technologies at the time this Plan was created. Future technologies and strategies not yet identified may offer significant carbon savings and opportunities to achieve carbon neutrality.
  - Explore partnerships to test new technologies for applicability to PSPC's portfolio. Innovative technology partnerships will allow PSPC to demonstrate leadership while evaluating the potential of emerging technologies to PSPC's carbon neutrality objectives.
- Carbon Neutral Program Management
  - Communicate this departmental mandate, and the requirement of all Branches to achieve the target
  - Have the Responsible Branch track and manage progress, evaluate compliance, and interface with other Branches as applicable.
  - Monitoring and verification protocol, Energy Star (i.e. International Performance Measurement and Verification Protocol – IPMVP)
  - Establish and communicate acceptable procurement paths for each noted activity, and clarify the role of P3, DBFMO, and energy performance contract (EPC) approaches
  - Establish timelines, targets and milestones.
  - Prioritize action which can be accomplished within the current government cycle in order to demonstrate the benefits of carbon reduction efforts to Canadians.
  - Organize and deliver ongoing Operator Training at both general and specific levels of detail
  - Integrate regional technical specialists, involve Centres of Excellence

- Consider establishing a "Federal Real Estate Office" to support other government departments (OGDs) (Corrections Canada, Department of National Defense – DND, etc.) to pursue carbon reductions, as several OGDs have already recently approached PSPC for support and guidance. The scope of supporting OGDs goes beyond PSPC's mandate, but supports Canada's national desire for carbon neutrality.
- Explore partnerships with:
  - Academic researchers, acknowledging typically long timelines
  - Natural Sciences and Engineering Research Council (NSERC) Smart Net-Zero Energy Buildings Strategic Research Network
  - National Research Council (NRC) including their academic partnership technology pilots
  - Natural Resources Canada (NRCan), in relation to programs such as Office of Energy Efficiency, Energy Star Portfolio Manager, etc.
  - Build in Canada technology pilots

→ Institutionalize Carbon Neutral Plan requirements and criteria in

- Treasury Board requirements/approvals and metrics
- Investment analysis report (IAR), planning group
- P3 evaluation and decision criteria
- Accelerated Infrastructure Program (AIP) funding (Program funds projects that are completed within 48 months)
- PPB master plans group (Program, Portfolio and Client Relationship Management team) activities who create and manage plans for PPB
- Review projects currently on the books, ensure GHG component gets incorporated (even if it means some re-planning)
- Smaller projects – establish process to limit circumventing of Plan requirements
- Existing and associated programs updated to complement the goals of this plan. For example, ABW's contribution to this plan relies ABW achieving hard targets for whole-building density (not just workspace density) coupled with property divestment.

→ Update or establish procedures to hold contractors accountable for updated performance outcomes

- Fix and enforce Terms of Reference; alert contractors to this change so they bid appropriately
- Create a template or structure to create consistency between different consultants' delivery
- Engage the consultant community in changing requirements
- Recognize value of contractors applying energy-related contract terms; e.g. enforce training/hand-over clause
- Need to get operations documentation from contractors; has been a challenge in the past
- Include ongoing commissioning manual as a deliverable when procuring contractor services
- Including targets for property managers in their Enterprise Performance Management Architecture (EPMA) system

  - Mandate measurement and verification (M+V) of building energy projects (either by PSPC or consultants), provide feedback to consultants on results, and hold consultants accountable for underperforming systems

→ Update the mandate of the Carbon Neutral Plan to incorporate all space occupied by PSPC, both owned and leased. Or, if this mandate cannot be broadened, then establish a GHG accounting protocol which retains responsibility for carbon emissions when assets are divested due to a transition from owned to leased occupancy across the portfolio.

APPENDICES

APPENDIX A: 2015-16 PSPC GHG EMISSIONS INVENTORY

Figure A-1: 2015-16 Emissions by Region

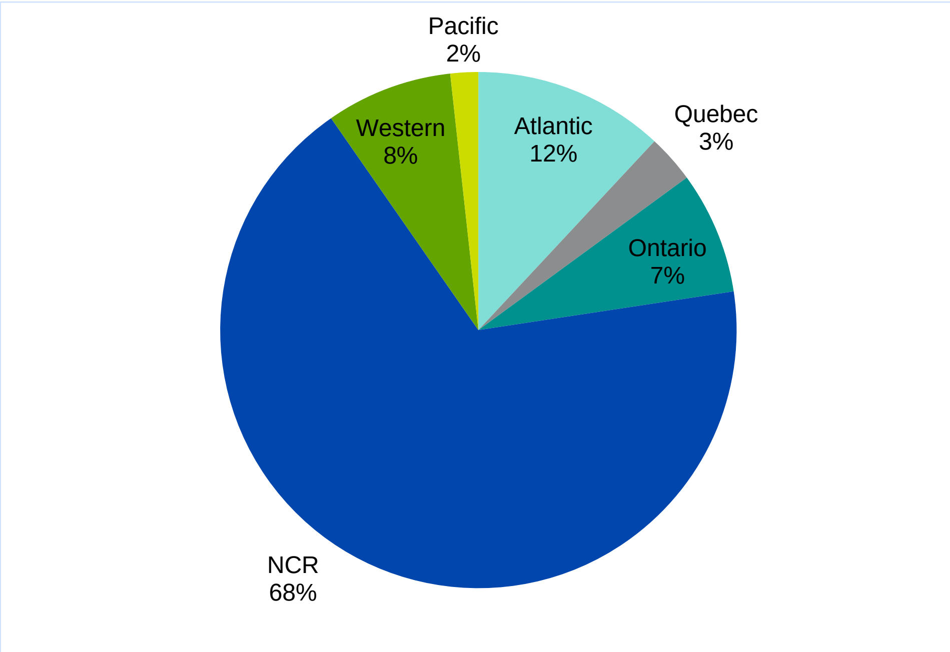


Table A-1: 2015-16 Emissions by Region as % of Portfolio Total

Region	Total Emissions	% of Portfolio Total
	tCO_2e	
Atlantic	25,513	14%
Quebec	6,998	4%
Ontario	11,844	7%
NCR	97,713	54%
Parliamentary Precinct	18,488	10%
Western	17,507	10%
Pacific	3,432	2%
Total	**181,496**	**100%**

Figure A-2: 2015-16 Regional Emissions by Source

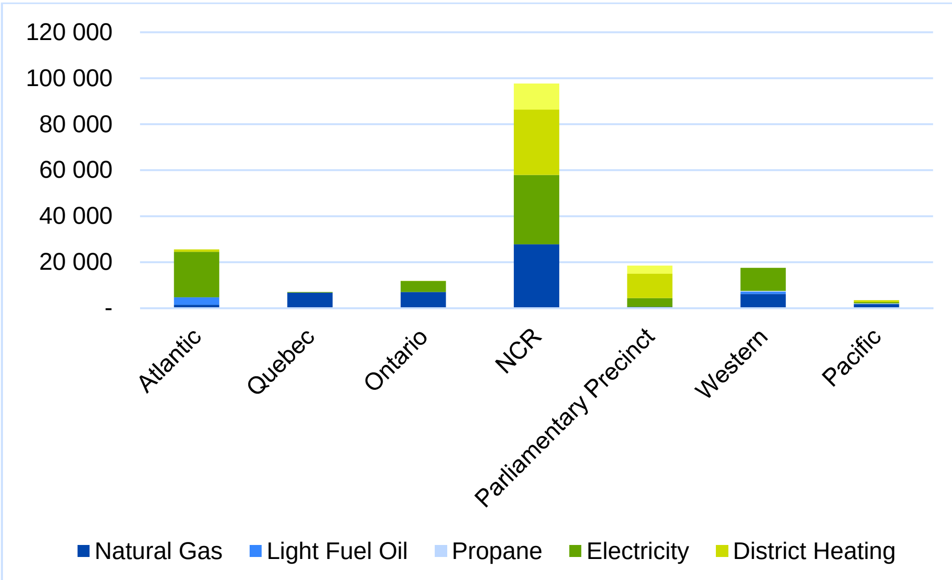


Table A-2: 2015-16 Regional Emissions by Source

Region	Natural Gas	Light Fuel Oil	Propane	Electricity	District Heating	District Cooling	Total Emissions
	tCO₂e	*tCO₂e*	*tCO₂e*	*tCO₂e*	*tCO₂e*	*tCO₂e*	*tCO₂e*
Atlantic	1,412	3,325	0	19,757	1,019	-	25,513
Quebec	6,725	20	-	253	-	-	6,998
Ontario	6,986	41	-	4,816	2	-	11,844
NCR	27,756	-	-	30,191	28,386	11,381	97,713
Parliamentary Precinct	503	-	-	3,877	10,595	3,513	18,488
Western	6,146	984	340	10,038	-	-	17,507
Pacific	1,773	69	252	438	900	-	3,432
Total	**51,301**	**4,438**	**592**	**69,370**	**40,901**	**14,894**	**181,496**

Table A-3: 2015-16 Emissions by Region and Scope

Region	Scope 1	Scope 2 (dynamic)	Total Emissions
	tCO₂e	*tCO₂e*	*tCO₂e*
Atlantic	4,737	20,776	25,513
Quebec	6,745	253	6,998
Ontario	7,026	4,818	11,844
NCR	27,756	69,958	97,713
Parliamentary Precinct	503	17,985	18,488
Western	7,469	10,038	17,507
Pacific	2,094	1,338	3,432
Total	**56,331**	**125,165**	**181,496**

APPENDIX B: STAKEHOLDER ENGAGEMENT RESULTS

This section contains minutes from seven stakeholder engagement sessions held in January and February 2017, as well as the set of slides presented at these sessions:

1. Stakeholder Engagement Session Slides
2. Energy Services Acquisition Program, January 18, 2017, 9:00AM-12:00PM EST
3. Parliamentary Precinct Branch, January 18, 2017, 1:00-4:00PM EST
4. National Capital Area (morning session), January 19, 2017, 9:00AM-4:00PM EST
5. National Capital Area (afternoon session), January 19, 2017, 1:00-4:00PM EST
6. Ontario Region, January 26, 2017, 10:30AM-4:00PM EST
7. Atlantic Region, January 31, 2017, 9:30AM-12:30PM AST (8:30-11:30AM EST)
8. Western Region, February 14, 2017, 10:00AM-1:00PM MST (12:00-3:00PM EST)

Engagement sessions were not held with Quebec and Pacific Region as these constitute the smallest portion of PSPC's GHG footprint.

APPENDIX C: PLAN SAVINGS AND COST ASSUMPTION REFERENCES

The below table presents savings and cost assumptions used to inform the PSPC Carbon Neutral Plan analysis. Sources and rationale for these assumptions for each plan element are detailed in the remainder of this section.

Table C-1: Plan Savings and Cost Assumptions

Plan Element	Energy Change (heating/ non-heating)	Energy Target (heating/ non-heating)	Heritage Savings Multiplier	District Energy GHG Intensity	Incremental Capital Cost	Heritage Cost Multiplier	Annual Maintenance Cost Change	Energy Cost Change	Lifetime
	%	ekWh/m^2		g/ekWh	\$/m^2		\$/m^2	\$	years
Grid Intensity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	50
Workplace Densification	-1.2%/ 3.3%	N/A	1	N/A	54	1.25	0.54	N/A	25
Divestment	-100%/ -100%	N/A	1	N/A	N/A	1	-10.76	N/A	50
LED Lighting	0%/ -14%	N/A	1	N/A	2.15	1.25	-0.22	N/A	10
EA, RCx, ECMs	-16%/ -16%	N/A	1	N/A	5.38	1	-0.54	N/A	5
Smart Buildings	-10%/ -10%	N/A	1	N/A	1.08 (annually)	1	-0.22	N/A	1
Deep Retrofit – Level 1	N/A	74/91	0.9	N/A	+10% to base cost	1.25	0	N/A	40
Deep Retrofit – Level 2	N/A	37/68	0.9	N/A	+10% to base cost	1.25	0	N/A	40
Deep Retrofit – Level 3	N/A	15/45	0.9	N/A	+10% to base cost	1.25	0	N/A	40
Fuel Switching	-73%/ 0%	N/A	1	N/A	108	1.25	1.08	Varies by fuel	20
ESAP Efficiency	-38%/ 0%	N/A	1	100	0	1	-0.27	N/A	40
ESAP Connections	0%/ 0%	N/A	1	100	65	1.25	-1.08	N/A	40

Plan Element	Energy Change (heating/ non-heating)	Energy Target (heating/ non-heating)	Heritage Savings Multiplier	District Energy GHG Intensity	Incremental Capital Cost	Heritage Cost Multiplier	Annual Maintenance Cost Change	Energy Cost Change	Lifetime
ESAP to Quebec	-7%/ 0%	N/A	1	96.6	242	1	0	0%	40
ESAP Biofuel	N/A	N/A	1	3.4	545	1	1.08	100%	40
Solar PV	Building-specific	N/A	1	N/A	565	1.25	3.23	N/A	25
Battery Storage	0%/ 0.1%	N/A	1	N/A	24	1	0.24	Building-specific	10

Grid Intensity
Electric grid decarbonisation and recarbonization is affected by factors external to PSPC, while impacting its future portfolio carbon emissions. Aside from anticipated future emissions factors documented in section 2.1, no savings and cost assumptions are used in this analysis.

Workplace Densification

Energy Change: A study by PWGSC found that workplace densification carried out to meet Workplace 2.0 standards resulted in an average 1.2% decrease in heating energy requirements and 3.3% increase in non-heating energy requirements at the building-level.[32]

Heritage Savings Multiplier: Since a significant portion of PSPC's portfolio consists of heritage-designated assets, it is assumed the ABW program is designed with such assets in mind and that savings are not impacted by heritage status.

