Corporate Carbon Neutral 2032 Plan

Regional District of Nanaimo

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Prepared for:

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1 INTRODUCTION

1.1 BACKGROUND

The Regional District of Nanaimo (the "RDN") has followed a collaborative process to develop its Corporate Carbon Neutral 2032 Plan ("the Plan"). That process, described in Appendix B, has identified a series of actions that allow the RDN to establish the conditions and processes required to effectively reduce its emissions. The planning process has also identified four different technology scenarios, that may be pursued in implementation, each achieving net zero with different degrees of reliance on carbon offsets. The actions, applicable to all scenarios, start the RDN on its carbon neutrality journey while the scenarios reflect the different impacts of prioritizing specific actions and approaches above others. The scenarios will inform implementation plan development by providing a reasonable sense of how different implementation approaches will affect emission reductions.

1.2 CONTEXT

The RDN's 2019-2022 Strategic Plan outlines a number of goals. Of greatest relevance is the Climate Change Goal 1.0 to *"Be leaders in climate change adaptation and mitigation, and become net zero by 2032"*, with Climate Change Action 1.2 *"Review and update corporate emissions plan and greenhouse gas (GHG) reduction strategy"* pertaining directly to the Plan. The RDN's *Corporate Carbon Neutral 2032 Plan* will complement the *Strategic Plan* and develop the means for the RDN to follow through on the implementation of actions to achieve carbon neutrality and the potential technological changes the move will necessitate.

1.3 CURRENT CARBON NEUTRALITY

The RDN has been carbon neutral in its operations under the provincial *Green Communities Committee Framework* (see *Section 3*) since 2012. The RDN had been generating carbon credits under the GCC framework through the collection and destruction of landfill gas. In 2016, provincial regulations changed to require that landfills in BC collect at least 75% of the landfill gas they generate and as such, the opportunity to generate carbon credits from the Nanaimo Regional Landfill ceased beyond those generated for collection above the regulated 75%. The carbon credits accumulated to date will allow the RDN to remain carbon neutral in its operations for several more years, but there are insufficient credits to allow the RDN to remain carbon neutral on an ongoing basis. Furthermore, under the *GHG Protocol* the carbon credits generated by the landfill cannot be used to offset operational emissions and, since the Nanaimo Regional Landfill is within the RDN's jurisdiction, it must reduce landfill gas emissions directly (see *Section 4.2* for further details) and cannot use improvements to generate emissions credits for use in other parts of its operations.

2 VISION AND GUIDING PRINCIPLES

2.1 VISION

A Vision Statement has been drawn up based on staff consultation. The statement is intended to provide an image of the future the RDN is striving for through its carbon neutral efforts, and reads:

The RDN strives to excel in its operations and be a regional leader in tackling climate change. By 2032 a carbon neutral RDN will responsibly invest in environmental stewardship, human health, and social equity initiatives, for the sustainable benefit of our community.

2.2 GUIDING PRINCIPLES

2.2.1 Carbon Management

The development process has been designed to generate scenarios, each of which gets the RDN closer to carbon neutrality. In all scenarios, energy conservation (not wasting energy) is the first step in the "carbon management hierarchy" (see *Figure 1*) with energy efficiency (doing more with less) the second. Only after these measures have been optimized should fuel-switching be considered, with emissions offsetting a final resort. The scenarios presented are consistent with this hierarchy.

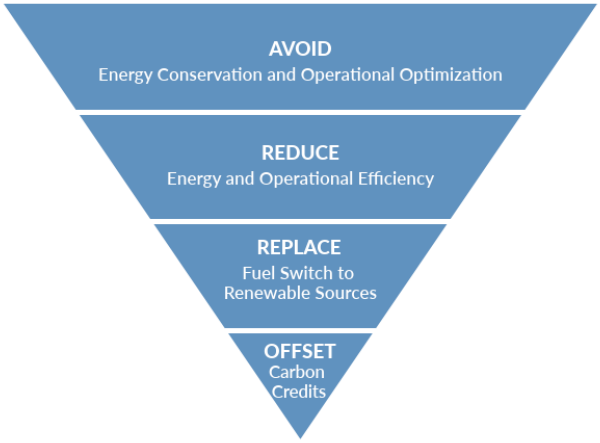


Figure 1: The Carbon Management Hierarchy

2.3 ORGANISATIONAL PRINCIPLES

To achieve its carbon neutral goals, the RDN will need to adhere to guiding principles beyond those above, in order to support its decision-making. In consultation with staff, the following Guiding Principles are under consideration.

In its transition to carbon neutral operations the RDN will be:

Evidence-based: using the best available information and knowledge to take action, and where data is not currently available seek to find it; allowing timely, quantifiable action with the appropriate resourcing.

Agile: while maintaining reliable service, respond to changing circumstances, technologies and realities; ensuring that the organization is resilient to external impacts and internal developments.
Fiscally Responsible: working to make the best use of taxpayers' dollars so that the organization does not take undue risks, responds to the risks of a changing climate and recognizes that there may be a role for offsets to cost efficiently tackle a portion of the RDN's emissions.
Innovative: being creative in both the identification and execution of opportunities to reduce emissions, be they operational or technical.
Collaborative: recognizing that the RDN cannot act alone in tackling emissions, it will seek to collaborate proactively and effectively with all its stakeholders, striving with them for common goals and not creating additional environmental or social impacts outside its boundaries.

3 PLAN SCOPE & PROVINCIAL CARBON NEUTRAL FRAMEWORK

The scope of the plan is consistent with guidance from the Provincial Government, under the Green Communities Committee (GCC) *Carbon Neutral Framework*[1]. The *Framework*, which is a core tenet of the Climate Action Charter to which the RDN is a signatory, ensures that local governments plan to eliminate their emissions from what are termed "traditional services". These include such things as: administration and facility buildings; fleet vehicles, solid waste collection and diversion; road and traffic operations; water management (drinking, storm and waste); fire protection; and recreation and cultural services. Outside the scope of the GCC Framework, but consistent with the internationally recognized GHG Protocol's need to manage emissions over which an organization has direct jurisdictional control[2], the emissions from the disposal of solid waste (i.e. landfill gas emissions) are also considered in-scope. Landfill gas related GHG emissions dominate the RDN's emissions profile (see *Section 4.1*) but should be considered in a somewhat different context to operational emissions since they are fugitive and not related to energy use in the RDN's buildings and facilities, or through its fleet operations.

Explicitly excluded from the scope are aviation and marine emissions, and emissions associated with the provision of transit services (both fleet and facilities), since, consistent with the GHG Protocol, these are under the control of BC Transit and outside the scope of the *GCC Framework*. Similarly, streetlighting which is not within the RDN's jurisdiction is out-of-scope. In some cases, emissions sources that are known to be, or can be rationally expected to be, very small may also be excluded since they do not materially impact the total emissions of the RDN. Construction related emissions (and other "embodied emissions") are considered out of scope by the *GCC Framework*.

3.1 TECHNOLOGY SCOPE

When considering which technologies to include in a potential pathway to achieve net-zero emissions, only commercially available technologies will be included in the technology scenarios. There is a role for the RDN to play in undertaking an innovative response to the climate crisis, but the RDN is better positioned to be on the "leading edge" rather than the "bleeding edge" of technology uptake and

[1] Province of BC, *Becoming Carbon Neutral Guide*, https://www.toolkit.bc.ca/sites/default/files/BecomingCarbonNeutralGuideV3.pdf
[2] GHG Protocol, *GHG Protocol for Cities*, https://ghgprotocol.org/standards

demonstration. The RDN should invest in commercially viable technologies that are developed for the purposes of emissions reduction rather than investing in untested or not yet viable tools.

3.2 GREENHOUSE GASES INCLUDED

The emissions considered within the Plan are consistent with the GCC Framework and include the six Kyoto gases: carbon dioxide (CO_2) methane (CH_4), nitrous oxide (N_2O), sulphurhexafluoride (SF_6), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs). However, the focus of the Plan is on CO_2, CH4 and N_2O as the most significant sources of emissions; fugitive refrigerant emissions (particularly from heat pumps and air conditioning) are considered negligible but should be assessed in more detail should the expanded use of heat-pumps be part of the RDN's chosen direction. PFC and SF_6 emissions are unlikely to be found in significant quantities as part of the RDN's operations.

4 CURRENT RDN EMISSIONS

4.1 OPERATIONAL EMISSIONS

The RDN currently reports its operational emissions to the Province of BC as part of the Climate Action Revenue Incentive Program (CARIP) that provides a rebate for the carbon tax paid by local governments on their fuel and electricity use. This reporting allows the sources of the RDN's emissions to be broken down by fuel type, as shown in *Figure 2*. Corporate emissions, totalling 2245tCO_2e, result from both stationary sources (building/facility space heating, hot water and electricity consumption), and mobile sources (RDN vehicle fleet and small equipment like that used for landscaping).

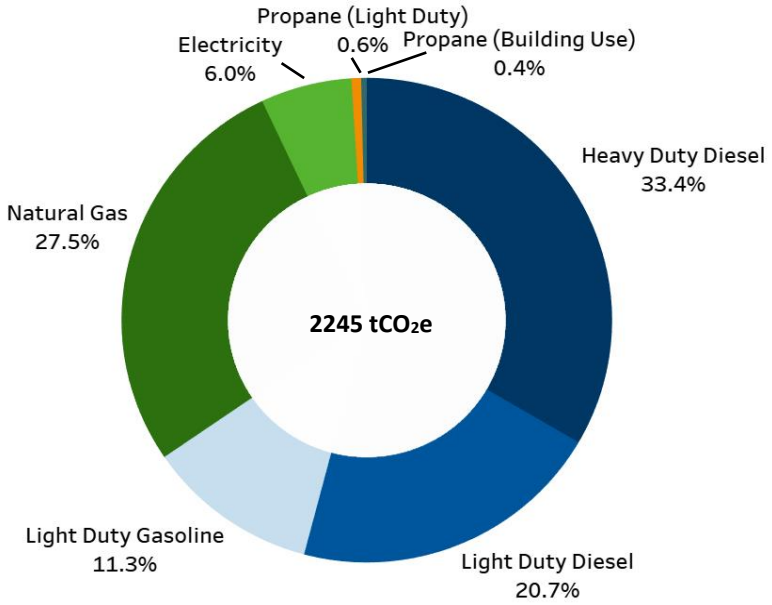


Figure 2: RDN GHG Emissions Distribution by Fuel Type (for 2019)

Diesel use in heavy-duty vehicles was the largest emission contributor at 33% of total emissions, followed, at 21%, by diesel use in light-duty vehicles. Natural-gas use accounts for 28% of total corporate

operational emissions, with light-duty gasoline use accounting for 11%. Electricity use in buildings and facilities accounts for only 6% of total operational emissions since electricity in B.C. is almost carbon neutral; while propane use within the RDN's operations is negligible at approximately 1% of total operational emissions.

Figure 3 shows total operational emissions broken down by Department, and with stationary emissions and mobile emissions demarked separately. It is apparent that emissions from contracted services for waste collection and haulage are the most significant, while solid waste handling is a close second. 12.1% of the RDN's emissions come from vehicles used by Solid Waste, while the stationary emissions (12.4%) are predominantly attributable to the waste compactors (which although mobile, tend to operate a single location). In aggregate, waste management accounts for 52% of the RDN operational emissions and presents the most significant opportunity to reduce emissions. The RDN's Community and Recreation facilities are the third most significant source with the provision of space and water heating dominating. The Water, Fire and Emergency, and Wastewater account for much of the remaining emissions at 5.9%, 5.4% and, 5% respectively, with an approximate even split across these three departments between building and facility emissions and fleet emissions. The balance of emissions is from miscellaneous stationary sources.