Incremental Capital Cost: Typical fit-out cost varies widely. One reference suggests Cost of a typical fit-out varies widely. One reference suggests \$3.62-\$6.22/m^2 as a reasonable typical range for periodic refreshment of occupied spaces.[33] The analysis assumes an incremental cost for ABW beyond necessary refreshment of \$54/m^2. Further research is warranted to improve pricing accuracy for ABW implementation.

Heritage Cost Multiplier: Heritage buildings typically have unique requirements, and are more likely to contain hazardous materials requiring more careful construction activities. An across-the-board 25% increase in cost at heritage assets has been applied. Further research in this area would increase accuracy of costing.

Annual Maintenance Cost Change: Workplace Solutions Group has estimated that annual maintenance costs may increase by about \$1/m^2 of office workspace due to more densely occupied space being used more aggressively (\$0.54/m^2 of net building area, since office workspace available for ABW retrofit is estimated to constitute about half of total portfolio area).

Lifetime: Full fit-out normally only occurs once as a space becomes occupied by a new group. A PSPC study suggests a typical turnover rate of 25% every 5 years, suggesting a 20 year average turnover period, while finishes are repaired on 10 to 15 year cycles. A conservative assumption of 25 years lifetime for ABW is used.

LED Lighting
Energy Change: More efficient lighting generates less heat. Some designers suggest installing more efficient lighting causes increased building heat use. However, since many office building fan systems operate in cooling mode year-round (even when the building perimeter is being heated), heat from lights is often lost from the building as opposed to being usefully used. As such, energy heating change is assumed to be 0%.

Anticipated regional savings from conversion to an LED model retrofit are 7.8% of total building energy. Since electrical energy is usually about 55% of total building energy, LED lighting retrofit is assumed to yield 14% non-heating savings.

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32 Public Works and Government Services Canada, 2013, Workplace 2.0 Impact Study on Green House Gas Emissions

33 Coy Davidson, 2011, The Cost of an Office Build-Out, http://www.coydavidson.com/construction/the-cost-of-an-office-build-out/

Heritage Savings Multiplier: While some heritage buildings may have restrictions on light fixtures in prominent spaces, these restrictions are not expected to have a significant impact on the building-wide ability to convert to more efficient lighting. The heritage savings multiplier is set to 1.0.

Incremental Capital Cost: PSPC's lighting retrofit analysis suggests LED options are about 10% more costly than standard lighting retrofits, indicating an incremental capital cost of $\$2.15/m^2$, as standard retrofits typically cost on the order of $\$22/m^2$.

Heritage Cost Multiplier: Heritage buildings have unique retrofit requirements and are more likely to contain hazardous materials necessitating more careful construction practices. The heritage cost multiplier is set to 1.25 to account for additional requirements. Further research is warranted to improve pricing accuracy for LED implementation at heritage assets.

Maintenance Cost Change: LED retrofits may reduce annual maintenance costs by 1% of incremental capital cost, or $\$0.22/m^2$, based on the reduced need to recurring relamping costs.

Lifetime: Reputable LED bulbs and drivers typically carry warranties in the range of 10 years of operation, and this lifecycle is assumed.

EA, RCx, ECMs

Energy Change: Research suggests an average RCx activity will save about 16% in energy use.[34] PSPC has indicated that buildings will either pursue Smart buildings, or RCx (but not both), savings for these two activities are shown separately. We expect that the combination of RCx and Smart Buildings could surpass the average 16% savings. To be conservative, we have kept at 16% for RCx and 10% for Smart Buildings.

Heritage Savings Multiplier: While some heritage buildings have restrictions on operating conditions, greater savings may be possible at older buildings, suggesting a heritage savings multiplier of 1.0 is appropriate.

Incremental Capital Cost: $\$5.38/m^2$ based on typical values observed in the industry.

Heritage Savings Multiplier: EA, RCx and ECM costs are not anticipated to be different at heritage buildings.

Maintenance Cost Change: RCx activities may reduce annual maintenance costs by 10% of incremental capital cost, or $\$0.54/m^2$, based on avoided early equipment failure.

Lifetime: PSPC completes property energy audits and RCx activities on a 5-year cycle. Programs such as LEED for Existing Buildings also require a recommissioning cycle of 5 years, indicating a 5 year lifetime for RCx activities is appropriate.

Smart Buildings

Energy Change: PSPC anticipates Smart Buildings can reduce energy use by 10% on average; four pilot buildings have achieved 16% energy reduction.[35] PSPC has indicated that buildings will either pursue Smart buildings, or RCx (but not both), savings for these two activities are shown separately.

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34 Mills, E, 2009, Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions

35 Ontario Region stakeholder engagement session, January 26, 2017

We expect that the combination of RCx and Smart Buildings could surpass the average 16% savings. To be conservative, we have kept at 16% for RCx and 10% for Smart Buildings.

Heritage Savings Multiplier: While some heritage buildings have restrictions on operating conditions, greater savings may be possible at older buildings, suggesting a heritage savings multiplier of 1.0 is appropriate.

Incremental Capital Cost: $1.08/m^2$ annually, based on similar order of magnitude costs to RCx but spread out over an annual cycle.

Heritage Savings Multiplier: Smart Building costs are not anticipated to be different at heritage buildings.

Maintenance Cost Change: Smart Building activities may reduce annual maintenance costs by 20% of incremental capital cost, or $0.22/m^2$, based on avoided early equipment failure.

Lifetime: The Smart Buildings program is an ongoing activity, with an annual (not one-time) investment, indicating a 'lifetime' of 1 year.

Deep Retrofit

Energy Change: Deep retrofit heating and non-heating energy intensity targets are based on typical measures included in each option, as calculated for 25 St Clair, an Ontario Region asset that completed the GHG options analysis in 2017.

Heritage Savings Multiplier: Some heritage buildings may be restricted from implementing the full suite of deep retrofits (e.g. envelope changes may be restricted for heritage buildings), so the multiplier has been set at 0.9.

Implementation Capital Cost: PSPC anticipates that addressing deep energy and GHG retrofits in the course of undertaking deep building retrofits may add an average 10% to capital costs.

Heritage Cost Multiplier: Heritage buildings typically have unique requirements, and are more likely to contain hazardous materials requiring more careful construction activities. An across-the-board 25% increase in cost at heritage assets has been applied. Further research in this area would increase accuracy of costing.

Maintenance Cost Change: Deep retrofits are not expected to introduce building maintenance cost changes.

Longevity: PSPC anticipates deep retrofits to last for at least 40 years.

Fuel Switching

Energy Change: Fuel switching from a natural gas boiler with a coefficient of performance (COP) of 0.8 to an air-source or ground-source (geothermal) heat pump (COP 3.0 for a typical air-source heat pump at mild-outdoor temperatures) is anticipated to reduce heating energy use by 73%.[36] No change to non-heating energy is anticipated from this measure.

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36 Natural Resources Canada, Air-Source Heat Pumps, http://www.nrcan.gc.ca/energy/publications/efficiency/heating-heat-pump/6831

Heritage Savings Multiplier: Fuel switching savings are not anticipated to be different at heritage buildings.

Incremental Capital Cost: The average cost of a ground-source heat pump system in Ontario is \$8,132/ton, or \$215/m^2 based on heating requirements of 1 ton per 37 m^2. For air-source heat pumps, average costs are \$2,400/ton or \$65/m^2.[37] Subtracting the cost of a boiler indicates an incremental capital cost of \$108/m^2 for this measure.

Heritage Cost Multiplier: Heritage buildings typically have unique requirements, and are more likely to contain hazardous materials requiring more careful construction activities. An across-the-board 25% increase in cost at heritage assets has been applied. Further research in this area would increase accuracy of costing.

Maintenance Cost Change: Fuel switching may command a net neutral or slightly increased maintenance cost on the order of 1% of incremental capital cost or \$1.08/m^2 to address greater maintenance needs for the heat pump system.

Energy Cost Change: Operational cost changes associated with fuel switching depend on local fuel and electricity costs for the building under analysis.

Lifetime: Geothermal systems have a long life of 50 years or more, while air-source heat pumps typically have a life of 15 to 25 years. The Plan analysis used an average 20 year lifetime assumption for fuel switching to be conservative, which is consistent with ASHRAE life expectancy for heat pump systems.[38]

ESAP Efficiency

Energy Change: The current ESAP steam system is 50% efficient, and ESAP is targeting 80% efficiency through a low-temperature hot water conversion (LTHW).[39] Assuming a 5% savings discount (to reflect increased energy used in new circulation pumps and any other balance-of-system equipment that may be required following conversion) plus additional 5% savings associated with plant impacts of Smart Buildings indicates heating energy savings of 38% (-100%-[50%/75%]+5%=38%). No non-heating savings are anticipated as planned ESAP efficiency upgrades do not include significant cooling system upgrades.

District Energy GHG Intensity Reduction: ESAP anticipates a 65% reduction in emissions will result from planned efficiency measures (reduction from 113 ktCO_2e to 73 ktCO_2e emissions annually).[40] The analysis assumes the ESAP system will use electricity from Quebec in tandem with biofuel. Quebec electricity grid emissions intensity is 95% lower than Ontario grid intensity (100%-4.8/96 = 95%).

District Energy GHG Emissions Factor: The blended emissions factor for ESAP district heating and cooling based on 2015-16 performance is approximately 174 gCO2e/ekWh. Reducing emissions by 65% through efficiency measures along with reducing energy consumption by 38% is anticipated to reduce emissions intensity to approximately 100 gCO_2e/ekWh.

37 Toronto Atmospheric Fund, 2015, Global Heat Pump Performance Review, http://taf.ca/wp-content/uploads/2015/06/TAF-Heat-Pumps-Final-Report-2015.pdf
38 ASHRAE Service Life Data Query, https://xp20.ashrae.org/publicdatabase/system_service_life.asp?selected_system_type=6
39 ESAP correspondence, February 24, 2017
40 ESAP stakeholder engagement session, January 18, 2017

Incremental Capital Costs: No incremental capital costs are identified for this measure as ESAP and PSPC have already identified funding to undertake efficiency.

Maintenance Cost Change: ESAP anticipates maintenance cost savings, but the magnitude of increase has not yet been quantified.[41] Savings may be quantified following further investigation and/or during early stages of implementation. The Plan analysis uses a placeholder savings value of $0.27/m^2$ of building space serviced by ESAP.

Lifetime: ESAP anticipates system longevity of 40 years.[42]

ESAP Connections

Incremental Capital Cost: Connecting to ESAP is anticipated to cost $65/m^2$ of building space served, based on the following assumptions:

- Average transfer station cost of $22/m^2$ ($500,000 total, divided over average 23,000 m^2 building)
- Average additional piping cost of $43/m^2$ ($1 million per building, divided over average 23,000 m^2 building)

Maintenance Cost Change: Eliminating building-level boilers may save approximately $20,000 to $30,000 ($10,000 per boiler) or $1.08/m^2$.

Lifetime: A lifetime of 40 years is used, for consistency with ESAP projections for system longevity.

ESAP Pre-Heating in Quebec

Energy Change: PSPC consumes approximately 660,000 GJ of district cooling and 940,000 GJ of district heating annually. If 10% of cooling capacity can be leveraged for pre-heating, heating energy consumption could be reduced by net 7% (660,000*10%/940,000 = 7%).

District Energy GHG Intensity Reduction: Quebec electricity grid emissions intensity is 95% lower than Ontario grid intensity (100%-4.8/96 = 95%).

District Energy GHG Emissions Factor: The blended emissions factor for ESAP district heating and cooling based on 2015-16 performance is approximately 174 gCO2e/ekWh. Using Quebec electricity for pre-heating in combination with efficiency improvements is anticipated to reduce emissions intensity to approximately 97 gCO2e/ekWh.

Incremental Capital Cost: $242/m^2$, anticipating that this measure may cost 25% more than ESAP efficiency measures. Further research in this area would increase accuracy of costing.

Maintenance Cost Change: No net change in maintenance costs is anticipated, to be conservative.

Lifetime: A lifetime of 40 years is used, for consistency with ESAP projections for system longevity.

ESAP Biofuel

Energy Change: No change in heating energy consumption is anticipated from switching to biofuel or waste-to-energy fuel from conventional fuel.

41 ESAP correspondence, February 24, 2017
42 ESAP correspondence, February 24, 2017

District Energy GHG Intensity Reduction: The analysis assumes the ESAP system will use electricity from Quebec in tandem with biofuel. Quebec electricity grid emissions intensity is 95% lower than Ontario grid intensity (100%-4.8/96 = 95%).

District Energy GHG Emissions Factor: The blended emissions factor for ESAP district heating and cooling based on 2015-16 performance is approximately 174 gCO_2e/ekWh. Using biofuel or waste-to-energy fuel, in combination with Quebec electricity for pre-heating is anticipated to reduce emissions intensity to approximately 3 gCO_2e/ekWh.

Incremental Capital Cost: $545/m^2, anticipating that this measure may cost 225% more than ESAP pre-heating in Quebec. Further research in this area would increase accuracy of costing.

Maintenance Cost Change: ESAP anticipates significant maintenance cost increases associated with a biofuel or waste-to-energy system but the magnitude of increase has not yet been quantified. A placeholder value of $1.08/m^2 of building space serves is used in this analysis, based on an assumption of additional maintenance costs of $1 million per year at ESAP plants.

Lifetime: A lifetime of 40 years is used, for consistency with ESAP projections for system longevity.

Solar PV

Energy Change: Solar PV will change non-heating energy consumption. The magnitude of change will depend on building- and project-specific characteristics.

Incremental Capital Cost: Typical solar PV costs are $565/m^2 of panel installed, based on an average cost of $3,500/KW installed and a typical panel rating of 160KW/m^2.