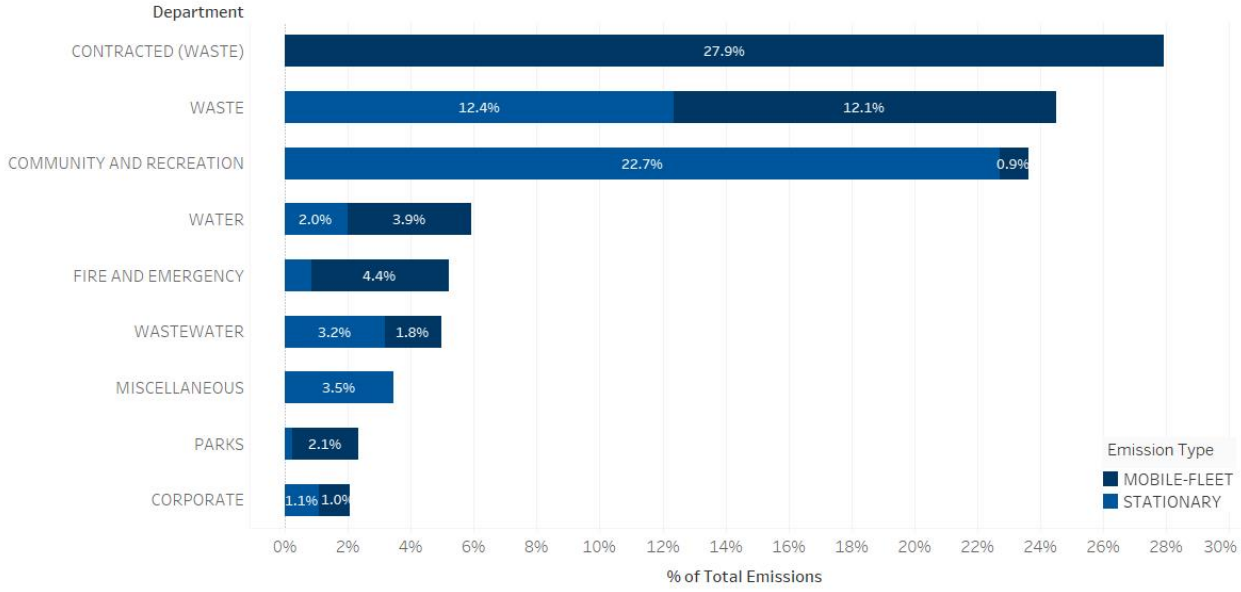


Figure 3: RDN GHG Emissions Distribution by Department (for 2019)

Figures 2 and *3* includes, as required by the GCC Framework, emissions from contracted services, e.g. waste collection and haulage trucks, but excludes emissions from Transit because transit services are out of scope (discussed in *Section 3*). Transit services produce approximately 250tCO_2e of emissions a year, equivalent to about 10% of the RDN's operational emissions (excluding those related to landfill gas release).

4.2 LANDFILL GAS EMISSIONS

Of the greenhouse gas emissions within the Plan's scope, those from fugitive landfill gas release (arising from the decomposition of solid waste, which produces methane – a potent greenhouse gas) were

estimated to be approximately 30,460 tonnes of CO_2 equivalent (tCO_2e)[3] in 2019, or 89% of total emissions (in addition to the operational emissions discussed above).

These fugitive emissions must be managed in a way fundamentally different from those related to the use of fossil fuels and electricity, since they are not from the consumption of energy. The RDN is already undertaking significant efforts to reduce waste disposal, and therefore related emissions, and this work should continue. Regardless of which technology scenario is followed for operational emissions, fugitive landfill gas emissions will remain, and should be addressed in their own right.

5 IMPLEMENTATION ACTIONS AND PLANNING

5.1 ACTION DEVELOPMENT

Detailed below, in *Section 5.2*, are the implementation actions with matching descriptions, rationale and the Department responsible for leading the work. The actions were developed through a comprehensive engagement with RDN staff, and with their direct input. *Figure 5* shows the process followed in developing the Plan, while Appendix B provides further detail on each of these steps, including a list of RDN staff involved throughout.

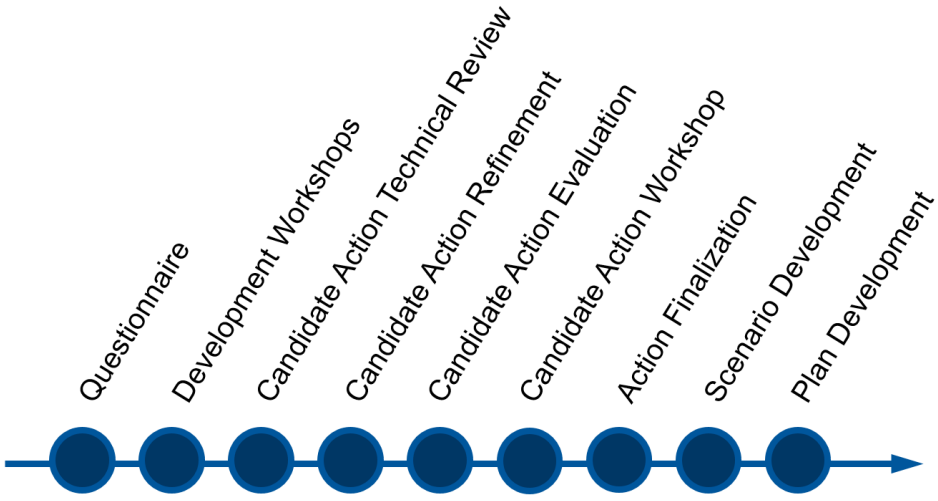


Figure 5: Plan Development Process

5.2 IMPLEMENTATION ACTIONS

The implementation actions are common to all scenarios, with the intent that they establish the RDN on the path to implementation and delivery of the projects necessary to significantly reducing emissions.

[3] Operational emissions estimated from energy use records, landfill gas emissions from 2018 provincial reporting, the latest year for which data is available.

The development process has identified 34 actions in total, which are categorized into seven key pillars, each of which is detailed below.

5.3 SEVEN KEY PILLARS

1. **Delivery Support and Project Management:** These actions recognize that appropriate policies, processes and tools are needed to support the RDN's emission reduction activities. These elements address some of the existing risks and barriers to emission reduction.

2. **Finance:** These actions recognize the importance of integrating climate planning with financial planning and that new approaches and tools are required to do so.

3. **Facilities and Services:** Actions that will be most important for ensuring successful facility and service-specific emission reductions.

4. **Fleet and Mobile Emissions:** Actions and supporting tools required to directly address the emissions from the RDN's fleet

5. **Performance and Benchmarking:** Actions that deliver facility managers the information they need to evaluate current facility status and identify carbon reduction strategies.

6. **Data and Reporting:** These actions recognize the importance of data acquisition, monitoring and reporting to allow continuous improvement, accountability, and opportunities for course correction.

7. **Knowledge Sharing:** These actions recognize the importance of knowledge transfer, interdepartmental collaboration and continuous learning.

Each pillar is articulated in more detail below.

5.3.1 Delivery Support and Project Management

	Action	Description	Rationale	Lead Dept
DS	**Delivery Support & Project Management**			
DS.1	Develop Corporate Carbon Neutral policy.	Develop a corporate policy, adopted by the Board, which specifically requires the RDN to identify and act upon emissions reductions opportunities across all its operations.	Efforts to reduce emissions are often countered by decision-making that considers only cost. The proposed policy would provide Staff with clear direction to include the strategic carbon neutral goal in business cases development and staff reports so that implications of rejecting the recommendation for a low carbon solution are clear.	Energy & Sustainability
DS.2	Develop project management tools.	Develop a number of easy-to-use, simple project management tools to support carbon neutral projects.	The move to carbon neutrality will impact a large number of projects over the next 12 years; these projects must be effectively delivered from 2021 onwards as no opportunity to reduce emissions can be missed if the 2032 target is to be achieved (equipment turnover time is too long).	Energy & Sustainability
DS.3	Develop a lifecycle cost estimator for fleet vehicles.	Develop a life-cycle cost estimator, through the Asset Management Program, to inform vehicle purchases and which considers, carbon tax, O&M, fuel costs, capital cost and potential fuel cost volatility.	Achieving carbon reductions often requires more capital investment upfront, but results in lower operating costs; to balance these often competing considerations a life-cycle approach to cost estimation should be developed.	Energy & Sustainability
DS.4	Develop a central delivery-focused carbon neutral support team.	Establish a specific carbon neutral planning and implementation team to support Departments (including a terms of reference) with achieving and meeting their carbon neutral commitments.	Consideration of carbon emissions is often new for project managers and Department staff; to support the organization as a whole, a carbon focused delivery team can provide guidance and advice on the integration of carbon considerations into project planning and delivery, while also working to integrate the RDN strategic direction into individual projects.	Energy & Sustainability
DS.5	Develop decision support tools.	Develop tools or expand on tools that already exist that ensure the carbon neutral mandate is effectively considered at all stages of RDN work. This could be the inclusion of carbon neutral commentary in all Board Reports, inclusion in staff Performance Planning (for senior staff), or inclusion of carbon benefits in all business cases.	The emission of carbon pollution is tied to almost every aspect of the RDN's service delivery and capital projects, it must therefore be fully integrated into the RDN's decision-making processes if emissions reductions are to be effectively integrated into projects from the start, and not as an afterthought.	Energy & Sustainability (and client Department)
DS.6	Develop corporate-wide prioritization system for carbon reduction.	All Departments will need to reduce emissions; prioritization of facilities and schedule will need to be established across the organization based on supporting data.	Recognizing that not all work can be undertaken at once, but that no opportunity can be missed to reduce emissions since equipment turnover and replacement schedules mean decisions made today will impact 2021, an approach must be developed to prioritize which emissions reduction projects are undertaken and when.	Energy & Sustainability (and client Department)

5.3.2 Finance

	Action	Description	Rationale	Lead Dept
F	**Finance**			
F.1	Continue to actively track and manage low carbon funding opportunities.	Assign clear responsibility to a corporate department to track and manage public funding opportunities, such as those available through FCM and Province of BC, related to emissions reductions.	There already exists various funding opportunities available for carbon reduction measures through the provincial and federal governments as well as FCM and similar; continuing to actively track these opportunities, which are likely to expand through COVID recovery funding, best positions the RDN to exploit them.	Asset Management & Strategic Initiatives
F.2	Integrate carbon neutrality into financial planning processes.	Align the carbon planning and capital planning cycles.	The move towards carbon neutrality will have capital expenditure implications which should be actively managed through the capital planning process to minimize risk and maximize opportunity.	Energy & Sustainability (partnered with Finance)
F.3	Investigate establishing, or being part of, a regional purchasing pool to increase the ability of the RDN to procure low-carbon vehicles and fuels.	With very limited biofuel availability (and no renewable diesel) on Vancouver Island, and the need to be able to bring low-emissions vehicles to market (especially beyond light-duty vehicles), there may be opportunity in working collectively across the region to achieve common goals.	The RDN is only able to buy commercially available vehicles and fuels, and because of its purchasing power is unlikely to be able to create a new market for low-emission technologies that is not already there. To increase its purchasing power, the RDN can work with other regional buyers to have more market presence.	Purchasing
F.4	Develop approaches to price carbon emissions and incentivize the use of low-emissions technologies.	Without including the negative impacts caused by fossil fuels in price signals and business cases it is difficult to make financial arguments for low-emissions technologies; mechanisms such as carbon prices and green reserve funds provide ways to accelerate the use of low-emissions technologies.	The ability to price carbon is inherent to effective decision-making when assessing carbon reductions, without it it is difficult to fully integrate carbon and financial implications together in a common decision-making framework or process.	Energy & Sustainability (and client Department)

5.3.3 Facilities and Services

	Action	Description	Rationale	Lead Dept
FS	**Facilities and Services**			
FS.1	**Planning & Guidance**			
FS.1.1	Develop implementation guidance for the Federal Climate Lens, integrating climate resilience considerations into all major RDN projects.	The Federal Climate Lens provides approaches to consider both emissions reduction and climate resilience for infrastructure projects, which may be tailored to apply to all major RDN projects, and provide decision-relevant insight.	Climate Lens assessments are becoming a required step in securing funding from a growing range of funding opportunities; as such integrating Climate Lens considerations (the principles for which have benefits wider than simply securing funding) can better position the RDN to secure funding and integrate climate considerations into its decision-making processes.	Energy & Sustainability
FS.1.2	Develop Departmental Carbon Action Plans for each department to clearly articulate its emissions reduction plans, yet with the intent of corporate-wide integration.	Each Department will develop, with centralized guidance, a plan specific to their facilities, demonstrating how they will achieve carbon neutrality and on what timelines.	To achieve carbon neutrality across the entire organization, each and every Department will need to take action. Each Department knows its operations and facilities best, as such they are best positioned to plan their own carbon reduction actions; however, this should not be done in isolation and without guidance for which other actions have been identified to such support.	Relevant Dept. (guided by Energy & Sustainability)
FS.1.3	Update New Building Design Guidelines.	Develop design guidelines which are integrated with Carbon Neutral Policy (see Action under *Delivery Support and Project Management*) to inform the energy and carbon performance of new construction. This may include building on or revisiting the existing Green Building and Wood First Policies	To ensure that new buildings do not inadvertently make it more difficult to achieve the RDN carbon goals, new build design guidelines should be developed that specifically take into account the RDN's carbon targets.	Energy & Sustainability
FS.1.4	Review and improve Preventative Maintenance Program, as part of an organizational Asset Management approach, and follow through with proactive measures.	Carry out preventative maintenance to prolong equipment lifetime, but recognize when equipment needs to be replaced in support of the organization's carbon goals. Develop a strategic approach to asset management for all RDN assets, especially those directly related to carbon emissions.	The reduction of carbon pollution is not just about new facilities, it is fundamentally about current ones since most will still be operating in 2032. To ensure that carbon reductions are well integrated into the RDN's approach to service delivery carbon considerations should be included in asset management practices.	Facilities & Fleet Manager
FS.2	**Buildings**			
FS.2.1	Undertake a comprehensive recommissioning and deep energy retrofit program.	Recommission the most energy and carbon intensive buildings first, progressing to the less so. Focus retrofits on building envelope performance for non-Rec facililties and systems for Rec facilities. Install active lighting, and heat controls in all buildings. Use pressure differential sensors to determine when ventilation filters need to be changed.	Expanding on the work that is already underway, facilities that have not had energy audits and energy efficiency measures identified should do so; such measures are known to be effective at reducing energy use and are a required step to identifying building specific measures that establish a pathway to carbon neutrality. Buildings, as they age, often fall out of their ideal operating conditions, and recommissioning measures can significantly improve building performance.	Facilities & Fleet Manager
FS.2.2	Investigate all heat recovery options.	For all facilities that have significant space heating demands, investigate the potential to recover and beneficially use space heating.	Heat recovery from buildings often presents a significant opportunity to improve overall building efficiency, and given space heating is a carbon intensive process measures to address this are an effective way to reduce emissions.	Facilities & Fleet Manager
FS.2.3	Expand smart commissioning of new facilities.	Using "smart commissioning" techniques to ensure new buildings perform optimally.	Ensuring new buildings perform as intended often requires more sophisticated commissioning techniques than is the industry standard.	Facilities & Fleet Manager
FS.3	**Water & Wastewater**			
FS.3.1	Continue and expand where appropriate water conservation education.	Support and expand existing program to increase public awareness of water conservation measures.	The Drinking Water & Watershed Protection Program already has an extensive outreach program (currently in it's 11th year) that could be expanded upon, if deemed necessary.	Water
FS.4	**Waste**			
FS.4.1	Continue to actively manage landfill gas emissions and seek advances where feasible.	Evaluate impact on landfill gas emissions when considering future landfill management scenarios and go above 75% collection efficiency mandate for LFG collection where feasible.	Landfill gas emissions are responsible for approximately 90% of the RDN's carbon footprint, as such every action to reduce landfill gas emission will have a significant impact.	Solid Waste
FS.4.2	Support implementation of Solid Waste Management Plan (SWMP) to ensure 90% targets are achieved.	Develop and expand on strategies identified in the SWMP to meet the aggressive diversion targets of 90% by 2029.	Reduction of waste volumes is critical to reducing waste emissions, which is by far the largest source of emissions for the RDN.	Solid Waste

5.3.4 Fleet and Mobile Emissions

	Action	Description	Rationale	Lead Dept
FM	**Fleet & Mobile Emissions**			
FM.1	**Operations**			
FM.1.1	Develop, as part of an integrated Green Fleet Strategy, an updated and emissions focused fleet operational strategy for fleet not included in Transit Fleet Partnership with BC Transit.	Consistent with the Strategic Plan, develop a Green Fleet Strategy that addresses operational considerations as well as technological choice. Develop a plan that addresses fleet right-sizing, vehicle right-sizing, the role of good upkeep on carbon emissions, and the integration of carbon into vehicle replacement decisions.	Vehicle emissions account for approximately two-thirds of the RDN's emissions (excluding those from landfill), a comprehensive approach to fleet operations, technology & fuel choice, as well as service delivery is required to fundamentally address how emissions can be reduced from RDN vehicles. The way in which fleet vehicles are used to deliver services, how the use of the entire fleet is optimized and what alterations to operations can be made to improve efficiency (through increased up time, reduced travel time, reduced travel distance, etc) all provide the opportunity to reduce vehicle emissions.	Facilities & Fleet Manager
FM.1.2	Develop and deliver a driver training program.	Develop better driving practices.	Poor driving habits lead to excessive fuel consumption and emissions; such habits can be effectively changed through driver training. This is a "quick win", but should be integrated into an operation Green fleet strategy.	Facilities & Fleet Manager
FM.1.3	Continue and expand contractor emissions requirements, considering in future emissions education, awareness and incentive programs for contractors.	Incentivise contractors to be more carbon efficient. This may include requiring contractors to install GPS tracking. Criteria would need to be defined, measurable.	Continue current work, becoming more stringent over time expanding to cover emissions from the full range of RDN contracted services.	Purchasing (with client Departments)
FM.2	**Technology**			
FM.2.1	Develop, as part of an integrated Green Fleet Strategy, an updated and emissions focused vehicle and fuel strategy for fleet not included in Transit Fleet Partnership with BC Transit.	Consistent with the Strategic Plan, develop a Green Fleet Strategy that addresses operational considerations as well as technological choice. Study to will identify technological opportunities to reduce emissions looking at both fuel choice/selection and vehicle platform, and ancillary equipment such as idle stop devices and cab heaters.	Vehicle emissions account for approximately two-thirds of the RDN's emissions (excluding those from landfill), a comprehensive approach to fleet operations, technology & fuel choice, as well as service delivery is required to fundamentally address how emissions can be reduced from RDN vehicles. Vehicle emissions are driven primarily by fuel choice, which is closely tied to the available vehicle platforms. The study will need to consider how the RDN can deliver the required level of service with lower emissions platforms.	Facilities & Fleet Manager (with Energy & Sustainability)
FM.2.2	Electrify all light-duty vehicles.	Upon replacement of all passenger vehicles, only EVs will be bought.	Electric vehicle technology and the batteries in them are advancing rapidly; vehicle ranges are increasing and costs reducing. The pace of change is expected to accelerate rapidly in the coming decade, making EVs the common choice for light-duty vehicles.	Facilities & Fleet Manager
FM.2.3	Install GPS/automatic vehicle location tracker on all fleet vehicles.	Data capture via GPS to inform better operational planning.	The installation of GPS tracking provides the information needed to better inform fleet operations, without such data operational improvements will be limited. This can be started now, will inform a green fleet strategy and provided on-going benefit.	Facilities & Fleet Manager
FM.2.4	Move to electrify all non-road equipment.	Electrification is making gains in many sectors included non-road and small equipment.	To achieve carbon neutrality, all emissions sources will need to be addressed including non-road equipment. Advances in battery technology, that can only be expected to advance in the coming decade, electrification of non-road equipment provides the opportunity to significantly reduce or eliminate emissions from these otherwise difficult to tackle sources.	Facilities & Fleet Manager

5.3.5 Performance and Benchmarking

	Action	Description	Rationale	Lead Dept
PB	**Performance and Benchmarking**			
PB.1	Undertake Building/Facility Performance benchmarking against peers and industry standards for both energy use and carbon emissions.	Benchmark facilities against each other and industry standards (or best performers) to understand relative facility performance.	As much as each facility or operation is unique in its own respect, understanding where an operation, facility, building sits when compared to peers or industry standards is instructive to informing anticipated performance, gains, level of effort or returns on investment.	Facilities & Fleet Manager
PB.2	Benchmark facilities energy and carbon intensities; and establish energy and/or GHG performance targets.	Use this insight to establish energy use intensity targets, and corresponding carbon intensity targets for individual facilities.	Benchmarking allows a better understanding of how facilities and buildings are performing against their peers, but does not inherently change their performance; to achieve a change in performance, performance targets should be established.	Facilities & Fleet Manager
PB.3	Undertake energy audits for all building facilities and energy balance studies for process facilities.	Complete energy audits for the RDN's most carbon intensive facilities to inform facility-specific technology options. Complete an energy balance for water/wastewater facilities to understand facility-specific energy consumption, and resultant carbon impact.	To understand where the best opportunities for energy efficiency improvements exist energy audits or energy balances should be completed for those facilities that have not had them; without this information it is difficult to assess what energy efficiency opportunities exist, their scale and the potential for fuel-switching. Furthermore, with such information it is very difficult for the RDN to prioritize its carbon reduction efforts.	Facilities & Fleet Manager

5.3.6 Data and Reporting

	Action	Description	Rationale	Lead Dept
DR	**Data & Reporting**			
DR.1	Improve data collection through enterprise-wide utility tracking software and install equipment specific data collection at the most energy and emissions intensive facilities.	Improve the data collection from all the RDN's utility accounts, including vehicle fuel use/purchases. Install improved SCADA systems with data warehousing to better inform operational planning.	Without this, the RDN will lack the data to take informed emissions reductions actions.	Facilities & Fleet Manager
DR.2	Develop a corporate approach to monitoring and reporting greenhouse gas emissions performance.	Establish procedures, tailored to each department, to track their energy use and carbon emissions. This would include developing a baseline and an approach to report carbon emissions reductions, a regularized structure to report progress and challenges against targets. Progress may be reported through dashboards for internal use that quantify and report energy, fuel and emissions performance.	To track and understand progress against the RDN carbon neutral goal an holistic approach needs to be developed; such an approach allows for "course correction", better prioritization of actions, improved accountability and transparency.	Energy & Sustainability (and relevant Groups)