Heritage Cost Multiplier: Heritage buildings typically have unique requirements, and are more likely to contain hazardous materials requiring more careful construction activities. An across-the-board 25% increase in cost at heritage assets has been applied. Further research in this area would increase accuracy of costing.

Maintenance Cost Change: Solar PV may increase maintenance costs by $20/KW or $3.23/m^2 of panel installed.[43]

Lifetime: Solar panels have a useful life of 25 to 40 years.[44] A lifetime of 25 years is used in this analysis to be conservative.

Battery Storage

Energy Change: Battery storage will increase building-wide non-heating energy consumption by an estimated 0.1% due to losses in the energy storage and extraction process.

GHG Intensity Reduction: Shifting energy consumption to non-peak times may reduce GHG intensity by 66% in Ontario, based on the difference between peak GHG intensity and average GHG intensity.[45]

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43 National Renewable Energy Laboratory (NREL), Distributed Generation Energy Technology Operations and Maintenance Costs, http://www.nrel.gov/analysis/tech_cost_om_dg.html

44 NREL, Useful Life, http://www.nrel.gov/analysis/tech_footprint.html

45 Toronto Atmospheric Fund, November 2016, TAF's GHG Quantification Methodology, http://www.toronto.ca/legdocs/mmis/2016/ta/bgrd/backgroundfile-98816.pdf

Incremental Capital Cost: Battery storage is anticipated to cost $24/m^2$ of building served (based on a cost of $1M per 1.2 MWh, and reducing building peak by about 30%.

Heritage Savings Multiplier: Battery storage costs are not anticipated to be different at heritage buildings.

Longevity: Battery equipment may last 5,000 cycles or 13.7 years (5,000 cycles/365 cycles per year). The Plan analysis uses a 10 year lifetime to be conservative.

APPENDIX D: LOW-CARBON PROCUREMENT BEST PRACTICES AND TRENDS

1 CARBON MARKETS

1.1 CARBON PRICING IMPLICATIONS

In October 2016, the Government of Canada proposed a national approach to carbon pricing. Under this approach, all Canadian jurisdictions will be required to implement a carbon pricing scheme by 2018. In order to accomplish this, the Government plans to set a benchmark for pricing carbon emissions, set at a level that will help Canada meet its GHG emission target, while providing greater certainty and predictability to Canadian businesses. Under the new approach, provinces and territories will have flexibility in deciding how they implement carbon pricing (i.e. direct price on carbon or cap-and-trade system). It also suggest that the price on carbon pollution should start at a minimum of $10 per tonne in 2018 and rise by $10 a year to reach $50 per tonne in 2022.[46]

1.2 CARBON INITIATIVES BY PROVINCE

Many province and territories already have existing carbon tax or cap and trade schemes in place, satisfying or facilitating meeting the proposed federal approach, while others have stated a commitment to do so by the deadline.

British Columbia

BC introduced a revenue-neutral carbon tax in 2008. The carbon tax is applied to the purchase or use of fuels in the province, and covers about 70% of BC's total emissions.

Carbon tax rates started at $10/tonne in 2008, and increased $5 each year until they reached the current rate of $30/tonne in 2012.

BC's carbon tax is revenue neutral. This means that every dollar generated by the carbon tax is returned to British Columbians through reductions in other taxes.

BC estimated that the carbon tax revenue they have earned from 2008-2015 is $7.3 billion, facilitating tax reductions of $8.9 billion and therefore there has been an estimated $1.6 billion net benefit to tax payers.[47]

46 Government of Canada, 2016, Government of Canada Announces Pan-Canadian Pricing on Carbon Pollution, http://news.gc.ca/web/article-en.do?nid=1132149
47 Government of British Columbia, B.C.'s Revenue-Neutral Carbon Tax, http://www2.gov.bc.ca/gov/content/environment/climate-change/policy-legislation-programs/carbon-tax

Alberta

As of January 1, 2017 a carbon levy is charged on all fuels that emit GHGs when combusted at a rate of $20/tonne in 2017 and $30/tonne in 2018. The rate is based on the amount of carbon pollution released by the fuel when it is combusted, not on the mass of fuel itself.

Included are transportation and heating fuels such as diesel, gasoline, natural gas and propane. Certain fuels, such as marked gas and diesel used on farms will be exempt from the levy. The levy does not apply to electricity.

All revenue from the levy will be reinvested in Alberta to grow and diversify the economy as well as reduce carbon pollution.[48]

This tax is expected to generate approximately $3 billion in new revenues.[49]

Manitoba

Manitoba signed a Memorandum of Understanding with Quebec and Ontario in December 2016 to eventually link all three provinces' cap and trade programs at a future date.[50]

Ontario

Cap and trade was introduced in Ontario as of January 1, 2017, with a focus on lowering GHG emissions from the largest emitters.

The cap limits how many tonnes of GHG pollution businesses and institutions can emit. The cap drops each year to encourage lower emissions. This number is 142 megatonnes per year for 2017 and will decline to 125 megatonnes per year by 2020.[7]

Entities emitting more GHG than permitted by the cap may purchase excess credits from entities that have reduced their emissions below the permitted level. Under the cap and trade regulation, organizations required to participate include:

- Electricity importers
- Facilities and natural gas distributors that emits 25,000 tonnes or more of GHG per year
- Fuel suppliers that sell more than 200 liters of fuel per year

Facilities that generate more than 10,000 but less than 25,000 tonnes of GHG emissions per year can choose to voluntarily participate in the program.[51]

Ontario has joined with California and Quebec in the Western Climate Initiative, creating a larger carbon trading system.

Ontario's cap and trade program is anticipated to result in a price of $19.40 per tonne by 2020.[7]

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48 Government of Alberta, Carbon levy and rebates, https://www.alberta.ca/climate-carbon-pricing.aspx
49 Tasker, J.P., 3 October 2016, CBC News, Here's where the provinces stand on carbon prices, http://www.cbc.ca/news/politics/provinces-with-carbon-pricing-1.3789174
50 Thomson Reuters Carbon Markets Survey, 2015 http://trmcs-documents.s3.amazonaws.com/3501ec8eae589bfbef9cc1729a7312f0_20160506103736_Carbon%202016_v7.pdf
51Government of Ontario, Cap and trade in Ontario, https://www.ontario.ca/page/cap-and-trade-ontario

Quebec

Quebec's cap and trade system has been in place since January 1, 2013. Quebec's system is very similar to Ontario's system. From 2013 to 2014 the system was applied to the industrial and electricity sectors. Starting in 2015 the system was expanded to all companies using fossil fuels.[52]

Nova Scotia, New Brunswick and Prince Edward Island

New Brunswick's premier has stated a commitment to implement carbon pricing in that province by 2018.[53]

The premier of Prince Edward Islands has stated the intent to introduce a carbon tax January 1, 2018, that will be "fiscally neutral"[54]

Nova Scotia has committed to implement a cap-and-trade program in line with federal requirements by 2018.55

Newfoundland and Labrador, and Northwest Territories

Newfoundland and Labrador as well as Northwest Territories have begun work to address the federal carbon pricing requirements, although have not released details of their planned approaches.[56],[57]

Saskatchewan, Yukon and Nunavut

The remaining provinces and territories have not yet enacted carbon pricing nor stated commitments to do so.

2 RENEWABLE ENERGY IN CANADA

2.1 POWER PURCHASE AGREEMENTS

PPAs are a contractual agreement used in the utility power sector for long-term purchase of electricity produced by a particular source of generation. For electricity purchasers, PPAs offer a long-term supply of green power with stability in prices, often at or below current market prices.

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52 Government of Québec, A brief look at the Québec cap-and-trade system for emission allowances, http://www.mddelcc.gouv.qc.ca/changements/carbone/documents-spede/in-brief.pdf

53 Poitras, J., 3 Jan. 2017, CBC News, New Brunswick-made carbon pricing scheme coming, Gallant says, http://www.cbc.ca/news/canada/new-brunswick/gallant-carbon-next-year-1.3911618

54 Wright, T., 26 Dec. 2016, The Guardian, A carbon tax will be coming to Prince Edward Island, http://www.theguardian.pe.ca/news/local/2016/12/26/a-carbon-tax-will-be-coming-to-prince-edwrd-island.html

55 Nova Scotia, 2017, Nova Scotia Cap and Trade Design Options, https://climatechange.novascotia.ca/sites/default/files/Cap-and-Trade-Document.pdf

56 Boone, M., 6 Jan. 2017, CBC News, Gas tax could morph into carbon tax, says N.L. environment minister, http://www.cbc.ca/news/canada/newfoundland-labrador/perry-trimper-gas-tax-carbon-tax-1.3923218

57 Hwang, P. 12 Dec. 2016, CBC News, N.W.T. will go into carbon pricing 'with eyes wide open' says Premier Bob McLeod, http://www.cbc.ca/news/canada/north/bob-mcleod-carbon-pricing-nwt-1.3892708

True PPAs are restricted to customers located in deregulated electricity markets. However, in some regulated markets like Ontario, agreements with government offer an alternative similar to a PPA, but using the power authority as an intermediary.

Benefits:

- → Provides a market signal for increased green power demand and can help bring additional projects online;
- → Off-site projects lower the cost of electricity supply through economies of scale and optimal siting in areas with high resource potential;
- → Contracted prices often at or below market prices;
- → Significant volume can be purchased in a single transaction.

Considerations:

- → Only available in provinces with deregulated electric power markets or direct access agreements. Currently Alberta is the only province where this applies;
- → Purchasers are limited to contracting with projects in the same power market as their facilities;
- → Long-term commitments of 10-20 years are typical;
- → Purchaser can be left exposed if future electricity prices drop below contract pricing.

2.2 RENEWABLE ENERGY CERTIFICATES

RECs represent the environmental attributes associated with renewable electricity such as wind and solar. They are typically sold in quantities of kWh or MWh. RECs are not electricity per se, they have the same environmental effect as buying green electricity.

For every unit of electricity generated from a renewable energy project, a corresponding REC can be sold. For any organization to claim and communicate the renewable energy benefits from a REC they must own and retire the RECS or have the RECs retired on their behalf. For example, if an organizations were to purchase a three year contract for 20,000 kWh worth of RECs per year from a RECs provider, for the following three years the RECs provider would retire 20,000 kWh worth of energy on behalf of that organization each year. Once the three years are over those 20,000 kWh of RECs would no longer continue to be retired on behalf of that organization and would be available for purchase by another organization.

There are two ways RECs can be sold: bundled or unbundled. If RECs are sold together with their associated electricity they are known as bundled. If RECs are sold separately, they are known as unbundled RECs. Bundled REC agreements are typically viewed as higher impact than unbundled agreements for several reasons. In most situations, bundled RECs are purchased as part of a long-term agreement and provide the financial backing necessary for a new project to be developed. In addition, because bundled RECs are sold with the accompanying electricity, they can be sold within an electricity market, while unbundled RECs can be sold nationally. The distinction helps motivate development of green power projects local to power demand.

The table below lists the major providers of quality RECs in Canada. To see how the GHG Protocol defines quality please see Table D-2.

Table D-1: Major Providers of Quality Unbundled RECs

Provider	Certification	Project Locations	Project Types
3Degrees	Green-e Energy®	Canada and US; region- and project-specific RECs are available	• Wind • Biomass • Hydropower • Solar • Landfill gas • Digester gas
Bullfrog Power	EcoLogo™	BC, AB, SK, MB, QC, ON, PEI, NWT, YK, NS, NB, NL	• Wind • Hydropower • Landfill gas • Solar • Biogas
Renewable Choice Energy	Green-e Energy®	AB, BC, PEI, US	• Wind
Sterling Planet	Green-e Energy®	Canada and US	• Wind • Biomass

Voluntary REC prices remained historically low through 2015. Voluntary REC prices fell from $1.13/MWh ($1.48 Canadian dollars - CAD) in January 2014 to $0.89/MWh ($1.17 CAD) in January 2015 and $0.34/MWH ($0.45 CAD) in January 2016[58]. Voluntary RECs markets are not required by law. They have been developed in the response to energy users who would like to voluntarily purchase renewable energy to meet internal goals, targets or commitments.[59]

The new changes to the GHG Protocol has driven increased interested in REC purchases as a valid means of neutralizing organizational scope 2 emissions from consumed electricity[60]. For example with the new double reporting if a company purchases RECs to cover all their Scope 2 emissions they will report zero tonnes of carbon dioxide equivalence for their market based emissions. Being able to report this in their GHG Inventory has only been acceptable practice since this new guidance has been introduced and therefore interest in purchasing RECs has increased (see section 2.3 below).

2.3 ACCOUNTING FOR RENEWABLE ENERGY

In January 2015, the World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD) released the GHG Protocol Scope 2 Guidance, an amendment to the GHG Protocol Corporate Standard.[61] This guidance is one of the most significant updates to the GHG Protocol since it was released. There was a need for this guidance to provide better consistency in reporting of scope 2 emissions, acknowledge the development within the energy supply chains since the original Standard was published in 2004 and add value to customer's energy choices and help play a role in changing supply by building demand.

The most significant change introduced by the guidance is the requirement that companies must quantify and report two Scope 2 emission totals using a location-based method and a market-based method.

58 NREL, Status and Trends in the U.S Voluntary Green Power Market (2015 Data).

59 http://www.wri.org/publication/bottom-line-renewable-energy-certificates, Bottom Line on Renewable Energy Certificates

60 Raising Ambition, State of the Voluntary Carbon Markets 2016, Ecosystem Marketplace – A forest trends initiative.

61 GHG Protocol Scope 2 Guidance, www.ghgprotocol.org

Location-based method[19] – A method to quantify scope 2 GHG emission based on average energy generation emission factors for defined location, including local, subnational, or national boundaries.