5.3.7 Knowledge Sharing

	Action	Description	Rationale	Lead Dept
KS	**Knowledge Sharing**			
KS.1	Deliver brown bag "lunch & learns" for staff related to carbon neutrality and implementing the transition.	Develop informal learning networks, open to anyone who wishes to attend, for people to share insights, challenges and use the general organizational knowledge to work through challenges.	The sharing of lessons learned, insights and a platform for staff to informally share their experiences, successes and set-backs and help keep the staff abreast of progress in general is an effective way to build a community committed to action and progress. It can also provide supportive environment on which to draw, since progress will not always be easy or smooth.	Energy & Sustainability
KS.2	Develop internal Community of Practice (focusing on Carbon Neutrality).	The internal Community of Practice, for those staff key to realizing the transition. would share knowledge, insights, lessons etc.	A more formal environment than the "brown bag lunches" the community of practice would allow effective knowledge sharing an all aspects of carbon neutral planning and delivery, this action would be particularly important during the development of Departmental Action Plans and in informing effective decision-making.	Energy & Sustainability

6 TECHNOLOGY SCENARIOS

The choice of which scenario to pursue will set the long-term strategic direction for the RDN and establish the basis from which to undertake more detailed implementation planning. Appendix A includes four technology Scenario Briefs, each intended to be read as a stand-alone description of the particular scenario. Below, the rationale for the four scenarios is described and, in *Section 6.2*, a summary of the different cases presented.

6.1 SCENARIO DEVELOPMENT

Viewing the need for action through a greenhouse gas lens highlights the need to primarily reduce landfill gas emissions, yet this cannot be at the expense of the operational emissions for which all departments must be responsible if carbon neutrality is to be achieved. The RDN has in place a clear carbon neutral target, which necessitates planning that is predominantly GHG focused. Therefore, the technology scenarios have been developed on that basis by considering only commercially viable technologies. Biofuels provide a technologically significant opportunity to reduce emissions and are commercially viable, yet they are currently limited in supply on Vancouver Island. Biofuels are considered in the technology scenarios below, however, the implications of the supply limitations are discussed further in *Section 6.4.1*.

6.1.1 Emissions Growth Forecast

The economy and population of the Nanaimo region continue to grow rapidly and, as such, the RDN will have to grow also. With exact growth in required service level to 2032, and differences between Departments and facilities, likely to vary over time, the growth in the RDN's operational emissions under "business-as-usual" was assumed to follow regional population growth. By 2032 it can be expected that the RDN will produce approximately 25% more operational greenhouse gas emissions than in 2019, equating to an increase of about 530 tCO_2e (yielding a total of 2775tCO_2e).

6.1.2 Stationary Source Emissions: Electricity in BC

When considering which technology scenarios to develop, it is important to recognize that in British Columbia there is an ample and reliable supply of renewable electricity from BC Hydro. BC Hydro is required to produce electricity that is at least 93% clean and in recent years has produced electricity significantly cleaner. The planning implication is, that when coupled with energy conservation and efficiency measures, electrification is the preferred pathway to carbon neutrality, and only when electrification is not viable or cost prohibitive should alternatives be investigated. However, there remains a core consideration for the RDN as to whether this fraction is high enough to deem grid-supplied electricity as carbon neutral. This consideration is significant since it will heavily influence the required resources to attain carbon neutrality. If grid supplied electricity is deemed 100% renewable it is only the facility's space heating (and hot water) demand that needs to be addressed for facilities and buildings, as well as emissions from the fleet's use of fossil fuels; otherwise the fraction of grid supplied electricity that is non-clean would also need to be addressed (at some point in the future). The technology scenarios are intended to reflect this, and each represents a progression on the previous one and has associated it with a more significant anticipated commitment of the RDN's resources.

6.1.3 Stationary Source Emissions: Solid Waste Compactors

Solid Waste consumes approximately 103,000 litres of diesel a year to run its solid waste compactors. This is the only significant stationary use of diesel fuel. The technology options to reduce the emissions from this source are the same as those for heavy-duty vehicles, which also primarily use diesel and are described below.

6.1.4 Mobile Source Emissions: Mobile Fuel Options

54% of the RDN's emissions come from mobile sources, where the fleet can, in general, be classified as comprising of light-duty vehicles (passenger cars, light trucks etc.) or heavy-duty vehicles (dump trucks, excavators, multi-axle vehicles, etc.). Improvements in battery technology are rapidly bringing to market hybrid vehicles which combine both a combustion engine and a battery, as well as battery electric vehicles which have only a battery. These advances are predominantly in the passenger car market but can reasonably be expected to extend to light-trucks in the coming decade.

Heavy-duty vehicles currently use diesel almost exclusively. Advances in electrification, through improved battery performance, are coming but to expect that all heavy-duty vehicles may be electrified by 2032 would be implausible. The pace of change in this area is, however, rapid and should be watched closely. This leaves bio-fuels and renewable diesel as the leading technology options to reduce emissions from diesel use.

6.1.5 Landfill Emissions

Greenhouse gas emissions from the landfill dominate the RDN's emission footprint accounting for 89% of total emissions. Through its *Solid Waste Management Plan*, the RDN is already undertaking significant efforts to reduce the volume of waste going to landfill and the extent to which organics end up on the landfill, which will reduce future emissions. Furthermore, it is also actively managing landfill gas collection and destruction at the Nanaimo Regional Landfill, while seeking to meet provincial regulation and minimize emissions as much as is feasible. This work should continue and, where possible, be expanded. The RDN should also continue to ensure that impacts to landfill greenhouse gas emissions are evaluated and considered when selecting between future landfill management options. In order to focus on areas that are not already part of a comprehensive plan or subject to regulation, the scenarios currently developed do not quantify any additional reductions to landfill waste volumes or improvements to landfill gas collection efficiency.

6.2 TECHNOLOGY SCENARIOS SUMMARY

The four scenarios developed were:

1. **Renewable Fuel**: this scenario reflects the ability to reduce emissions from only acting to change fuel supply (to renewable natural gas and the use of renewable diesel) and replacing aging passenger vehicles with hybrids. This scenario requires little change to equipment and no energy efficiency measures to be undertaken.
2. **Efficiency and Improvement**: this scenario is intended to show the progress that could come from focusing efforts on energy efficiency measures and improving space heating and hot water provision through the use of heat-pumps, while also introducing electrification for all light-duty vehicles and a modest amount of biofuel for heavy-duty vehicles.

3. **Acceleration**: this scenario considers what it would take to eliminate greenhouse gas emissions from all space heating and hot water, while introducing electrification for all light-duty vehicles and expanding the use of biofuel for heavy-duty vehicles.
4. **Zero Emission**: this scenario addresses what it would take to eliminate all operational emissions; including those associated with the grid supplied electricity, through the use of solar power; and also, from the fleet through the use of only electricity and biofuels/renewable diesel for all vehicles.

Figure 4 shows the RDN's total operational emissions in 2019, what they would be in 2032 under "business-as-usual" conditions, and the estimated emissions for each of the four Technology Scenarios. The Renewable Fuel scenario reduces emissions from business-as-usual by 84% (to 440 tCO_2e). The Efficiency and Improvement scenario achieves a 40% reduction (to 1659 tCO_2e), with the extra measures taken in Acceleration yielding an additional 797tCO_2e of reductions, cutting emissions by 69% over business-as-usual. The Zero Emission scenario eliminated all emissions without the use of offsets.

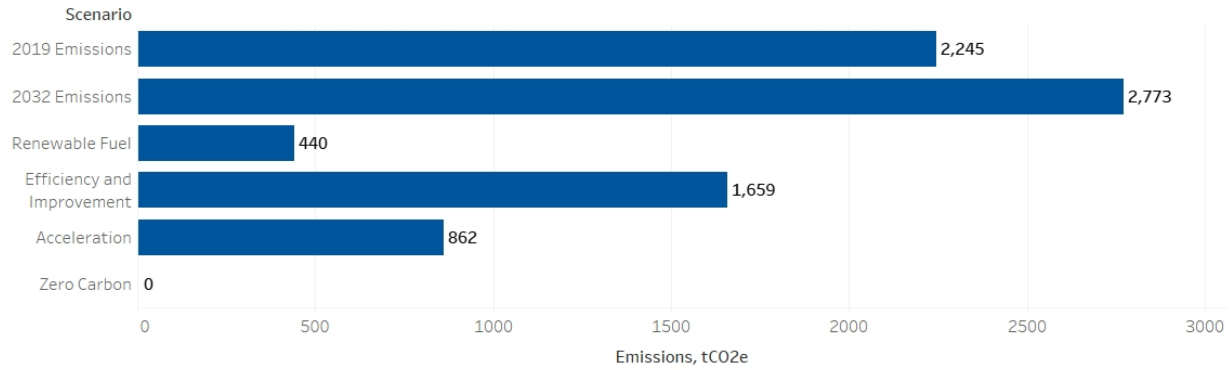


Figure 4: RDN Operational GHG Emissions in 2019 and in 2032 under different scenarios

6.3 DISCUSSION OF TECHNICAL SCENARIOS

6.3.1 Renewable Fuel

Of the four technical scenarios, the Renewable Fuel scenario represents the least disruptive since it requires no changes to equipment other than the introduction of hybrid vehicles into the fleet as current non-hybrid cars reach the end of their life. However, relying heavily on greening energy supply does not set up the RDN for long term success since the organization becomes wholly reliant on the extent to which renewable natural gas (RNG) and renewable diesel can be acquired. It is worth noting that RNG supplies are currently limited in BC and renewable diesel is not currently available on Vancouver Island. Given the cost premium of renewable fuels, without effort to increase energy efficiency, the organization will also be accepting a persistent utility cost increase.

6.3.2 Zero Emission

The Zero Emission scenario represents the other end of the spectrum, whereby even the small fraction of grid supplied electricity that is generated by fossil fuels is displaced with green power generation. The provision of even a small amount of green power will incur significant additional effort and cost to the RDN, and for which the environmental benefit is limited since grid supplied electricity is already close to carbon neutral and can reasonably be expected to remain so (see Appendix C for further discussion).

6.3.3 Efficiency and Improvement

The Efficiency and Improvement scenario represents the first significant steps to reducing the RDN's emissions through improving building energy efficiency and the use of heat pumps to reduce the use of natural gas for space heating and hot water; while fleet emissions are reduced through a significant commitment to electrification and the modest use of biofuels. The most significant technical challenges with this scenario are that biofuel is not currently available on Vancouver Island and that heat-pumps often require significant electrical upgrades for facilities' current provisions. This scenario does have a significant capital investment required for the conversion of facilities heating systems to heat-pumps, and without a current biofuel market on Vancouver Island, the cost premium of biofuels (if any) is difficult to determine. This scenario does, however, represent a large step towards long-term emissions reductions.

6.3.4 Acceleration

The Acceleration scenario builds on Efficiency and Improvement, to further reduce emissions by replacing the remaining natural gas use with renewable natural gas and increasing the amount of biofuel used in the fleet. To a large extent, the Acceleration goal is highly adaptable in that the amount of renewable natural gas purchased can be varied with concomitant emissions reductions; as can the amount of biofuel (within what an emergent Vancouver Island market would allow), which again would directly impact the extent to which emissions reductions are realized. There is limited capital cost increase with the Acceleration scenario, although higher blend biofuels may necessitate changes to the heavy-duty fleet, and there may also be some alterations to fuel storage depending upon the particulars of how biofuel is delivered to the RDN.

6.4 ADDITIONAL CONSIDERATIONS

6.4.1 Biofuel Supply Limitations

Of the RDN's total emissions, approximately one third comes from the use of diesel in heavy duty on-road vehicles. Currently, the predominant technology alternatives centre on using less carbon intensive fuels to replace diesel. Fossil diesel can be blended with biodiesel, a low carbon alternative to diesel and up to about a 20% blend of biodiesel requires few, if any, changes needing to be made to vehicles, however, beyond this point modifications typically need to be made to the vehicles in order to use higher concentrations of biodiesel (which may go as high as 100%). Another low carbon option is to use "renewable diesel" (also called HDRD) which is chemically identical to diesel, so requires no modifications to vehicles.

Currently, there is a modest biodiesel market in BC and no significant market for renewable diesel, however, neither of these fuels are currently available on Vancouver Island. The RDN is not a large enough consumer of diesel to be a "market maker" and, as such, would be reliant on the development of a purchasing pool or the reinstatement of past provincial financial support (or similar supporting policy) to bring biodiesel or renewable diesel to the Island. As noted in *Section 6.4.3*, in the medium-term there are likely significant advances in other clean technologies for heavy-duty vehicles such as electrification and, potentially, the use of hydrogen.

Accordingly, the RDN finds itself at a crossroads in what the market can provide for low-carbon heavy-duty transport. As such, it would be prudent to put a "place hold" on what technology will be used for a heavy-duty fleet and focus on concrete actions for the light-duty fleet and facilities, where there is more

technological certainty and more supply security with the use of electricity. That "place hold" could be revisited with a dedicated fleet strategy in 2025 or so.

6.4.2 Offset Considerations

Except for Zero Emission, there will remain some residual emissions from the RDN's operations in all scenarios and the landfill will continue to emit greenhouse gases since its emissions cannot be fully eliminated. The market cost of offsets varies widely depending on the quality of the offset, the project, its location, and the registry from which the offset is purchased. High-quality offsets must have been generated from projects that have the following attributes:

Additional: realize reductions in emissions, or store carbon, through a project that would not have taken place under business-as-usual conditions or which is regulated to take place.
Verifiable: be able to be independently verified by qualified personnel or organizations.
Permanent: provide emissions reductions, or the removal of carbon from the atmosphere, that is long-lasting, and which does not simply cause emissions to be moved to another location (so-called "leakage").
Conservative: be calculated on a basis that does not overestimate the amount of carbon avoided or removed.
Do no significant social harm: avoid causing additional social or environmental harm.

Consistent with the Carbon Management Hierarchy, when deciding on the role of offsets, the RDN should consider aspects such as whether the offsets are sourced from within the RDN's boundary or outside (in BC, nationally, or internationally), the implications for how the RDN's revenues are assigned, whether there are local benefits to jobs, trades, technology, as well as the long-term implications for a move towards carbon neutrality.

High-quality offsets start in the range $20-30 per unit (i.e. per tonne offset) and are available from a number of suppliers[4]. Public Sector Organizations that are regulated under the *Climate Change Accountability Act* in BC and required to purchase offsets do so at 25 $/t$CO_2$e[5]. At this price, the (undiscounted) cost of offsetting the RDN's remaining emissions for the different scenarios is detailed in *Table 1*.

Table 1: Approximate Annual Offset Costs Under Different Scenarios

2019 Emissions	2032 Business As Usual Emissions	Renewable Fuel	Efficiency and Improvement	Acceleration	Zero Carbon
$56,000	$69,500	$11,000	$41,500	$21,500	$0

The RDN's landfill gas liability to achieve carbon neutrality is approximately $763,000 (at 25 $/t$CO_2$e) in all future scenarios. Offsets may also be considered as a way to counter emissions from heavy-duty vehicles that remain until there is greater certainty on the most appropriate technology, and the fleet is fully decarbonized.

[4] Pembina Institute, Purchasing Carbon Offsets: A Guide for Canadian Consumers, Businesses and Organization, https://www.pembina.org/reports/offset-purchase-guide-v3.pdf
[5] Government of BC, Carbon Neutral Action Reports Instructions and Templates, https://www2.gov.bc.ca/assets/gov/environment/climate-change/cng/guidance-documents/cnar_instructions_and_template.docx

6.4.3 Technology Advancements

Facilities

Low carbon technologies are evolving rapidly for both the provision of space heat and hot water, as well as both road and non-road vehicles. Commercial heat-pump technology has improved significantly in the last 5 years or so, with performance increasing and costs reducing. This trend is likely to continue, and cold weather performance is likely to improve further, thereby reducing the need for natural gas to provide heating on the coldest of days.

Fleet

Similarly, battery technology and the electrification of vehicles has advanced markedly in the past five years and continues apace. As advances flow from passenger vehicles to light-duty trucks and in to heavy-duty vehicles, it is likely that in the next decade there will be an emergent case to move away from combustion technologies (biofuels and renewable diesel) for heavy-duty vehicles that return to base daily or have short operating ranges. This trend is something that will have to be watched closely and should be considered in a comprehensive green fleet strategy.

Furthermore, hydrogen has seen a resurgence in interest as a low-carbon fuel, particularly with the launch of Alberta's Natural Gas Vision and Strategy[6], which includes a hydrogen component, and the Federal Government's recent strategy[7]. Currently, the vast majority of hydrogen come from steam-reforming natural gas (and is often called "grey hydrogen"), thereby limiting the extent to which hydrogen can be considered low carbon. However, hydrogen produced from the electrolysis of water using renewable electricity would produce zero- or near -zero carbon hydrogen (so called "green" hydrogen). The technologies to produce, distribute and use hydrogen are maturing rapidly, although there is still significant debate about when they will become commercially viable.

6.4.4 Contractor Emissions

The reduced influence that the RDN must tackle emissions from contracted services, primarily from waste collection and haulage, must be heeded given the predominance of this source in the RDN's operational emissions profile. The RDN cannot expect its contractors to do more to reduce emissions than the RDN is doing itself. As such, in all scenarios the RDN's contracted fleet is assumed to use the same fuel (biofuel or renewable diesel) as the RDN's own vehicles. In establishing a Vancouver Island market for alternative heavy-duty fuels, inclusion of contractors' fuel purchases would increase the market size, buttressing the case for bringing alternative fuels to the Island.

[6] Natural Gas Vision and Strategy, Government of Alberta, pp. 23-25, https://open.alberta.ca/dataset/988ed6c1-1f17-40b4-ac15-ce5460ba19e2/resource/a7846ac0-a43b-465a-99a5-a5db172286ae/download/energy-getting-alberta-back-to-work-natural-gas-vision-and-strategy-2020.pdf

[7] Hydrogen Strategy for Canada, Government of Canada, https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/environment/hydrogen/NRCan_Hydrogen-Strategy-Canada-na-en-v3.pdf

7 NEXT STEPS

Undertaking the actions described will build, within the RDN, the ability to deliver on its emissions reductions commitments through the development of enhanced business planning and business process. The Implementation Actions will also develop staff capacity and knowledge to systematically deliver low-carbon projects while maintaining service levels. The current 2032 target date to achieve carbon neutrality is aggressive, but not unrealistic. *Figure 6* shows an indicative roadmap for the next two-to-three years, and which will inform the prioritization and timing of specific project implementation.

Figure 6: Indicative Roadmap

"Quick Start" actions include assigning clear roles and responsibilities to RDN departments and staff to undertake the Implementation Actions and support the on-going development of tools and business processes tailored for carbon neutrality. There are also procedural steps to be taken to refine the Technology Scenarios, the first of which is a "quick start" to complete an indicative costing for the Technical Scenarios. The costing exercise will inform capital planning and the prioritization of projects. With capital plans in place facility specific feasibility and predesign studies can be completed as prerequisites to project delivery. To support the decarbonization of the RDN vehicle fleet a detailed Green Fleet Plan would allow for vehicle and facility specific planning and afford a smooth transition to low-carbon vehicles.

The Implementation Actions outlined set the RDN on a path to delivery, while the initial emissions analysis, the results of which are described in the Technology Scenarios of *Section 6*, demonstrates where the most significant opportunities exist for the RDN to cut emissions. Those opportunities are predominantly tied to changes in the technology used by the RDN to heat its facilities and power its fleet. Assuming work begins in 2023, over the next ten years, the RDN will need to complete a deep energy retrofit on a facility approximately once every 18 months and replace about five fossil-fueled, light-duty vehicles a year with low carbon alternatives.

8 CONCLUSION

Implementing the Corporate Carbon Neutral 2032 Plan will begin with the Implementation Actions and chosen Technical Scenario. The Implementation Actions may be viewed independently from the chosen Technical Scenario and will support the move towards carbon neutrality through enhanced business processes, improved business intelligence and increased progress tracking and reporting. The choice of Technical Scenario to follow will prioritize specific actions and analysis required to move the Corporate Carbon Neutral 2032 Plan from strategic direction to facility and department specific low-carbon technology choices.

Given the uncertainty about viable heavy-duty vehicle options, the RDN should focus its near-term emissions reduction efforts on its facilities and light-duty fleet, addressing heavy-duty emissions when suitable technologies come to market. Furthermore, recognizing the significance of landfill gas emissions to the RDN's emissions footprint, existing plans to divert organics and manage landfill gas emissions should be supported, including the assessment of emission impacts in landfill management scenarios.

The current 2032 target date to achieve carbon neutrality is aggressive but not unrealistic. The Implementation Actions and chosen Technical Scenario will set the long-term strategic direction to RDN carbon neutrality and establish the basis for more detailed implementation planning and action that needs to start now.

A APPENDIX A: SCENARIO BRIEFS

See following pages.

1

Renewable Fuel

By 2032, the RDN is serving a population 25% larger than in 2020. There has been a significant uptake of renewable natural gas to provide space heating and hot water in all RDN facilities. Operational improvements keep the fleet size at 2020 levels, with what used to be light-duty diesel and heavy-duty vehicles now using renewable diesel, while gasoline vehicles have been replaced with plug-in hybrids. Water and wastewater treatment facilities remain mostly unchanged, with the exception that in wastewater facilities, renewable natural gas has replaced natural gas.

Scenario Description

Buildings and Facilities: to meet large heating demands (space heating and hot water), the use of natural gas in conventional heating systems has been replaced with the use of Renewable Natural Gas ("RNG", also called biomethane).