Market-based method[19] – A method to quantify scope 2 GHG emissions based on GHG emissions emitted by the generation from which the reporter contractually purchases electricity bundled with instruments, or unbundled instruments on their own. Under this method, RECs applied to Canadian electricity consumption must be generated within Canada.

This new method changes the common practice that organizations would use in the past of calculating gross Scope 2 emissions based on the location-based method. If an organization was including green power purchases in its inventory, net Scope 2 emissions were calculated. With the new guidance, power purchases will be accounted for under the market-bases method.

The guidance defines quality criteria for electricity and green power purchases that go beyond minimum requirements. The key quality issues are listed in Table D-2.

Table D-2: Best-practice quality standards

Criteria	Best Practice
Certification	Green-e in U.S. and Canada; other standards are still emerging elsewhere
Installation date of the generating facility	Installed within the past 15 years is good practice; more recent installation is better practice
Incremental funding	Certificate purchases support an incremental funding program that directly funds development of new renewable energy resources
Regulatory surplus	Ensure that the purchase of renewable energy is not also used to meet a regulatory requirement for renewable energy supply
Aggregated GHG benefits	In areas with a cap on GHG emissions, retire GHG allowances along with the voluntary electricity certificates so that GHG reduction benefits are “fully aggregated” in the certificate
Bundled purchase of energy and attributes	Certificates purchased together with the underlying electricity through a power purchase agreement
Commitment period	Certificates purchased through long-term contracts of 10 to 20 years
Technology type	Renewable energy technologies that meet Green-e requirements

2.4 CARBON OFFSETS

Carbon offsets are credits for GHG reductions achieved by one party that can be purchased and used to compensate (offset) the emissions of another party. Carbon offsets are generally measured and sold in tonnes of carbon dioxide equivalent (tCO_2e). Unless an entity is subject to cap and trade, it purchases offsets on the voluntary market, so the remainder of this section will focus on that market.

Recent trends in the global voluntary carbon offset include:

- A 10% increase in the amount of voluntary carbon transactions made in 2015 compared to 2014
- Average global offset prices decreased by 14% from $5.00/$tCO_2e$ CAD in 2014 to $4.34/$tCO_2e$ CAD in 2015; offset prices are largely driven by project type, quality standard, offset age (vintage) and location
- Prices are subject to economies of scale; large organizations purchasing significant quantities of offsets are often able to obtain lower prices per tCO_2e
- Offsets generated from wind power projects were the most sought-after project type in 2015, followed by "Reducing Emissions from Deforestation and Forest Degradation" (REDD+) offsets; note that wind projects can be used to produce either RECs or offsets, depending on how the project is set up and quantified
- The majority of offsets purchased in 2015 (98%) were verified in alignment with a third-party standard, such as the Verified Carbon Standard
- Key decision criteria when choosing the type, source and provider from which to purchase offsets include: fit with organizational mission, cost and associated co-benefits of offset projects
- Approximately 124,000 tCO_2e of carbon offsets were transacted in Canada in 2015, at an average price of $10.14/$tCO_2e$ CAD, which is higher than global average prices observed in 2015 as noted above

Table D-3: Major Providers of Quality Offsets

Provider	Standards[62]	Project Locations	Project Types
Blue Source Canada	• International Standards Organisation (ISO) 14064-2 • ISO 14064-3 • ISO 14065 • PCS • CAR • VCS • GS • ACR	BC, AB, ON, most US states, overseas	• Forests • Landfill • Methane • Energy efficiency • Renewable energy • Fuel switching
Carbon Zero	• ISO 14064-2 • VER+ • CCB	ON, QC	• Organics biodigestion • Social housing energy retrofits • Landfill gas to energy
CarbonNeutral Company	• ACR • CAR • CCB • CDM • GS • SC	BC, LA, MS, AR, NY, CA, overseas	• Energy efficiency • Renewable energy • Landfill gas • Forests • Methane Capture • Cogeneration

62 ACR = American Carbon Registry; ARB = Air Resources Board; BC EOR = British Columbia Emission Offsets Regulation; CAR = Climate Action Reserve; CCB = Climate, Community and Biodiversity; CDM = Clean Development Mechanism; GS = Gold Standard; ISO = International Standards Organization; PCS = Pacific Carbon Standard; SC = Social Carbon; VCS = Verified Carbon Standard; VER+ = Voluntary Emissions Reduction

Provider	Standards[62]	Project Locations	Project Types
	• VCS		
Less	• GS • VER+ • CDM	NB, overseas	• Renewable energy • Landfill gas
LivClean	• VCS • CDM	AB, QC, ON, TX, IL, overseas	• Agricultural/industrial methane destruction • Cogeneration • Composting • Fuel efficiency • Renewable energy • Landfill gas capture
Offsetters	• GS • VCS • CAR • VER+ • ISO + CDM • BC EOR	QC, NB, BC, FL, overseas	• Renewable energy • Energy efficiency • Waste to energy • Reforestation • Landfill gas capture • Fuel switching • Forest preservation
PlanetAir	• GS	QC, overseas	• Renewable energy • Wastewater treatment • Landfill gas to energy • Energy efficiency • Fuel efficiency • Reforestation • Portfolio option
Renewable Choice Energy	• CAR • VCS • GS • ACR • Green-e Carbon ®	Not listed	• Not listed

APPENDIX E: PLAN SUMMARY AND RESULTS TABLES BY PROVINCE/TERRITORY

Table E-1: Number of Activities

	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	LED Lighting	ReCx/Audit/No & Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
Parliamentary Precinct	**27**	**0**	**0**	**27**	**1**	**9**	**25**	**0**	**26**	**0**	**26**	**26**	**0**	**3**
Atlantic Region	**60**	**35**	**25**	**35**	**17**	**12**	**17**	**2**	**0**	**0**	**0**	**0**	**8**	**0**
NB	23	14	9	14	9	3	5	1	0	0	0	0	0	0
NL	13	9	4	9	3	3	6	0	0	0	0	0	0	0
NS	19	8	11	8	5	3	3	0	0	0	0	0	8	0
PE	5	4	1	4	0	3	3	1	0	0	0	0	0	0
National Capital Area	**62**	**56**	**6**	**56**	**12**	**40**	**28**	**13**	**29**	**7**	**36**	**36**	**0**	**19**
ON	47	41	6	41	7	30	23	5	29	4	33	33	0	19
QC	15	15	0	15	5	10	5	8	0	3	3	3	0	0
Ontario Region	**41**	**28**	**13**	**28**	**9**	**6**	**18**	**10**	**0**	**0**	**0**	**0**	**0**	**6**
Pacific Region	**30**	**27**	**3**	**27**	**13**	**4**	**13**	**14**	**0**	**0**	**0**	**0**	**0**	**0**
BC	27	25	2	25	11	4	13	12	0	0	0	0	0	0
YT	3	2	1	2	2	0	0	2	0	0	0	0	0	0
Quebec Region	**34**	**28**	**6**	**28**	**11**	**5**	**15**	**10**	**0**	**0**	**0**	**0**	**0**	**0**
Western Region	**31**	**23**	**8**	**23**	**12**	**4**	**11**	**7**	**0**	**0**	**0**	**0**	**5**	**0**
AB	3	1	2	1	0	1	1	0	0	0	0	0	1	0
MN	10	9	1	9	3	2	6	3	0	0	0	0	0	0
NT	13	8	5	8	6	0	2	3	0	0	0	0	0	0
NU	1	1	0	1	1	0	0	1	0	0	0	0	0	0
SA	4	4	0	4	2	1	2	0	0	0	0	0	4	0
TOTAL	**285**	**197**	**61**	**224**	**75**	**80**	**127**	**56**	**55**	**7**	**62**	**62**	**13**	**28**

Table E-2: Change in Energy Consumption (GJ)

	ABW (Densification)	Asset Divestment	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
Parliamentary Precinct	**-**	**-**	**(31,040)**	**(2,084)**	**(22,358)**	**(150,190)**	**-**	**(15,813)**	**-**	**(1,786)**	**-**	**-**	**33**
Atlantic Region	**3,835**	**(62,199)**	**(23,214)**	**(10,497)**	**(16,292)**	**(73,884)**	**(11,049)**	**-**	**-**	**-**	**-**	**(10,121)**	**-**
NB	1,122	(19,295)	(6,708)	(3,793)	(4,477)	(21,647)	(855)	-	-	-	-	-	-
NL	1,075	(3,640)	(6,735)	(1,356)	(5,213)	(34,761)	-	-	-	-	-	-	-
NS	708	(38,721)	(4,183)	(5,348)	(865)	(3,094)	-	-	-	-	-	(10,121)	-
PE	929	(542)	(5,588)	-	(5,737)	(14,382)	(10,195)	-	-	-	-	-	-
National Capital Area	**47,172**	**(359,559)**	**(252,867)**	**(26,683)**	**(198,164)**	**(614,912)**	**(161,224)**	**(71,472)**	**-**	**(12,186)**	**-**	**-**	**415**
ON	32,080	(359,559)	(171,912)	(9,728)	(135,054)	(454,117)	(81,869)	(71,472)	-	(9,180)	-	-	415
QC	15,092	-	(80,954)	(16,954)	(63,110)	(160,795)	(79,355)	-	-	(3,006)	-	-	-
Ontario Region	**3,604**	**(52,025)**	**(22,314)**	**(6,873)**	**(16,583)**	**(77,250)**	**(21,130)**	**-**	**-**	**-**	**-**	**-**	**45**
Pacific Region	**4,227**	**(4,039)**	**(21,565)**	**(9,313)**	**(9,841)**	**(38,350)**	**(14,860)**	**-**	**-**	**-**	**-**	**-**	**-**
BC	3,901	(300)	(20,048)	(7,705)	(9,841)	(38,350)	(14,321)	-	-	-	-	-	-
YT	326	(3,739)	(1,517)	(1,608)	-	-	(539)	-	-	-	-	-	-
Quebec Region	**7,024**	**(59,810)**	**(38,282)**	**(9,929)**	**(26,100)**	**(104,565)**	**(28,270)**	**-**	**-**	**-**	**-**	**-**	**-**
Western Region	**2,691**	**(21,105)**	**(18,870)**	**(6,169)**	**(12,116)**	**(111,155)**	**(13,459)**	**-**	**-**	**-**	**-**	**(7,490)**	**-**
AB	161	(9,317)	(2,793)	-	(5,638)	(39,142)	-	-	-	-	-	(4,028)	-
MN	2,023	(3,598)	(12,259)	(3,381)	(5,195)	(55,713)	(9,758)	-	-	-	-	-	-
NT	30	(8,190)	(802)	(355)	-	(10,516)	(1,309)	-	-	-	-	-	-
NU	33	-	(354)	(964)	-	-	(2,392)	-	-	-	-	-	-
SA	443	-	(2,662)	(1,469)	(1,283)	(5,783)	-	-	-	-	-	(3,462)	-
TOTAL	**68,554**	**(558,738)**	**(408,150)**	**(71,547)**	**(301,454)**	**(1,170,306)**	**(249,991)**	**(87,284)**	**-**	**(13,972)**	**-**	**(17,611)**	**492**

Table E-3: Change in GHG Emissions (tCO_2e)

	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
Parliamentary Precinct	**1,324**	**-**	**-**	**(1,236)**	**(83)**	**(1,316)**	**(9,470)**	**-**	**(1,403)**	**-**	**(229)**	**(1,957)**	**-**	**(48)**
Atlantic Region	**(5,697)**	**191**	**(5,450)**	**(1,186)**	**(952)**	**(652)**	**(2,706)**	**(1,029)**	**-**	**-**	**-**	**-**	**(1,534)**	**-**
NB	(3,268)	89	(1,403)	(521)	(293)	(331)	(1,596)	(58)	-	-	-	-	-	-
NL	(231)	(3)	(105)	(17)	(3)	(39)	(369)	-	-	-	-	-	-	-
NS	(2,055)	124	(3,922)	(634)	(656)	(92)	(272)	-	-	-	-	-	(1,534)	-
PE	(143)	(20)	(20)	(13)	-	(190)	(469)	(971)	-	-	-	-	-	-
National Capital Area	**10,461**	**919**	**(15,625)**	**(6,600)**	**(862)**	**(7,548)**	**(23,599)**	**(9,832)**	**(6,074)**	**(1,287)**	**(1,157)**	**(9,880)**	**-**	**(580)**
ON	10,144	1,006	(15,625)	(6,493)	(482)	(6,766)	(22,527)	(4,488)	(6,074)	(346)	(1,037)	(8,849)	-	(580)
QC	317	(87)	-	(107)	(380)	(783)	(1,072)	(5,344)	-	(940)	(121)	(1,030)	-	-
Ontario Region	**1,645**	**110**	**(2,193)**	**(798)**	**(292)**	**(696)**	**(3,402)**	**(1,159)**	**-**	**-**	**-**	**-**	**-**	**(58)**
Pacific Region	**(10)**	**(18)**	**(181)**	**(63)**	**(204)**	**(131)**	**(564)**	**(1,126)**	**-**	**-**	**-**	**-**	**-**	**-**
BC	115	(18)	(12)	(63)	(194)	(131)	(564)	(1,074)	-	-	-	-	-	-
YT	(125)	(1)	(169)	(0)	(10)	-	-	(52)	-	-	-	-	-	-
Quebec Region	**163**	**(51)**	**(1,415)**	**(51)**	**(99)**	**(484)**	**(1,454)**	**(1,909)**	**-**	**-**	**-**	**-**	**-**	**-**
Western Region	**(2,929)**	**127**	**(1,549)**	**(920)**	**(320)**	**(732)**	**(5,606)**	**(898)**	**-**	**-**	**-**	**-**	**(1,155)**	**-**
AB	(1,395)	80	(897)	(465)	-	(478)	(2,843)	-	-	-	-	-	(671)	-
MN	(77)	(35)	(93)	(1)	(112)	(103)	(1,470)	(662)	-	-	-	-	-	-
NT	(144)	4	(559)	(60)	(20)	-	(713)	(63)	-	-	-	-	-	-
NU	(67)	2	-	(23)	(66)	-	-	(174)	-	-	-	-	-	-
SA	(1,247)	75	-	(372)	(122)	(151)	(580)	-	-	-	-	-	(484)	-
TOTAL	**4,957**	**1,277**	**(26,414)**	**(10,853)**	**(2,812)**	**(11,561)**	**(46,799)**	**(15,953)**	**(7,477)**	**(1,287)**	**(1,387)**	**(11,836)**	**(2,689)**	**(687)**