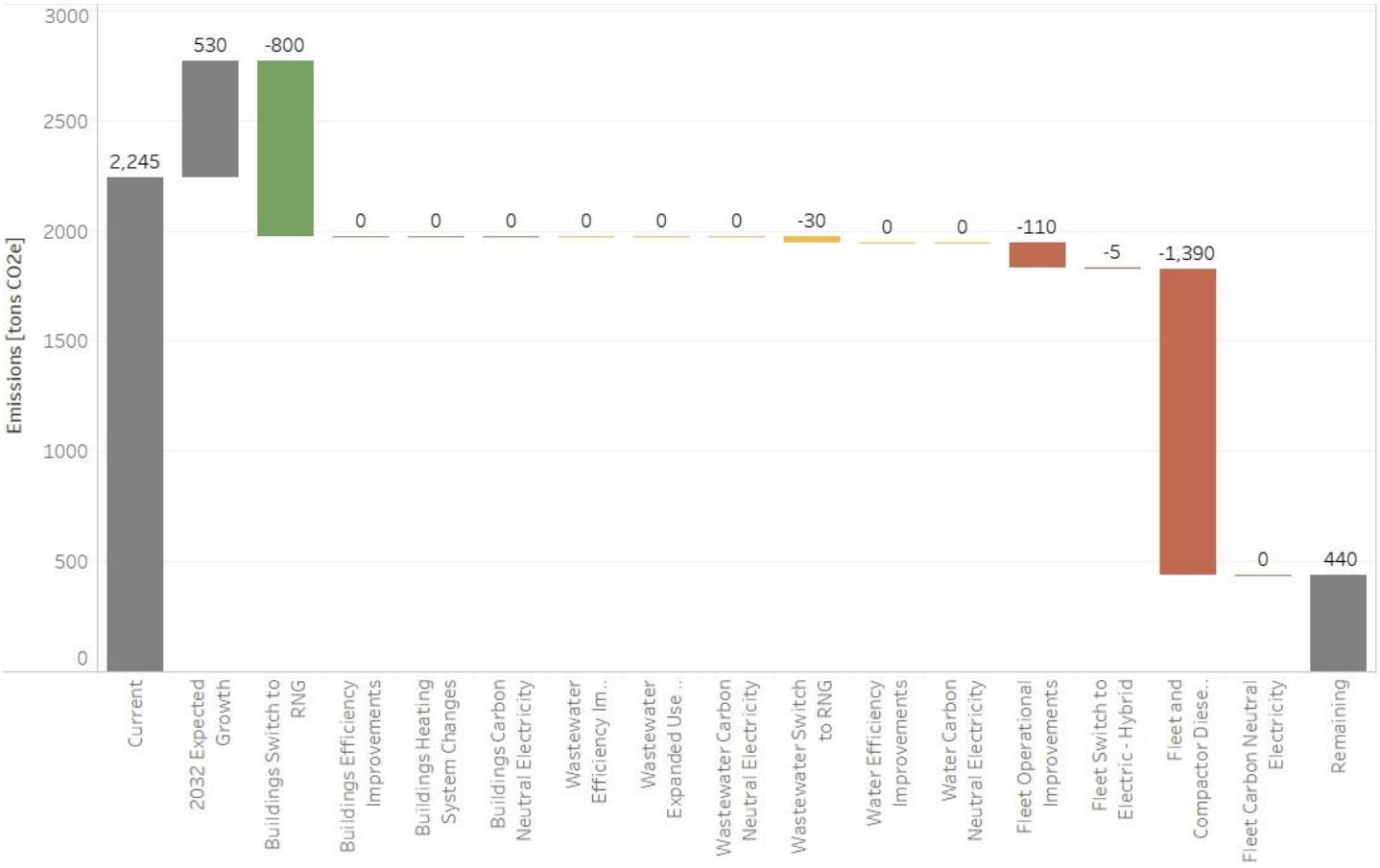
Fleet: fleet optimization has maintained the pool of fleet vehicles at 2020 levels, with all light-duty gasoline vehicles having been replaced by plug-in hybrids; while the light-duty diesel and heavy-duty fleet has been transitioned to renewable diesel (a fuel chemically identical to diesel but made from carbon neutral sources).

Water: continued reliance on existing equipment (and current operational efficiency) persists.

Wastewater: continued reliance on existing equipment (and current operational efficiency) persists. To meet heating demand in wastewater treatment facilities, the use of natural gas in conventional heating systems has been replaced with the use of Renewable Natural Gas (biomethane). Continued generation and use of biogas at the wastewater treatment facilities remains unchanged.

Emissions Performance

Assuming organizational emissions grow in line with the population the RDN serves, by 2032, without actions to reduce emissions, the RDN would emit approximately 530 tCO_2e (or 25%) more than in 2019, yielding a total of about 2775 tCO_2e. The use of renewable natural gas in facilities could cut emissions by approximately 830tCO_2e (800tCO_2e from buildings, and approximately 30tCO_2e from wastewater facilities). While if the RDN were able to maintain its current level of service without growing the fleet, emissions could be reduced by approximately 110tCO_2e. The balance of fleet emissions reductions would come from partial electrification of the light-duty fleet (saving approximately 5tCO_2e) and the use of renewable diesel (saving approximately 1,390 tCO_2e). The RDN would still have to offset approximately 440tCO_2e from the use of gasoline in its light-duty plug-in hybrid vehicles and the fossil fuel derived portion of electricity generated by BC Hydro.



Advantages

- Renewable Fuel means the capital expense for facility retrofits is deferred.
- Light-duty vehicle changes follow broad market trends and existing heavy-duty vehicles do not require retrofit.
- Emissions reductions can be realized as soon as RNG and renewable diesel can be sourced.

Disadvantages

- The use of “drop in” (i.e. ones where no changes to equipment are required) does not inherently provided efficiency increases and limits the extent to which the RDN is starting to fully prepare for a decarbonized future.
- The RDN is not able to gain experience with, and prepare for, a transition away from fossil fuels – a transition that will occur at some stage and which the RDN should be actively planning for.
- This scenario does not fundamentally address the need to increase efficiency in buildings and address the most difficult to reduce emissions source, i.e. those from the fleet.
- The environmental impacts of renewable diesel need to be carefully assessed since not all sources of renewable diesel are desirable (e.g. those sources from palm oil).
- Drop-in fuels, such as RNG and renewable diesel, are costlier than their conventional equivalents and should not been considered in isolation (i.e. with energy efficiency and conservation measures).

Challenges and Risk

- Renewable diesel is not currently available on Vancouver Island; and the RDN does not purchase fuel in significant enough volumes to be the “market maker”. The RDN would likely have to become part of a purchasing pool to influence the availability of renewable diesel on the Island.
- Province-wide there are currently limited amounts of RNG available through Fortis BC, and in the future increased demand with limited supply, means that RNG cannot be viewed as a like for like replacement for natural gas.

Opportunities

- Fleet vehicles are the most significant source of emissions for the RDN and, as such, the organization has the opportunity to lead a regional conversation about how to address this difficult to address source.

Lifetime Cost Estimate

2

Efficiency and Improvement

By 2032, the RDN is serving a population 25% larger than in 2020. Buildings and facilities have made significant energy efficiency improvements though envelope retrofits, the use of active controls for heating and lighting, and the wholesale use of LED lighting. There has been a significant uptake of air source heat pumps to provide space heating and hot water in almost all RDN facilities; but the use of natural gas persists to meet peak demand and most heating needs at pool facilities. Operational improvements keep the fleet size at 2020 levels and light-duty vehicles have been electrified, while heavy-duty vehicles use modest amounts of biofuels. Water and wastewater facilities have had energy improvement upgrades to all their systems.

Scenario Description

Buildings and Facilities: buildings and facilities have been retrofitted to improve weather sealing and have better performing windows and insulation. Energy efficiency is enhanced further with ventilation heat-recovery, which is integrated with air-source heat pumps that provide space heating and hot water. To meet demand on the coldest days, and in facilities with large heating demands such as pools, the use of natural gas in conventional heating systems persists.

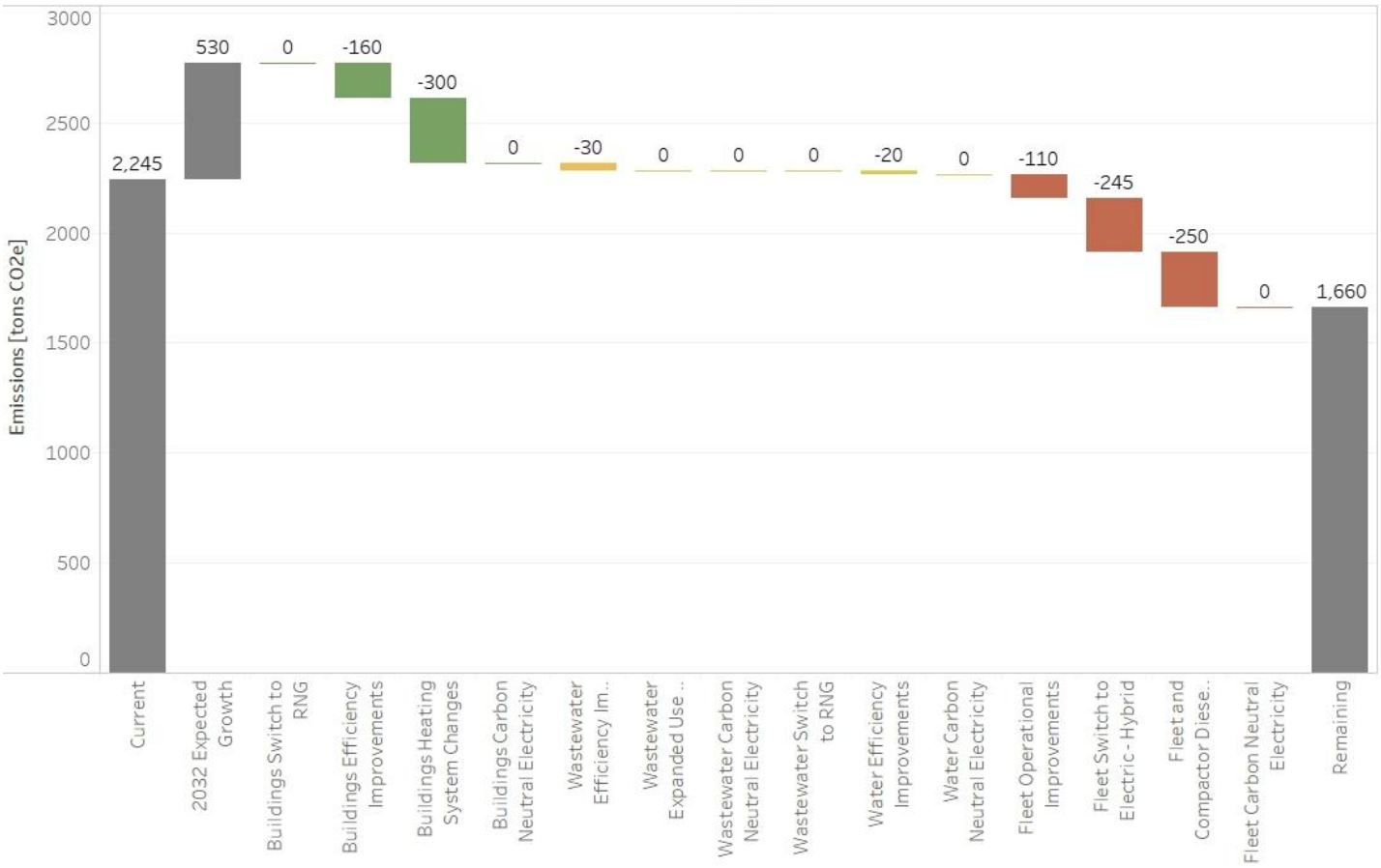
Fleet: fleet optimization has maintained the pool of fleet vehicles at 2020 levels, with all light-duty vehicles being fully electrified and the heavy-duty fleet using a 20% biofuel blend (the balance 80% is conventional fossil-diesel).