Table E-4: Final Electricity Consumption (kWh) and Non-Electricity GHG Emissions (tCO_2e) for Procurement Activities

	Final Electricity Consumption	Final Electricity GHG Emissions	Final Non-Electricity GHG Emissions
Parliamentary Precinct	**16,211,517**	**2,088**	**1,983**
Atlantic Region	**30,675,195**	**5,180**	**1,318**
NB	10,504,492	2,936	207
NL	9,123,397	84	188
NS	3,844,389	2,098	600
PE	7,202,917	62	323
National Capital Area	**246,940,977**	**18,918**	**7,132**
ON	143,039,356	18,422	7,094
QC	103,901,621	496	38
Ontario Region	**26,699,278**	**3,439**	**1,562**
Pacific Region	**25,569,409**	**263**	**872**
BC	23,373,614	262	872
YT	2,195,796	0	-
Quebec Region	**44,299,931**	**211**	**1,487**
Western Region	**18,044,861**	**2,128**	**1,396**
AB	974,708	584	202
MN	13,130,580	2	640
NT	1,009,420	270	112
NU	741,278	171	-
SA	2,188,876	1,101	443
TOTAL	**408,441,169**	**32,227**	**15,750**

Table E-5: Change in Annual Heating Energy Cost ($)

	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
Parliamentary Precinct	**$0**	**$0**	**$0**	**$0**	**-$4,808**	**-$255,254**	**-$2,094,339**	**$561,345**	**-$466,387**	**$0**	**-$53,151**	**$703,848**	**$0**	**$0**
Atlantic Region	**$0**	**-$37,002**	**-$630,739**	**$0**	**-$146,893**	**-$188,925**	**-$1,121,078**	**$279,158**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
NB	$0	-$11,800	-$244,304	$0	-$63,428	-$55,409	-$318,322	$44,976	$0	$0	$0	$0	$0	$0
NL	$0	-$13,319	-$47,160	$0	-$22,027	-$74,600	-$619,691	$31,352	$0	$0	$0	$0	$0	$0
NS	$0	-$5,757	-$334,553	$0	-$61,437	-$8,866	-$45,201	$215,457	$0	$0	$0	$0	$0	$0
PE	$0	-$6,125	-$4,723	$0	$0	-$50,050	-$137,865	-$12,627	$0	$0	$0	$0	$0	$0
National Capital Area	**$0**	**-$173,432**	**-$1,689,993**	**$0**	**-$186,337**	**-$1,312,644**	**-$3,974,674**	**$2,415,004**	**-$2,056,478**	**$1,282,558**	**-$377,450**	**$4,998,350**	**$0**	**$0**
ON	$0	-$130,886	-$1,689,993	$0	-$86,080	-$1,009,597	-$3,465,848	$2,698,300	-$2,056,478	$333,699	-$273,184	$3,617,623	$0	$0
QC	$0	-$42,546	$0	$0	-$100,257	-$303,047	-$508,826	-$283,296	$0	$948,859	-$104,265	$1,380,727	$0	$0
Ontario Region	**$0**	**-$11,708**	**-$204,595**	**$0**	**-$28,226**	**-$63,510**	**-$394,668**	**$998,032**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Pacific Region	**$0**	**-$6,377**	**-$46,323**	**$0**	**-$36,606**	**-$17,637**	**-$114,892**	**$44,483**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
BC	$0	-$6,113	-$3,148	$0	-$32,974	-$17,637	-$114,892	$51,503	$0	$0	$0	$0	$0	$0
YT	$0	-$264	-$43,175	$0	-$3,632	$0	$0	-$7,021	$0	$0	$0	$0	$0	$0
Quebec Region	**$0**	**-$20,775**	**-$419,229**	**$0**	**-$45,856**	**-$116,342**	**-$512,774**	**$41,837**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Western Region	**$0**	**-$12,851**	**-$179,576**	**$0**	**-$47,645**	**-$37,228**	**-$586,782**	**$496,827**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
AB	$0	-$2,462	-$30,050	$0	$0	-$21,161	-$168,694	$117,329	$0	$0	$0	$0	$0	$0
MN	$0	-$4,684	-$12,516	$0	-$15,077	-$13,813	-$198,160	$97,086	$0	$0	$0	$0	$0	$0
NT	$0	-$3,365	-$137,010	$0	-$8,432	$0	-$201,509	$79,762	$0	$0	$0	$0	$0	$0
NU	$0	-$1,269	$0	$0	-$17,459	$0	$0	-$29,281	$0	$0	$0	$0	$0	$0
SA	$0	-$1,070	$0	$0	-$6,676	-$2,254	-$18,419	$231,931	$0	$0	$0	$0	$0	$0
TOTAL	**$0**	**-$262,145**	**-$3,170,455**	**$0**	**-$496,370**	**-$1,991,539**	**-$8,799,207**	**$4,836,686**	**-$2,522,864**	**$1,282,558**	**-$430,601**	**$5,702,198**	**$0**	**$0**

Table E-6: Change in Annual Non-Heating Energy Cost ($)

	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
Parliamentary Precinct	**$0**	**$0**	**$0**	**-$1,073,647**	**-$74,767**	**-$462,433**	**-$2,646,396**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**-$379,958**
Atlantic Region	**$0**	**$195,536**	**-$1,127,658**	**-$880,980**	**-$227,654**	**-$347,903**	**-$1,323,892**	**$0**	**$0**	**$0**	**$0**	**$0**	**-$422,962**	**$0**
NB	$0	$55,217	-$425,807	-$248,779	-$73,119	-$97,854	-$424,360	$0	$0	$0	$0	$0	$0	$0
NL	$0	$50,899	-$58,916	-$229,321	-$24,133	-$98,486	-$515,647	$0	$0	$0	$0	$0	$0	$0
NS	$0	$38,804	-$632,187	-$174,828	-$130,402	-$20,177	-$42,250	$0	$0	$0	$0	$0	-$422,962	$0
PE	$0	$50,617	-$10,748	-$228,051	$0	-$131,385	-$341,636	$0	$0	$0	$0	$0	$0	$0
National Capital Area	**$0**	**$1,783,325**	**-$7,331,460**	**-$8,034,689**	**-$376,081**	**-$4,206,136**	**-$13,777,987**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**-$3,944,571**
ON	$0	$1,380,117	-$7,331,460	-$6,218,054	-$169,116	-$3,236,192	-$10,854,542	$0	$0	$0	$0	$0	$0	-$3,944,571
QC	$0	$403,208	$0	-$1,816,636	-$206,965	-$969,944	-$2,923,445	$0	$0	$0	$0	$0	$0	$0
Ontario Region	**$0**	**$192,661**	**-$1,098,157**	**-$868,026**	**-$139,981**	**-$357,762**	**-$1,251,201**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**-$505,222**
Pacific Region	**$0**	**$115,413**	**-$60,672**	**-$519,988**	**-$187,057**	**-$172,031**	**-$633,359**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
BC	$0	$94,733	-$898	-$426,815	-$96,846	-$172,031	-$633,359	$0	$0	$0	$0	$0	$0	$0
YT	$0	$20,680	-$59,775	-$93,173	-$90,211	$0	$0	$0	$0	$0	$0	$0	$0	$0
Quebec Region	**$0**	**$190,670**	**-$649,280**	**-$859,056**	**-$159,940**	**-$377,232**	**-$1,564,333**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Western Region	**$0**	**$104,543**	**-$355,709**	**-$471,013**	**-$62,669**	**-$142,448**	**-$927,603**	**$0**	**$0**	**$0**	**$0**	**$0**	**-$253,349**	**$0**
AB	$0	$21,244	-$127,186	-$95,713	$0	-$57,919	-$262,967	$0	$0	$0	$0	$0	-$138,046	$0
MN	$0	$45,224	-$28,814	-$203,754	-$18,859	-$52,145	-$435,272	$0	$0	$0	$0	$0	$0	$0
NT	$0	$12,763	-$199,709	-$57,503	-$951	$0	-$121,256	$0	$0	$0	$0	$0	$0	$0
NU	$0	$5,634	$0	-$25,384	-$24,577	$0	$0	$0	$0	$0	$0	$0	$0	$0
SA	$0	$19,678	$0	-$88,660	-$18,283	-$32,385	-$108,109	$0	$0	$0	$0	$0	-$115,303	$0
TOTAL	**$0**	**$2,582,148**	**-$10,622,937**	**-$12,707,399**	**-$1,228,148**	**-$6,065,945**	**-$22,124,771**	**$0**	**$0**	**$0**	**$0**	**$0**	**-$676,312**	**-$4,829,752**

Table E-7: Change in Annual Maintenance Cost ($)

	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
Parliamentary Precinct	**$0**	**$0**	**$0**	**-$79,458**	**-$25,454**	**-$40,395**	**$0**	**$0**	**-$80,084**	**$0**	**$0**	**$320,335**	**$0**	**$33,014**
Atlantic Region	**$0**	**$162,847**	**-$799,920**	**-$65,139**	**-$46,429**	**-$40,904**	**$0**	**$24,601**	**$0**	**$0**	**$0**	**$0**	**$71,692**	**$0**
NB	$0	$52,845	-$318,363	-$21,138	-$17,221	-$10,745	$0	$2,354	$0	$0	$0	$0	$0	$0
NL	$0	$48,097	-$28,234	-$19,239	-$7,830	-$11,235	$0	$0	$0	$0	$0	$0	$0	$0
NS	$0	$33,372	-$426,209	-$13,349	-$21,379	-$8,120	$0	$0	$0	$0	$0	$0	$71,692	$0
PE	$0	$28,533	-$27,114	-$11,413	$0	-$10,803	$0	$22,247	$0	$0	$0	$0	$0	$0
National Capital Area	**$0**	**$1,604,800**	**-$2,609,546**	**-$641,920**	**-$106,797**	**-$515,563**	**$0**	**$928,598**	**-$297,856**	**-$584,947**	**$0**	**$1,740,689**	**$0**	**$320,560**
ON	$0	$1,010,502	-$2,609,546	-$404,201	-$30,765	-$319,984	$0	$465,771	-$297,856	-$131,846	$0	$1,308,851	$0	$320,560
QC	$0	$594,298	$0	-$237,719	-$76,031	-$195,579	$0	$462,827	$0	-$453,101	$0	$431,837	$0	$0
Ontario Region	**$0**	**$202,339**	**-$1,058,337**	**-$80,935**	**-$34,801**	**-$49,050**	**$0**	**$124,227**	**$0**	**$0**	**$0**	**$0**	**$0**	**$54,820**
Pacific Region	**$0**	**$162,686**	**-$65,922**	**-$65,074**	**-$49,410**	**-$37,697**	**$0**	**$133,268**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
BC	$0	$155,343	-$33,927	-$62,137	-$42,067	-$37,697	$0	$118,582	$0	$0	$0	$0	$0	$0
YT	$0	$7,343	-$31,996	-$2,937	-$7,343	$0	$0	$14,686	$0	$0	$0	$0	$0	$0
Quebec Region	**$0**	**$241,746**	**-$638,866**	**-$96,699**	**-$70,749**	**-$51,400**	**$0**	**$172,573**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Western Region	**$0**	**$135,159**	**-$251,235**	**-$54,064**	**-$26,925**	**-$23,649**	**$0**	**$68,349**	**$0**	**$0**	**$0**	**$0**	**$51,820**	**$0**
AB	$0	$16,510	-$130,820	-$6,604	$0	-$6,604	$0	$0	$0	$0	$0	$0	$27,126	$0
MN	$0	$83,670	-$57,047	-$33,468	-$18,212	-$11,722	$0	$64,012	$0	$0	$0	$0	$0	$0
NT	$0	$8,166	-$63,368	-$3,266	-$1,121	$0	$0	$1,386	$0	$0	$0	$0	$0	$0
NU	$0	$1,476	$0	-$590	-$1,476	$0	$0	$2,952	$0	$0	$0	$0	$0	$0
SA	$0	$25,338	$0	-$10,135	-$6,116	-$5,324	$0	$0	$0	$0	$0	$0	$24,694	$0
TOTAL	**$0**	**$2,509,577**	**-$5,423,827**	**-$1,083,289**	**-$360,565**	**-$758,657**	**$0**	**$1,451,617**	**-$377,940**	**-$584,947**	**$0**	**$2,061,024**	**$123,512**	**$408,394**

Table E-8a: Incremental Capital Cost ($)

		Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	LED Lighting	ReCx/Audit/No & Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit	Fuel Switching
Parliamentary Precinct		**$0**	**$0**	**$0**	**$794,582**	**$254,541**	**$201,973**	**$93,092,246**	**$0**
Atlantic Region		**$0**	**$16,284,703**	**$0**	**$651,388**	**$701,204**	**$204,520**	**$62,107,879**	**$2,460,102**
NB		$0	$5,284,499	$0	$211,380	$296,378	$53,727	$20,427,248	$235,417
NL		$0	$4,809,709	$0	$192,388	$128,282	$56,175	$24,160,390	$0
NS		$0	$3,337,198	$0	$133,488	$276,543	$40,602	$7,074,513	$0
PE		$0	$2,853,297	$0	$114,132	$0	$54,017	$10,445,729	$2,224,685
National Capital Area		**$0**	**$160,479,971**	**$0**	**$6,419,199**	**$1,323,741**	**$2,577,814**	**$541,093,976**	**$92,859,843**
ON		$0	$101,050,207	$0	$4,042,008	$464,027	$1,599,920	$348,558,250	$46,577,107
QC		$0	$59,429,764	$0	$2,377,191	$859,714	$977,894	$192,535,727	$46,282,736
Ontario Region		**$0**	**$20,233,858**	**$0**	**$809,354**	**$564,096**	**$245,249**	**$94,748,962**	**$12,422,680**
Pacific Region		**$0**	**$16,268,615**	**$0**	**$650,745**	**$716,496**	**$188,483**	**$57,631,357**	**$13,326,778**
BC		$0	$15,534,312	$0	$621,372	$598,379	$188,483	$57,631,357	$11,858,172
YT		$0	$734,303	$0	$29,372	$118,116	$0	$0	$1,468,606
Quebec Region		**$0**	**$24,174,643**	**$0**	**$966,986**	**$918,996**	**$256,998**	**$85,816,613**	**$17,257,328**
Western Region		**$0**	**$13,515,915**	**$0**	**$540,637**	**$375,526**	**$118,246**	**$56,250,240**	**$6,834,932**
AB		$0	$1,650,969	$0	$66,039	$0	$33,019	$9,905,811	$0
MN		$0	$8,367,027	$0	$334,681	$218,868	$58,608	$30,998,624	$6,401,179
NT		$0	$816,556	$0	$32,662	$28,014	$0	$4,226,987	$138,575
NU		$0	$147,589	$0	$5,904	$36,897	$0	$0	$295,179
SA		$0	$2,533,775	$0	$101,351	$91,746	$26,618	$11,118,818	$0
TOTAL		**$0**	**$250,957,705**	**$0**	**$10,832,890**	**$4,854,598**	**$3,793,283**	**$990,741,273**	**$145,161,662**

Table E-8b: Incremental Capital Cost ($)

	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
Parliamentary Precinct	**$0**	**$0**	**$72,075,480**	**$162,169,831**	**$0**	**$3,301,443**
Atlantic Region	**$0**	**$0**	**$0**	**$0**	**$9,409,532**	**$0**
NB	$0	$0	$0	$0	$0	$0
NL	$0	$0	$0	$0	$0	$0
NS	$0	$0	$0	$0	$9,409,532	$0
PE	$0	$0	$0	$0	$0	$0
National Capital Area	**$0**	**$35,096,838**	**$391,654,913**	**$881,223,555**	**$0**	**$32,055,955**
ON	$0	$7,910,786	$294,491,520	$662,605,919	$0	$32,055,955
QC	$0	$27,186,052	$97,163,394	$218,617,636	$0	$0
Ontario Region	**$0**	**$0**	**$0**	**$0**	**$0**	**$5,482,046**
Pacific Region	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
BC	$0	$0	$0	$0	$0	$0
YT	$0	$0	$0	$0	$0	$0
Quebec Region	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Western Region	**$0**	**$0**	**$0**	**$0**	**$6,801,373**	**$0**
AB	$0	$0	$0	$0	$3,560,227	$0
MN	$0	$0	$0	$0	$0	$0
NT	$0	$0	$0	$0	$0	$0
NU	$0	$0	$0	$0	$0	$0
SA	$0	$0	$0	$0	$3,241,146	$0
TOTAL	**$0**	**$35,096,838**	**$463,730,394**	**$1,043,393,386**	**$16,210,905**	**$40,839,444**

Table E-9a: 25-Year Net Present Value Lifecycle Cost ($)

	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit	Fuel Switching
Parliamentary Precinct	**$0**	**$0**	**$0**	**-$36,273,758**	**-$1,933,458**	**-$18,995,417**	**-$68,840,671**	**$0**
National Capital Area	**$0**	**$0**	**$0**	**-$36,273,758**	**-$1,933,458**	**-$18,995,417**	**-$68,840,671**	**$0**
ON	$0	$0	$0	-$36,273,758	-$1,933,458	-$18,995,417	-$68,840,671	$0
RPB	**$0**	**$415,925,362**	**-$656,417,213**	**-$392,334,458**	**-$37,741,147**	**-$152,574,191**	**$3,287,995**	**$399,149,413**
Atlantic Region	**$0**	**$27,262,384**	**-$87,386,399**	**-$29,764,700**	**-$9,822,888**	**-$12,748,062**	**-$21,406,818**	**$4,117,149**
NB	$0	$8,572,595	-$33,764,052	-$8,391,441	-$3,326,387	-$3,766,973	-$4,941,094	$359,576
NL	$0	$7,736,219	-$4,587,707	-$7,736,348	-$1,010,542	-$4,377,186	-$14,620,196	$0
NS	$0	$5,605,921	-$47,580,021	-$5,904,600	-$5,485,958	$117,441	$4,087,406	$0
PE	$0	$5,347,649	-$1,454,619	-$7,732,311	$0	-$4,721,345	-$5,932,934	$3,757,572
National Capital Area	**$0**	**$270,286,679**	**-$397,288,912**	**-$271,218,653**	**-$14,256,659**	**-$118,067,297**	**-$65,297,228**	**$259,336,568**
ON	$0	$178,237,614	-$397,288,912	-$210,361,988	-$6,752,357	-$101,306,907	-$140,594,244	$145,580,300
QC	$0	$92,049,065	$0	-$60,856,664	-$7,504,301	-$16,760,390	$75,297,015	$113,756,268
Ontario Region	**$0**	**$33,326,257**	**-$80,649,512**	**-$29,242,781**	**-$3,268,575**	**-$7,687,976**	**$38,529,760**	**$38,757,582**
Pacific Region	**$0**	**$25,550,020**	**-$5,906,484**	**-$17,434,352**	**-$4,671,453**	**-$1,328,106**	**$32,072,789**	**$36,189,831**
BC	$0	$23,867,529	-$1,297,061	-$14,266,533	-$1,982,749	-$1,328,106	$32,072,789	$32,052,919
YT	$0	$1,682,491	-$4,609,423	-$3,167,819	-$2,688,703	$0	$0	$4,136,912
Quebec Region	**$0**	**$38,235,402**	**-$58,320,114**	**-$28,857,126**	**-$3,474,115**	**-$9,836,622**	**$14,867,271**	**$42,735,524**
Western Region	**$0**	**$21,264,620**	**-$26,865,794**	**-$15,816,846**	**-$2,247,458**	**-$2,906,128**	**$4,522,221**	**$18,012,760**
AB	$0	$2,856,451	-$9,839,361	-$3,236,123	$0	-$1,798,890	-$4,838,778	$0
MN	$0	$12,609,750	-$3,360,315	-$6,791,448	-$358,991	-$651,427	$9,362,022	$18,040,765
NT	$0	$1,416,469	-$13,666,118	-$1,947,733	-$176,728	$0	-$6,797,953	$92,485
NU	$0	$347,084	$0	-$864,077	-$1,246,486	$0	$0	-$120,490
SA	$0	$4,034,866	$0	-$2,977,465	-$465,253	-$455,811	$6,796,929	$0
TOTAL	**$0**	**$415,925,362**	**-$656,417,213**	**-$428,608,216**	**-$39,674,604**	**-$171,569,608**	**-$65,552,675**	**$399,149,413**

Table E-9b: 25-Year Net Present Value Lifecycle Cost ($)

	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
Parliamentary Precinct	**-$18,666,216**	**$0**	**$70,259,960**	**$197,153,664**	**$0**	**$1,086,535**
National Capital Area	**-$18,666,216**	**$0**	**$70,259,960**	**$197,153,664**	**$0**	**$1,086,535**
ON	-$18,666,216	$0	$70,259,960	$197,153,664	$0	$1,086,535
RPB	**-$80,418,778**	**$58,925,667**	**$378,762,074**	**$1,111,414,038**	**-$2,671,503**	**$7,927,360**
Atlantic Region	**$0**	**$0**	**$0**	**$0**	**-$2,589,093**	**$0**
NB	$0	$0	$0	$0	$0	$0
NL	$0	$0	$0	$0	$0	$0
NS	$0	$0	$0	$0	-$2,589,093	$0
PE	$0	$0	$0	$0	$0	$0
National Capital Area	**-$80,418,778**	**$58,925,667**	**$378,762,074**	**$1,111,414,038**	**$0**	**$1,829,558**
ON	-$80,418,778	$14,805,611	$285,160,153	$830,883,264	$0	$1,829,558
QC	$0	$44,120,056	$93,601,920	$280,530,774	$0	$0
Ontario Region	**$0**	**$0**	**$0**	**$0**	**$0**	**$6,097,802**
Pacific Region	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
BC	$0	$0	$0	$0	$0	$0
YT	$0	$0	$0	$0	$0	$0
Quebec Region	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Western Region	**$0**	**$0**	**$0**	**$0**	**-$82,410**	**$0**
AB	$0	$0	$0	$0	-$228,577	$0
MN	$0	$0	$0	$0	$0	$0
NT	$0	$0	$0	$0	$0	$0
NU	$0	$0	$0	$0	$0	$0
SA	$0	$0	$0	$0	$146,167	$0
TOTAL	**-$99,084,994**	**$58,925,667**	**$449,022,034**	**$1,308,567,702**	**-$2,671,503**	**$9,013,895**

Table E-10: Average Lifecycle Cost per GHG Emissions Reduction ($/tCO₂e)

	Grid De/Re-Carbonization	ABW & Divestment	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
Parliamentary Precinct	**$0**		**-$1,174**	**-$930**	**-$577**	**-$291**		**-$532**		**$12,262**	**$4,031**		**$912**
Atlantic Region	**$0**	**-$457**	**-$1,004**	**-$413**	**-$782**	**-$316**	**$160**					**-$68**	
NB	$0	-$767	-$645	-$454	-$455	-$124	$248						
NL	$0	$1,172	-$17,902	-$11,617	-$4,507	-$1,586							
NS	$0	-$442	-$372	-$335	$51	$602						-$68	
PE	$0	$3,909	-$23,159		-$992	-$506	$155						
National Capital Area	**$0**	**-$345**	**-$1,644**	**-$662**	**-$626**	**-$111**	**$1,055**	**-$530**	**$1,832**	**$13,091**	**$4,500**		**$126**
ON	$0	-$599	-$1,296	-$561	-$599	-$250	$1,298	-$530	$1,710	$11,004	$3,756		$126
QC	$0	$42,152	-$22,691	-$790	-$856	$2,808	$851		$1,877	$31,017	$10,889		
Ontario Region	**$0**	**-$909**	**-$1,465**	**-$448**	**-$442**	**$453**	**$1,338**						**$4,173**
Pacific Region	**$0**	**$3,932**	**-$11,138**	**-$917**	**-$406**	**$2,276**	**$1,285**						
BC	$0	$30,278	-$9,126	-$409	-$406	$2,276	$1,193						
YT	$0	-$689	-$1,625,831	-$10,812			$3,194						
Quebec Region	**$0**	**-$548**	**-$22,753**	**-$1,399**	**-$812**	**$409**	**$896**						
Western Region	**$0**	**-$158**	**-$688**	**-$281**	**-$159**	**$32**	**$802**					**-$3**	
AB	$0	-$342	-$278		-$151	-$68						-$14	
MN	$0	$2,904	-$469,129	-$128	-$254	$255	$1,091						
NT	$0	-$882	-$1,309	-$358		-$381	$59						
NU	$0	-$7,556	-$1,528	-$759			-$28						
SA	$0	-$2,145	-$320	-$152	-$120	$469						$12	
TOTAL	**$0**	**-$383**	**-$1,580**	**-$564**	**-$594**	**-$56**	**$1,001**	**-$530**	**$1,832**	**$12,954**	**$4,422**	**-$40**	**$525**

APPENDIX F: PLAN ELEMENTS BY SITE

Table F-1: Carbon Neutral Plan Elements by Site

Region	Facility	Province	Building floor area (m²)	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	Data Centre Consolidation	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit (option)	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
Atlantic Region	310 Baig Boulevard	NB	5,636	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Atlantic Region	C&I Complex - Clair	NB	621	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Atlantic Region	C&I Complex - Edmunston	NB	1,625	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Atlantic Region	C&I Complex - St. Croix	NB	185	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Atlantic Region	C&I Complex - St. Leonard	NB	743	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Atlantic Region	C&I Complex - St. Stephen	NB	1,712	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Atlantic Region	Caraquet GOCB	NB	610	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Atlantic Region	Customs Building	NB	7,425	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	DSS Building	NB	7,553	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Atlantic Region	Edmundston GOCB	NB	1,711	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	Florenceville GOC Buildig	NB	304	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	Fredericton GOCB	NB	5,490	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Atlantic Region	Grand Falls GOCB	NB	1,449	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	Gulf Fisheries Centre	NB	13,318	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	Kentville GOCB	NS	2,831	Y	-	Y		-	-		-	-	-	-	-	-	-	-

Region	Facility	Province	Building floor area (m^2)	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	Data Centre Consolidation	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit (option)	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
Atlantic Region	Miramichi GOCB	NB	2,187	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Atlantic Region	Moncton, Dominion Public	NB	23,486	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
Atlantic Region	Nicholas Denys Building	NB	11,881	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
Atlantic Region	Postal Station A and Annex	NB	11,735	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Atlantic Region	RCMP J Division	NB	14,547	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
Atlantic Region	Shippagan GOCB	NB	1,086	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	St. Stephen GOCB	NB	2,302	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	Woodstock GOCB	NB	1,956	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	Building 223, Churchill .	NL	2,776	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Atlantic Region	Burgeo GOCB	NL	430	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	F&O Storage Facility	NL	780	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Atlantic Region	Grand Bank GOCB	NL	1,449	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	John Cabot Building	NL	14,237	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Atlantic Region	Joseph R. Smallwood Building	NL	4,924	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Atlantic Region	Mount Pearl GOCB	NL	1,233	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Atlantic Region	NL Data Tax	NL	15,130	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
Atlantic Region	NWAFC	NL	21,301	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
Atlantic Region	RCMP B Division	NL	15,757	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
Atlantic Region	Sir Humphrey Gilbert	NL	12,535	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Atlantic Region	St. Georges GOCB	NL	452	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	Witless Bay GOCB	NL	293	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	49, Dorchester St., Sydney	NS	7,238	Y	Y	-		Y	Y		-	-	-	-	-	-	Y	-
Atlantic Region	Amherst GOCB	NS	4,697	Y	Y	-		Y	Y		-	-	-	-	-	-	Y	-
Atlantic Region	Antigonish GOCB	NS	2,508	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	Dawson B. Dauphinee	NS	2,116	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	Fisheries Building	NS	1,430	Y	-	Y		-	-		-	-	-	-	-	-	-	-

Region	Facility	Province	Building floor area (m^2)	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	Data Centre Consolidation	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit (option)	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy [text cut off on page]	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
Atlantic Region	Halifax, Dominion Public	NS	14,547	Y	Y	-		Y	-	Y	2	-	-	-	-	-	Y	-
Atlantic Region	Marine House	NS	6,874	Y	Y	-		Y	Y		-	-	-	-	-	-	Y	-
Atlantic Region	New Glasgow GOCB	NS	2,603	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	Ralston Building	NS	17,226	Y	-	Y		-	-	Y	-	-	-	-	-	-	-	-
Atlantic Region	RCMP H Division	NS	5,948	Y	-	Y		-	-	Y	-	-	-	-	-	-	-	-
Atlantic Region	Shelburne GOCB	NS	832	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	Sherbrooke GOCB	NS	383	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	Sydney Arts Building	NS	1,504	Y	Y	-		Y	Y		-	-	-	-	-	-	Y	-
Atlantic Region	Sydney Manpower Building	NS	1,068	Y	Y	-		Y	-		2	-	-	-	-	-	Y	-
Atlantic Region	Sydney Science Building	NS	2,126	Y	Y	-		Y	-		2	-	-	-	-	-	Y	-
Atlantic Region	Westville GOCB	NS	469	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	Yarmouth GOCB	NS	3,250	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	Daniel MacDonald Building	PE	16,435	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
Atlantic Region	Jean Canfield	PE	13,080	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
Atlantic Region	RCMP L Division	PE	2,833	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Atlantic Region	Summerside GOCB*	PE	2,519	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	Summerside Taxation Centre	PE	20,668	Y	Y	-		Y	-	Y	-	Y	-	-	-	-	-	-
Atlantic Region	Bayside Trailer GOCB	NB	26	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Atlantic Region	RCMP "H" Division HQs	NS	19,410	Y	Y	-		Y	Y		-	-	-	-	-	-	Y	-
National Capital Area	111 Sussex Drive (Diefenbaker Building)	ON	53,587	Y	Y	-		Y	-	Y	2	-	-	Y	Y	Y	-	Y
National Capital Area	350 King Edward Ave.	ON	11,821	Y	Y	-		Y	-	Y	2	-	-	Y	Y	Y	-	-
National Capital Area	Sir John A MacDonald/Bank of Montreal	ON	3,785	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	Bank of Nova Scotia	ON	4,677	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	Bates Building	ON	1,743	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-

Region	Facility	Province	Building floor area (m^2)	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	Data Centre Consolidation	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit (option)	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
National Capital Area	Birks Building	ON	5,285	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	Blackburn Building	ON	14,191	Y	-	-		Y	-	Y	2	-	Y	-	Y	Y	-	-
National Capital Area	Booth Administration	ON	9,721	Y	Y	-		Y	-	Y	2	-	Y	-	Y	Y	-	-
National Capital Area	Booth Building	ON	6,185	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	Brooke Claxton Building	ON	26,868	Y	Y	-		Y	-	Y	2	-	Y	-	Y	Y	-	-
National Capital Area	Brouse-Slater Building	ON	1,897	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	Butler Hut	ON	309	Y	Y	-		Y	Y		-	-	Y	-	Y	Y	-	-
National Capital Area	C.D. Howe Building	ON	148,410	Y	Y	-		Y	-	Y	2	-	Y	-	Y	Y	-	Y
National Capital Area	Canada Four Corners	ON	1,361	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	Centennial Flame	ON		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
National Capital Area	Centre Block	ON	61,985	Y	-	-		Y	-	Y	2	-	Y	-	Y	Y	-	Y
National Capital Area	Confederation Building	ON	27,934	Y	-	-		Y	-	Y	2	-	Y	-	Y	Y	-	Y
National Capital Area	Connaught Building	ON	20,466	Y	Y	-		Y	-	Y	2	-	Y	-	Y	Y	-	-
National Capital Area	Constitution Building	ON	28,696	Y	Y	-		Y	-		2	-	-	Y	Y	Y	-	Y
National Capital Area	DND Data Ctr. Ottawa Building	ON	18,983	Y	Y	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	Dover	ON	906	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	East Block	ON	16,567	Y	-	-		Y	-	Y	2	-	Y	-	Y	Y	-	-
National Capital Area	East Memorial	ON	37,140	Y	Y	-		Y	-	Y	2	-	Y	-	Y	Y	-	Y
National Capital Area	Edward Drake Building	ON	11,580	Y	Y	-		Y	Y		-	-	Y	-	Y	Y	-	-

Region	Facility	Province	Building floor area (m^2)	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	Data Centre Consolidation	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit (option)	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
National Capital Area	Exhibition Commission	ON	23,545	Y	Y	-		Y	-	Y	-	Y	-	-	-	-	-	-
National Capital Area	Federal Study Centre	ON	18,042	Y	-	Y		-	-		-	-	-	-	-	-	-	-
National Capital Area	Finance Annex	ON	7,219	Y	Y	-		Y	Y		-	-	Y	-	Y	Y	-	-
National Capital Area	Finance Building	ON	7,912	Y	Y	-		Y	-	Y	2	-	Y	-	Y	Y	-	-
National Capital Area	Fisher Building	ON	1,180	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	General Records Centre	ON	18,221	Y	Y	-		Y	Y		-	-	Y	-	Y	Y	-	-
National Capital Area	GOC Conference Centre	ON	12,532	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	Graham Spry Building	ON	14,988	Y	Y	-		Y	-		2	-	-	Y	Y	Y	-	-
National Capital Area	Health Protection Building	ON	12,432	Y	Y	-		Y	-	Y	2	-	Y	-	Y	Y	-	-
National Capital Area	Hope Chambers	ON	2,820	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	House of Norcano	ON	725	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	Insurance Building	ON	2,859	Y	-	Y		-	-		-	-	-	-	-	-	-	-
National Capital Area	Jackson Building	ON	25,375	Y	-	Y		-	-	Y	-	-	-	-	-	-	-	-
National Capital Area	Jean Talon Building	ON	70,971	Y	Y	-		Y	-	Y	-	-	Y	-	Y	Y	-	Y
National Capital Area	Jeanne-Mance Building	ON	38,472	Y	Y	-		Y	-	Y	2	-	Y	-	Y	Y	-	Y
National Capital Area	Justice Building	ON	16,425	Y	-	-		Y	-	Y	2	-	Y	-	Y	Y	-	-
National Capital Area	L.H.Nicholson RCMP HQ	ON	71,308	Y	-	Y		-	-		-	-	-	-	-	-	-	-
National Capital Area	La Promenade	ON	19,236	Y	-	-		Y	-	Y	2	-	Y	-	Y	Y	-	-
National Capital Area	La Salle Academy	ON	14,071	Y	Y	-		Y	-	Y	2	-	Y	-	Y	Y	-	-

Region	Facility	Province	Building floor area (m^2)	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	Data Centre Consolidation	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit (option)	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
National Capital Area	Langevin Building	ON	11,435	Y	-	-		Y	-	Y	2	-	Y	-	Y	Y	-	-
National Capital Area	L'Esplanade Laurier	ON	88,707	Y	-	Y		-	-		-	-	-	-	-	-	-	-
National Capital Area	Lester B. Pearson	ON	102,524	Y	Y	-		Y	-	Y	2	-	Y	-	Y	Y	-	Y
National Capital Area	Major-General G. R. Pearkes Building	ON	105,494	Y	Y	-		Y	-	Y	2	-	Y	-	Y	Y	-	Y
National Capital Area	Mulligan Building	ON	13,482	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
National Capital Area	Nat. Library & Public Archives	ON	47,691	Y	Y	-		Y	-	Y	-	-	Y	-	Y	Y	-	Y
National Capital Area	National Press	ON	5,012	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	Nelms	ON	537	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	P.A. Storage	ON	19,946	Y	Y	-		Y	-	Y	-	-	-	N	-	-	-	-
National Capital Area	Personnel Records Tunneys	ON	21,119	Y	Y	-		Y	-	Y	-	-	Y	-	Y	Y	-	-
National Capital Area	Plouffe Park	ON	35,536	Y	Y	-		Y	-		2	-	-	N	-	-	-	Y
National Capital Area	Postal Station B	ON	6,035	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	Private Branch Exchange	ON	164	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
National Capital Area	R.H. Coats Building	ON	48,660	Y	Y	-		Y	-	Y	2	-	Y	-	Y	Y	-	Y
National Capital Area	Saint Andrews Tower	ON	20,956	Y	Y	-		Y	-	Y	2	-	Y	-	Y	Y	-	-
National Capital Area	Saxe Canada Life	ON	1,588	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	Sir Charles Tupper Building	ON	36,144	Y	-	Y		-	-		-	-	-	-	-	-	-	-
National Capital Area	Sir Leonard Tilley Building	ON	25,316	Y	Y	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	Sir William Logan	ON	39,696	Y	Y	-		Y	-	Y	-	-	Y	-	Y	Y	-	Y

Region	Facility	Province	Building floor area (m^2)	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	Data Centre Consolidation	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit (option)	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
National Capital Area	Standards Lab-Tunney's	ON	6,190	Y	Y	-		Y	Y		-	-	Y	-	Y	Y	-	-
National Capital Area	Statistics Canada, Main Building	ON	45,265	Y	Y	-		Y	-	Y	2	-	Y	-	Y	Y	-	Y
National Capital Area	Supreme Court	ON	30,825	Y	Y	-		Y	-	Y	-	-	Y	-	Y	Y	-	Y
National Capital Area	Taxation Data Centre	ON	67,740	Y	Y	-		Y	-	Y	2	-	Y	-	Y	Y	-	Y
National Capital Area	Uniform #2	ON	4,068	Y	Y	-		Y	-	Y	-	Y	-	-	-	-	-	-
National Capital Area	Victoria	ON	8,914	Y	-	-		Y	-		2	-	Y	-	Y	Y	-	-
National Capital Area	Wellington Building	ON	47,295	Y	-	-		Y	Y		-	-	Y	-	Y	Y	-	Y
National Capital Area	West Block	ON	17,353	Y	-	-		Y	-	Y	-	-	Y	-	Y	Y	-	-
National Capital Area	West Memorial	ON	33,621	Y	Y	-		Y	-	Y	2	-	Y	-	Y	Y	-	Y
National Capital Area	1170 Algoma Rd	ON	2,513	Y	-	-		Y	-	Y	2	-	-	N	-	-	-	-
National Capital Area	Carling Campus	ON	250,568	Y	Y	-		Y	-	Y	-	Y	-	-	-	-	-	Y
National Capital Area	MJ Nadon RCMP National Headquarters	ON	78,411	Y	Y	-		Y	-	Y	-	Y	-	-	-	-	-	Y
National Capital Area	Jim Flaherty Building	ON	69,000	Y	Y	-		Y	-	Y	-	-	Y	-	Y	Y	-	Y
National Capital Area	Asticou Centre	QC	41,997	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
National Capital Area	Bisson Centre	QC	9,165	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
National Capital Area	CMN- Curatorial Centre	QC	14,134	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
National Capital Area	Gatineau Preservation Centre	QC	62,335	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
National Capital Area	Les Terrasses de la Chaudière	QC	176,075	Y	Y	-		Y	-	Y	2	-	-	Y	Y	Y	-	-
National Capital Area	Louis Saint Laurent Building	QC	63,888	Y	Y	-		Y	-	Y	-	-	-	-	-	-	-	-