Water: equipment and operational efficiency improvements have been the focus for water facilities leading them to be the regional benchmark.

Wastewater: equipment and operational efficiency improvements have been the focus for wastewater facilities leading them to be the regional benchmark.

Emissions Performance

Assuming organizational emissions grow in line with the population the RDN serves, by 2032, without actions to reduce emissions, the RDN would emit approximately 530tCO_2e (or 25%) more than in 2019, yielding a total of about 2775tCO_2e. Building efficiency improvements could bring approximately 160tCO_2e of savings, while improvements to space heating and hot water could save an additional approximate 300tCO_2e. Equipment efficiency improvements to the RDN's water and wastewater facilities could save an additional 20tCO_2e and 30tCO_2e respectively. While if the RDN were able to maintain its current level of service without growing the fleet, emissions could be reduced by approximately 110tCO_2e. The balance of fleet emissions reductions would come from electrification of the light duty fleet (saving approximately 245tCO_2e) and the use of B20 biodiesel (saving approximately 250tCO_2e). The RDN would still have to offset approximately 1660tCO_2e from the use of conventional diesel in heavy-duty vehicles, natural gas to meet peak building heating demand and the fossil fuel derived portion of electricity generated by BC Hydro.



Advantages

- The use of heat pumps in buildings provides significant energy efficient improvements and limits the need for natural gas on the coldest days when heat-pumps are ineffective; and to facilities with large hot water demands.
- The option to replace the natural gas use with renewable natural gas remains (see *Scenario 3: Stretch Goal*) without necessitating any further equipment changes.
- Fleet optimization helps manage fleet costs and significant electrification makes the best use of the rapidly advancing technology.
- The use of "B20" biofuel can be accommodated within most existing diesel engines without significant modification or impacts to vehicle performance.

Disadvantages

- Emissions remain from the use of natural gas to provide heating and hot water on the coldest days, and for pool facilities.
- The retrofitting of facilities to use air source heat pumps is disruptive, but not debilitating; especially if tied to natural building retrofit cycles.
- The use of biofuel does typically necessitate changes to vehicle maintenance regimes and may have implications for fuel supply and storage.

Challenges and Risk

- Biofuel availability is limited on Vancouver Island, the RDN would likely have to find new local partners to supply the fuel, with the associated risk of being tied to a single producer. The RDN may also seek to become part of the purchasing pool to influence the availability of biofuel on the Island.
- The environmental impacts of biofuel need to be carefully assessed since not all sources used to make these fuels are desirable (e.g. those sources from palm oil).

- There are limited opportunities to reduce emissions from heavy-duty vehicles, although electrification may become more applicable over the next decade.
- Air source heat pumps are commercially available, yet still a relatively new technology so are likely to require more maintenance and an increase in operational supervision in the short-term.

Opportunities

- Vehicle electrification is picking up pace and the RDN can play a role in supporting trades development in this new field.
- The move to air source heat pumps and electric vehicles significantly cuts the emission of traditional air pollutants such as particulate matter, carbon monoxide, ozone and oxides of nitrogen.
- Air source heat pumps will become more ubiquitous as BC electrifies in general, the RDN can play a role in supporting this emergent technology, its local supply chains and the associated trades.
- The RDN can, through its fuel purchases, start to impact the local biofuel market and, although not a “market maker” on its own, through a purchasing pool could influence the development of more renewable fuel development.

Lifetime Cost Estimate

3

Acceleration

By 2032, the RDN is serving a population 25% larger than in 2020. Buildings and facilities have made significant energy efficiency improvements though envelope retrofits, the use of active controls for heating and lighting, and the wholesale use of LED lighting. There has been a significant uptake of air source heat pumps to provide space heating and hot water in all RDN facilities; but the use of natural gas persists to meet peak demand and most heating needs at pool facilities. Operational improvements keep the fleet size at 2020 levels, where light-duty vehicles have been electrified, while heavy-duty vehicles use significant amounts of biofuel. Water and wastewater treatment facilities have had energy improvement upgrades to all their systems; wastewater treatment facilities have eliminated the reliance on natural gas through the optimization of biogas production and use.

Scenario Description

Buildings and Facilities: buildings and facilities have been retrofitted to improve weather sealing and have better performing windows and insulation. Energy efficiency is enhanced further with ventilation heat-recovery, which is integrated with air-source heat pumps that provide space heating and hot water. To meet demand on the coldest days, and in facilities with large heating demands such as pools, the use of renewable natural gas replaces reliance on conventional heating systems using natural gas.

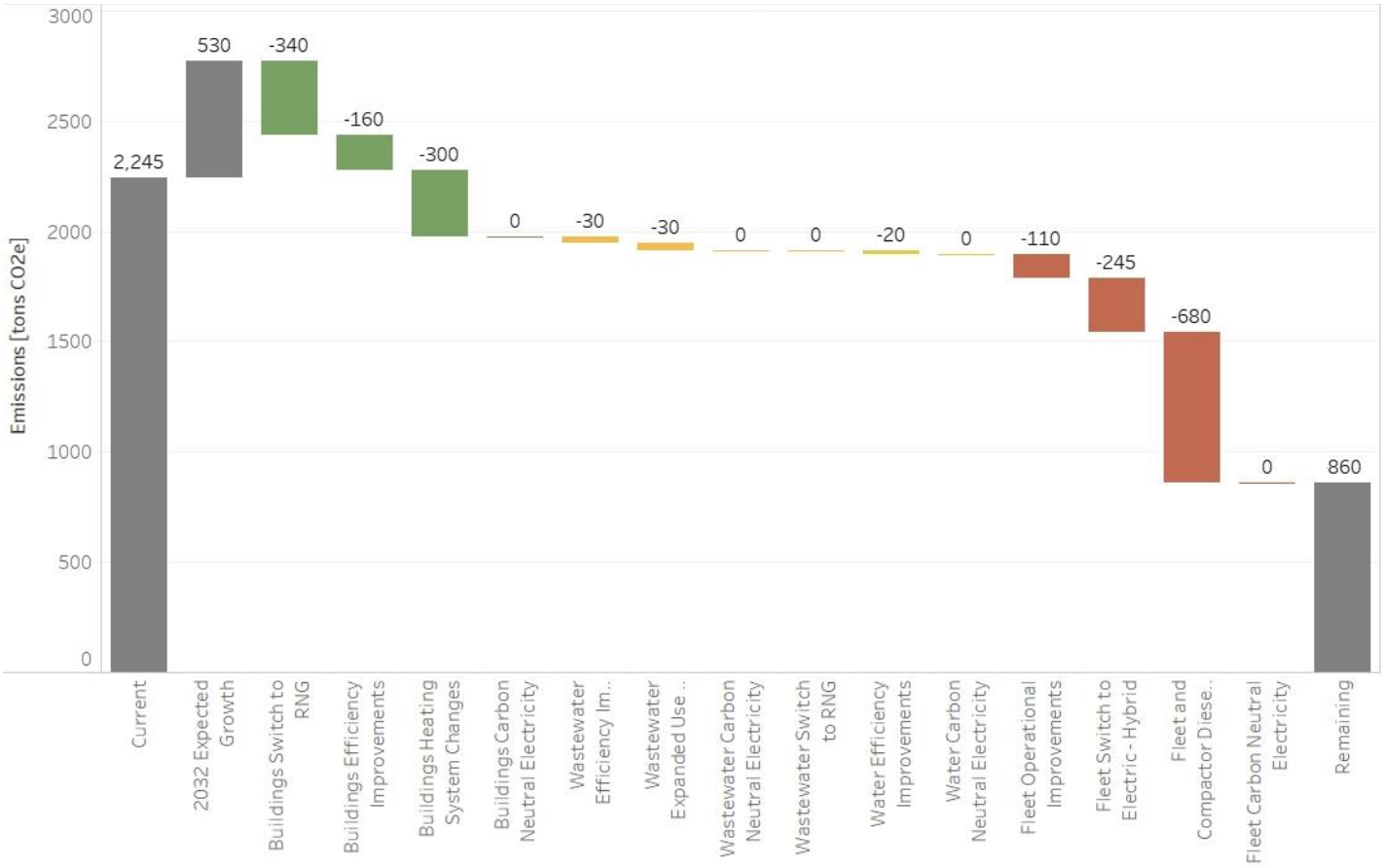
Fleet: fleet optimization has maintained the pool of fleet vehicles at 2020 levels, with all light-duty vehicles being fully electrified and the heavy-duty fleet using a 50% biofuel blend (the balance 50% is conventional fossil-diesel).

Water: equipment and operational efficiency improvements have been the focus for water facilities leading them to be the regional benchmark.

Wastewater: equipment and operational efficiency improvements have been a major focus for wastewater treatment facilities leading them to be the regional benchmark. Another major focus for the wastewater treatment facilities is the optimization of biogas on site to completely displace reliance on natural gas.

Emissions Performance

Assuming organizational emissions grow in line with the population the RDN serves, by 2032, without actions to reduce emissions, the RDN would emit approximately 530tCO_2e (or 25%) more than in 2019, yielding a total of about 2775tCO_2e. Building efficiency improvements could bring approximately 160tCO_2e of savings, while improvements to space heating and hot water could save an additional approximate 300tCO_2e; and the use of RNG an additional approximate 340tCO_2e. Equipment efficiency improvements to the RDN's water and wastewater facilities could save an additional 20tCO_2e and 30tCO_2e respectively, with a further 30 tCO_2e of savings from the use of biogas to replace natural gas use at the RDN's wastewater facilities. While if the RDN were able to maintain its current level of service without growing the fleet, emissions could be reduced by approximately 110tCO_2e. The balance of fleet emissions reductions would come from electrification of the light duty fleet (saving approximately 245tCO_2e) and the use of B50 biodiesel (saving approximately 680tCO_2e). The RDN would still have to offset approximately 860tCO_2e from the use of conventional diesel in heavy-duty vehicles and the fossil fuel derived portion of electricity generated by BC Hydro.



Advantages

- The use of heat pumps and RNG in buildings provides significant energy efficient improvements and eliminates the direct use of all fossil fuels in RDN buildings and facilities.
- Fleet optimization helps manage fleet costs, and significant electrification makes the best use of the rapidly advancing technology.
- Significant progress is starting to be made on the difficult task to replace emissions from diesel use.

Disadvantages

- The retrofitting of facilities to use air source heat pumps is disruptive, but not debilitating; especially if tied to natural building retrofit cycles.
- The use of B50 biofuel may be challenging to accommodate within the existing diesel engines, depending on vehicle age and manufacturer. The use of B50 will likely require changes to vehicle maintenance regimes and may have implications for fuel supply and storage.
- The retrofitting of equipment and changes to operations at wastewater facilities to maximize biogas production will require a concerted program for minimal emissions improvements.

Challenges and Risk

- Biofuel availability is limited on Vancouver Island; the RDN would likely have to find new local partners to supply the fuel, with the associated risk of being tied to a single producer. The RDN may also seek to become part of the purchasing pool to influence the availability of biofuel on the Island.
- There are limited opportunities to reduce emissions from heavy-duty vehicles, although electrification may become more applicable over the next decade.
- Capacity of wastewater treatment facilities may limit the biogas production capabilities (i.e. ability to meet the demand) within the facilities.
- Air source heat pumps are commercially available, yet still a relatively new technology so are likely to require more maintenance and increase operational supervision in the short-term.