Region	Facility	Province	Building floor area (m²)	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	Data Centre Consolidation	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit (option)	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
National Capital Area	National Printing Bureau	QC	87,727	Y	Y	-		Y	-	Y	-	Y	-	-	-	-	-	-
National Capital Area	Storage Collection Facility (Old Zellers*)	QC	13,640	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
National Capital Area	Place du Centre	QC	61,945	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
National Capital Area	Place du Portage I & II	QC	79,018	Y	Y	-		Y	-	Y	2	-	-	Y	Y	Y	-	-
National Capital Area	Place du Portage III	QC	146,097	Y	Y	-		Y	-	Y	2	-	-	Y	Y	Y	-	-
National Capital Area	Place du Portage IV	QC	113,349	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
National Capital Area	22 Eddy	QC	65,661	Y	Y	-		Y	-	Y	-	Y	-	-	-	-	-	-
National Capital Area	30 Victoria	QC	69,655	Y	Y	-		Y	-	Y	-	Y	-	-	-	-	-	-
National Capital Area	455 Blvd de la Carriere	QC	45,079	Y	Y	-		Y	-	Y	-	Y	-	-	-	-	-	-
Ontario Region	1 North Front GOCB	ON	4,569	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Ontario Region	1, Front St.W., Toronto B	ON	39,439	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Ontario Region	11 Station, Belleville GB	ON	7,382	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Ontario Region	130, Syndicate Ave. S.	ON	4,232	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Ontario Region	221, Archibald St. N.	ON	5,833	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Ontario Region	33, Court St., Thunder By	ON	8,241	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Ontario Region	338, Keele St. GOCB	ON	5,274	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Ontario Region	494 Dundas, Belleville GB	ON	5,916	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Ontario Region	Arthur Meighen Building	ON	41,086	Y	Y	-		Y	-	Y	3	-	-	-	-	-	-	Y
Ontario Region	Barrie GOCB	ON	3,655	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Ontario Region	Bracebridge GOCB	ON	1,529	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Ontario Region	Brantford GOCB	ON	9,543	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Ontario Region	Canada Centre GOCB	ON	47,348	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	Y

Region	Facility	Province	Building floor area (m^2)	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	Data Centre Consolidation	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit (option)	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
Ontario Region	Caretaker's Residence	ON	1,424	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Ontario Region	Chatham GOCB	ON	9,004	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Ontario Region	Collingwood GOCB	ON	1,876	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Ontario Region	Custom's House GOCB	ON	868	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Ontario Region	Environment Canada Downsview	ON	31,861	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	Y
Ontario Region	Fort Frances GOCB	ON	2,004	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Ontario Region	GOC Building [Dominion	ON	12,370	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Ontario Region	Greater Sudbury GOCB	ON	9,765	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Ontario Region	Hamilton GOCB	ON	36,997	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	Y
Ontario Region	Judy Lamarsh Building	ON	6,142	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Ontario Region	Kapuskasing GOCB	ON	1,317	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Ontario Region	Kenora GOCB	ON	2,467	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Ontario Region	Kitchener GOCB	ON	3,587	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Ontario Region	Kitchener, National Revee	ON	5,390	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Ontario Region	Lipton Building	ON	3,836	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Ontario Region	London GOCB	ON	29,428	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	Y
Ontario Region	Orillia GOCB	ON	3,556	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Ontario Region	Parry sound GOCB	ON	1,898	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Ontario Region	Paul Martin Building	ON	14,694	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Ontario Region	Sarnia GOCB	ON	7,898	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Ontario Region	Sault Ste. Marie GOCB	ON	4,890	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Ontario Region	Sioux Lookout GOCB	ON	975	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Ontario Region	Sir Lionel Chevrier Building	ON	10,522	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Ontario Region	St. Catharines GOCB	ON	9,859	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Ontario Region	Sudbury Tax Centre	ON	41,124	Y	Y	-		Y	-	Y	-	Y	-	-	-	-	-	Y
Ontario Region	Thunder Bay, National Ree	ON	2,576	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Ontario Region	Timmins GOCB	ON	3,014	Y	Y	-		Y	-		2	-	-	-	-	-	-	-

Region	Facility	Province	Building floor area (m^2)	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	Data Centre Consolidation	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit (option)	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
Ontario Region	Windsor GOCB	ON	5,254	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Pacific Region	1415 Vancouver St., Victoria	BC	7,083	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Pacific Region	Annacis Island Office	BC	4,198	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Pacific Region	Campbell River GOCB	BC	699	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Pacific Region	Douglas Jung Building	BC	29,635	Y	Y	-		Y	-	Y	-	Y	-	-	-	-	-	-
Pacific Region	Fed. Office & Warehouse Pr.George	BC	1,295	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Pacific Region	Fisheries and Oceans	BC	513	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Pacific Region	Fisheries and Oceans - CW	BC	302	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Pacific Region	Fort Nelson GOCB	BC	1,044	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Pacific Region	Harry Stevens Building	BC	5,868	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Pacific Region	Kamloops GOCB	BC	3,693	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Pacific Region	Kelowna GOCB	BC	3,839	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Pacific Region	Library Square	BC	30,805	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Pacific Region	Nanaimo GOCB	BC	5,780	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Pacific Region	Oxford Building	BC	4,891	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Pacific Region	P.L. James Place	BC	14,990	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Pacific Region	Penticton GOCB	BC	6,111	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Pacific Region	Port Alberni GOCB	BC	2,850	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Pacific Region	Prince Rupert GOCB	BC	3,137	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Pacific Region	Queen Charlotte City GOCB	BC	739	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Pacific Region	RCMP Federal Operations	BC	8,284	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Pacific Region	Revelstroke GOCB	BC	1,820	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Pacific Region	Sinclair Centre	BC	35,215	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
Pacific Region	Standards Building	BC	1,386	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Pacific Region	Steveston GOC Building	BC	402	Y	Y	-		Y	-		2	-	-	-	-	-	-	-

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Pacific Region	Surrey Taxation Data Centre	BC	34,095	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
Pacific Region	Vernon GOCB	BC	3,668	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Pacific Region	Elijah Smith Building	YT	12,163	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Pacific Region	Takhini_GOC 419 Range Road	YT	2,973	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Pacific Region	Workshop Quonset 421 Range Road	YT	1,481	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Pacific Region	Green Timbers RCMP	BC	76,162	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
Quebec Region	Cap-aux-Meules	QC	1,437	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Quebec Region	Chandler	QC	1,276	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Quebec Region	Chicoutimi	QC	3,367	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Quebec Region	Complexe Guy-Favreau	QC	111,769	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
Quebec Region	Edifice Douanes Montreal	QC	21,144	Y	Y	-		Y	-	Y	-	Y	-	-	-	-	-	-
Quebec Region	Gaspé, 120 de la Reine	QC	1,870	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Quebec Region	Gaspé, 194Jacques-Cartier	QC	398	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Quebec Region	Gaspé, 98 de la Reine	QC	1,608	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Quebec Region	Grande-Rivière	QC	559	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Quebec Region	Havre-St-Pierre	QC	1,299	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Quebec Region	Jonquière	QC	20,035	Y	Y	-		Y	-	Y	-	Y	-	-	-	-	-	-
Quebec Region	Lacolle	QC	2,034	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Quebec Region	Laval, 1575 Chomedey	QC	4,925	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Quebec Region	Matane	QC	12,322	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Quebec Region	Montréal,1420 Ste-Cather	QC	3,393	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Quebec Region	Normand Maurice	QC	38,690	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Quebec Region	Office National du Film	QC	38,996	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Quebec Region	Québec, 104 Dalhousie	QC	4,792	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Quebec Region	Québec, 130 Dalhousie	QC	3,245	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-

Region	Facility	Province	Building floor area (m²)	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	Data Centre Consolidation	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit (option)	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
Quebec Region	Québec, 94 Dalhousie	QC	1,787	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Quebec Region	Québec,155-165 Pte-aux-Lièvres	QC	11,881	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Quebec Region	Québec,3 passage Chien-d'Or	QC	6,411	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Quebec Region	Québec,330 Gare-du-Palais	QC	10,382	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Quebec Region	Québec-112 Dalhousie	QC	4,777	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Quebec Region	Rimouski	QC	4,179	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Quebec Region	Rouyn-Noranda, 151 du Lac	QC	5,693	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Quebec Region	Rouyn-Noranda, 44 du Lac	QC	1,865	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Quebec Region	Saint-Laurent, 645-655 Mtée Liese	QC	7,907	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Quebec Region	Sept-Iles	QC	9,786	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Quebec Region	Shawinigan-Sud	QC	26,627	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
Quebec Region	Sherbrooke	QC	11,637	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Quebec Region	715 Peel St	QC	59,184	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
Quebec Region	NEC - 1550 Estimauville	QC	30,266	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Quebec Region	2575 Ste-Anne	QC	14,955	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Western Region	J D Higenbotham	AB	8,902	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Western Region	RCMP "K" Division Headquarter	AB	30,676	Y	Y	-		Y	-	Y	2	-	-	-	-	-	Y	-
Western Region	Red Deer GOCB	AB	3,252	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Western Region	269, Main St., Winnipeg B	MN	14,677	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Western Region	Brandon GOCB	MN	5,300	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Western Region	Canadian Grain Commission	MN	21,400	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Western Region	Customs Examining Warehouse	MN	6,071	Y	Y	-		Y	Y		2	-	-	-	-	-	-	-
Western Region	Federal Records Centre	MN	20,184	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Western Region	MacDonald Building	MN	8,555	Y	Y	-		Y	-		2	-	-	-	-	-	-	-

Region	Facility	Province	Building floor area (m²)	Grid De/Re-Carbonization	ABW (Densification)	Asset Divestment	Data Centre Consolidation	LED Lighting	ReCx/Audit/No& Low-Cost ECM Implementation	Smart Buildings	Deep Retrofit (option)	Fuel Switching	ESAP efficiency (+Smart Plants)	Connect to District Energy	ESAP to QC	ESAP biomass/W2E	Solar PV On Site	Battery storage
Western Region	RCMP "D" Division HQ	MN	22,749	Y	Y	-		Y	-	Y	2	-	-	-	-	-	-	-
Western Region	Revenue Canada Warehouse	MN	7,585	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Western Region	Stanley Knowles Building	MN	13,885	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Western Region	Winnipeg Taxation Centre	MN	31,700	Y	Y	-		Y	-	Y	-	Y	-	-	-	-	-	-
Western Region	4- BAY Norman Wells	NT	107	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Western Region	Fort Simpson GOCB	NT	464	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Western Region	Fort Smith GOCB	NT	3,237	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Western Region	Greenstone Building	NT	8,165	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Western Region	Hay River GOCB	NT	1,156	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Western Region	Henry Larsen Bldg.	NT	4,925	Y	Y	-		Y	-		2	-	-	-	-	-	-	-
Western Region	Inuvik GOCB	NT	923	Y	-	Y		-	-		-	-	-	-	-	-	-	-
Western Region	Inuvik Trade Shop	NT	236	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Western Region	Inuvik Warehouse #1	NT	650	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Western Region	Inuvik Warehouse #2	NT	285	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Western Region	Inuvik Warehouse #3	NT	274	Y	Y	-		Y	Y		-	-	-	-	-	-	-	-
Western Region	Inuvik Warehouse #4	NT	281	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Western Region	Yellowknife Trade Shop	NT	357	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-
Western Region	Alvin Hamilton	SA	24,729	Y	Y	-		Y	-	Y	2	-	-	-	-	-	Y	-
Western Region	Income Tax Building	SA	6,236	Y	Y	-		Y	Y		-	-	-	-	-	-	Y	-
Western Region	Regina GOCB	SA	5,128	Y	Y	-		Y	Y		-	-	-	-	-	-	Y	-
Western Region	Saskatoon GOCB	SA	9,703	Y	Y	-		Y	-		2	-	-	-	-	-	Y	-
Western Region	Qimugjuk Building	NU	2,742	Y	Y	-		Y	Y		-	Y	-	-	-	-	-	-

APPENDIX G: 2030 PLAN SUMMARY

Table G-1: 2030 Plan Summary

Plan Element	Draft 2030 Strategy	Number of Projects by 2030	Capital Cost by 2030 ($ millions)	Anticipated GHG Reduction (tCO_2e)	GHG Reduction (% of 2015-16 Portfolio Footprint)	Other Factors
LED Lighting Retrofits	All tier 1, 2, 3 buildings by 2030	224	$108	10,728	6%	
ReCx/Energy Audits and ECM Implementation	All tier 1, 2, 3 buildings on a 5-year cycle (unless doing Smart Buildings)	75	$5	2,797	2%	
Smart Buildings	All identified in RFSO	80	$4	11,540	6%	
Deep Energy/GHG Retrofits	All tier 2 and 3 (excluding Parliamentary Precinct) with 2015-16 GHG intensity > 32 kgCO2e/m2, plus Centre Block	52	$5,852	36,236	20%	
Activity Based Workplace (ABW) & Densification	Only at facilities undertaking a deep retrofit, where ABW applies	51 (4/year)	$447	5,409	3%	Frees up 120,000 m2 of space (to divest)
Unsupported Divestment	Divesting all tier 4 facilities by 2030			20,137	11%	Requires additional 380,000 m2 space to be vacated (beyond what is vacated by ABW densification)
Fuel Switching	All previously identified facilities with >22 kgCO2e/m2 in 2015-16	40 (3/year)	$129	15,591	9%	
ESAP Efficiency	Completed by 2030		$272	8,922	5%	
ESAP Connections	All previously identified facilities	7	$35	1,707	1%	

Plan Element	Draft 2030 Strategy	Number of Projects by 2030	Capital Cost by 2030 ($ millions)	Anticipated GHG Reduction (tCO_2e)	GHG Reduction (% of 2015-16 Portfolio Footprint)	Other Factors
ESAP Pre-Heating/Cooling in Quebec and Biomass/Waste to Energy	Not implemented by 2030	N/A	N/A	N/A	N/A	
Solar PV	All previously identified facilities	13 (1/year)	$16	2,689	1%	Sites in NS, SK, AB
Battery Storage	All previously identified facilities	28 (2/year)	$41	685	0%	Sites in ON
TOTAL BEFORE PROCUREMENT		**570**	**$6,909**	**116,442**	**64%**	
Procurement	Address gap between reduction and 0 with renewable energy and carbon offset procurement		$0.8/year			