Opportunities

- The move to air source heat pumps and electric vehicles significantly cuts the emission of traditional air pollutants such as particulate matter, carbon monoxide, ozone and oxides of nitrogen.
- Air source heat pumps will become more ubiquitous as BC electrifies in general, the RDN can play a role in supporting this emergent technology, its local supply chains and supporting trades.
- Vehicle electrification is picking up pace, and the RDN can play a role in supporting trades development in this new field.
- The environmental impacts of biofuel need to be carefully assessed since not all sources used to make these fuels are desirable (e.g. those sources from palm oil).
- The RDN can, through its fuel purchases, start to impact the local biofuel market and, although not a “market maker” on its own, through a purchasing pool could influence the development of more renewable fuel development.

Lifetime Cost Estimate

4

Zero Emission

By 2032, the RDN is serving a population 25% larger than in 2020. Buildings and facilities have made significant energy efficiency improvements though envelope retrofits, the use of active controls for heating and lighting, and the wholesale use of LED lighting. There has been a significant uptake of air source heat pumps to provide space heating and hot water in all RDN facilities, but the use of natural gas persists to meet peak demand and most heating needs at pool facilities. Operational improvements keep the fleet size at 2020 levels, where light-duty vehicles have been electrified, while heavy-duty vehicles use biofuels exclusively. Water and wastewater treatment facilities have had energy improvement upgrades to all of their systems; wastewater treatment facilities have eliminated the reliance on natural gas through the optimization of biogas production. All systems include grid supplied electricity, supplemented with 7% electricity demand from clean off-grid sources.

Scenario Description

Buildings and Facilities: buildings and facilities have been retrofitted to improve weather sealing and have better performing windows and insulation. Energy efficiency is enhanced further with ventilation heat-recovery, which is integrated with air-source heat pumps that provide space heating and hot water. To meet demand on the coldest days, and in facilities with large heating demands such as pools, the use of renewable natural gas replaces reliance on conventional heating systems using natural gas. There is a shift in the reliance of electricity demand from 100% grid supplied electricity to grid supplied electricity plus 7% clean electricity generation from off-grid sources (to account for the portion of BCHydro supplied electricity that is generated by fossil fuel sources).

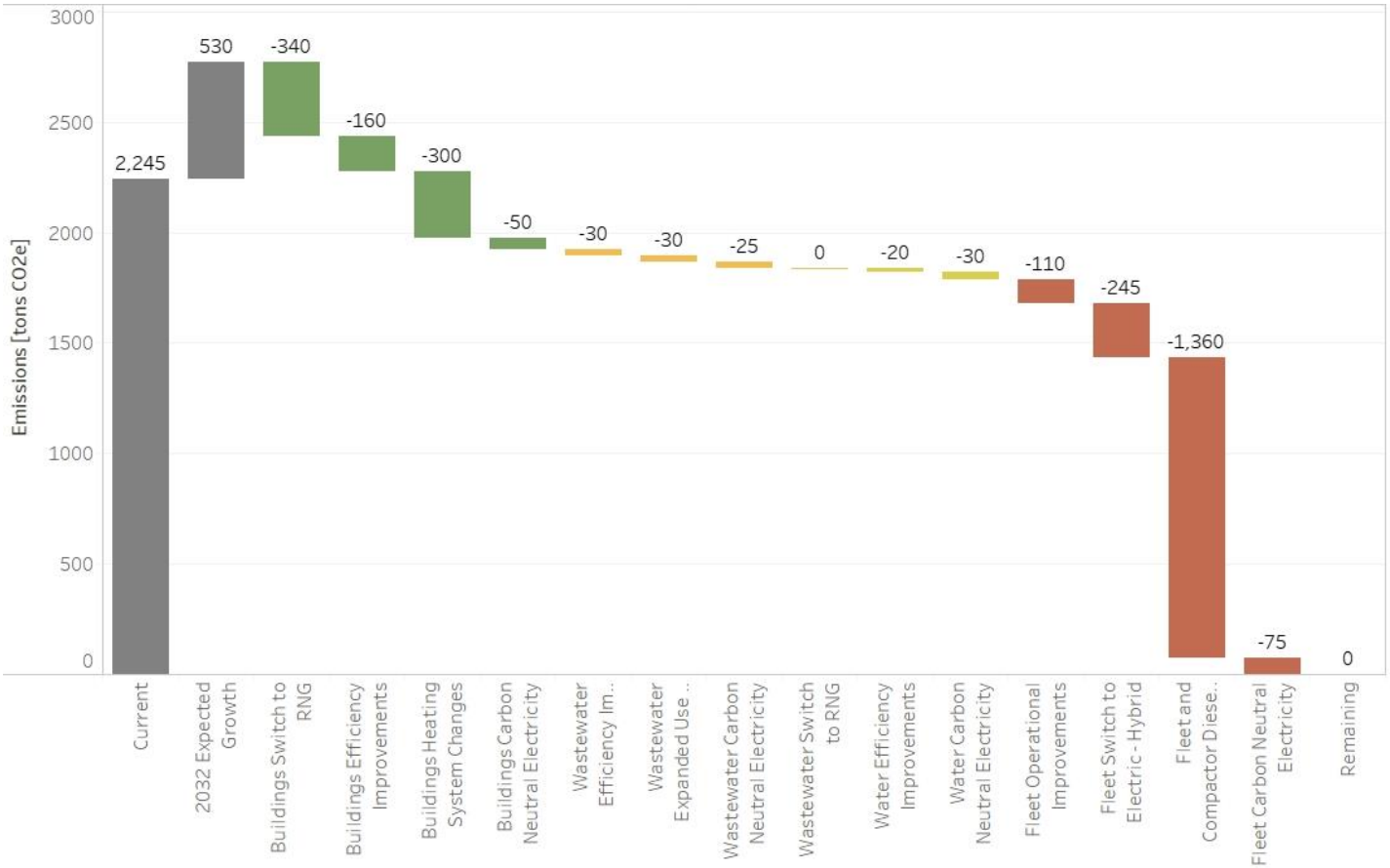
Fleet: fleet optimization has maintained the pool of fleet vehicles at 2020 levels, with all light-duty vehicles being fully electrified and the heavy-duty fleet using a 100% biofuel (i.e. no reliance on conventional fossil-diesel) or renewable diesel. There is a shift in the reliance of electricity demand from 100% grid supplied electricity to grid supplied electricity plus 7% clean electricity generation from off-grid sources (to account for the portion of BCHydro supplied electricity that is generated by fossil fuel sources).

Water: equipment and operational efficiency improvements have been one of the main focuses for water facilities leading them to be the regional benchmark. There a is shift in the reliance of electricity demand from 100% grid supplied electricity to grid supplied electricity plus 7% clean electricity generation from off-grid sources (to account for the portion of BCHydro supplied electricity that is generated by fossil fuel sources).

Wastewater: equipment and operational efficiency improvements have been a major focus for wastewater treatment facilities leading them to be the regional benchmark. Another major focus for the wastewater treatment facilities is the optimization of biogas on site to completely displace reliance on natural gas. There a is shift in the reliance of electricity demand from 100% grid supplied electricity to grid supplied electricity plus 7% clean electricity generation from off-grid sources (to account for the portion of BCHydro supplied electricity that is generated by fossil fuel sources).

Emissions Performance

Assuming organizational emissions grow in line with the population the RDN serves, by 2032, without actions to reduce emissions, the RDN would emit approximately 530tCO_2e (or 25%) more than in 2019, yielding a total of about 2775tCO_2e. Building efficiency improvements could bring approximately 160tCO_2e of savings, while improvements to space heating and hot water could save an additional approximate 300tCO_2e; and the use of RNG an additional approximate 340tCO_2e. The generation of clean electricity would save a further 50tCO_2e of emissions in buildings, and approximately 55tCO_2e more at RDN facilities (25tCO_2e in Wastewater, and 20tCO_2e in Water). Equipment efficiency improvements to the RDN's water and wastewater facilities could save an additional 20tCO_2e and 30tCO_2e respectively, with an additional 30tCO_2e of savings from the use of biogas to replace natural gas use at the RDN's wastewater facilities. While if the RDN we able to maintain its current level of service without growing the fleet, emissions could be reduced by approximately 110tCO_2e. The balance of fleet emissions reductions would come from electrification of the light duty fleet (saving approximately 245tCO_2e) and the use of 100% biodiesel or renewable diesel (saving approximately 1,360 tCO_2e), while the generation of clean electricity for use in the light-duty fleet would save approximately an additional 75tCO_2e. The RDN would have no emissions to offset, since they would have been addressed through the range of other actions.



Advantages

- The RDN would fully realize the goal for becoming carbon neutral.
- The use of heat pumps and RNG in buildings provides significant energy efficient improvements and eliminates the need for natural gas use.
- Fleet optimization helps manage fleet costs, and significant electrification makes the best use of the rapidly advancing technology.
- The RDN has led the way in eliminating emissions from difficult to address heavy-duty vehicles.

Disadvantages

- The retrofitting of facilities to use air source heat pumps is disruptive, but not debilitating; especially if tied to natural building retrofit cycles.
- The use of B100 biofuel is highly unlikely to be able to be met with existing diesel engines necessitating new vehicles purchased, depending on vehicle age and manufacturer. The use of B100 will require changes to vehicle maintenance regimes and may have implications for fuel supply and storage. These challenges could be offset through the use of renewable diesel.
- The retrofitting of equipment and changes to operations at wastewater facilities to maximize biogas production will require a concerted program for minimal emissions improvements.
- The generation of renewable electricity is costly (and complex) for a limited emissions benefit.

Challenges and Risk

- The ability to produce renewable electricity would need significant investigation to understand if it is feasible at the required scale.
- Air source heat pumps are commercially available, yet still a relatively new technology so are likely to require more maintenance and an increase in operational supervision in the short-term.
- Biofuel availability is limited on Vancouver Island; the RDN would likely have to find new local partners to supply the fuel, with the associated risk of being tied to a single producer. The RDN may also seek to become part of the purchasing pool to influence the availability of biofuel on the Island.
- The environmental impacts of renewable diesel and/or biofuel need to be carefully assessed since not all sources used to make these fuels are desirable (e.g. those sources from palm oil).
- There are limited opportunities to reduce emissions from heavy-duty vehicles, although electrification may become more applicable over the next decade.
- Capacity of wastewater treatment facilities may limit the biogas production capabilities (i.e. ability to meet the demand) within the facilities.

Opportunities

- Renewable sources of electricity are becoming increasingly implemented in BC.
- Vehicle electrification is picking up pace and the RDN can play a role in supporting trades development in this new field.
- The move to air source heat pumps and electric vehicles significantly cuts the emission of traditional air pollutants such as particulate matter, carbon monoxide, ozone and oxides of nitrogen.
- Air source heat pumps will become more ubiquitous as BC electrifies in general, the RDN can play a role in supporting this emergent technology, its local supply chains and the associated trades.
- Through generation of its own renewable electricity the RDN would support the growth of the industry at large, and the associated trades (the particulars of which would depend on the chosen generation technology).

Lifetime Cost Estimate

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B APPENDIX B: DEVELOPMENT PROCESS SUMMARY

The Plan development process is shown in *Figure B-1*, with completed tasks shown in green, current tasks in red (split green/red indicates partial completion), and future work with no colour.

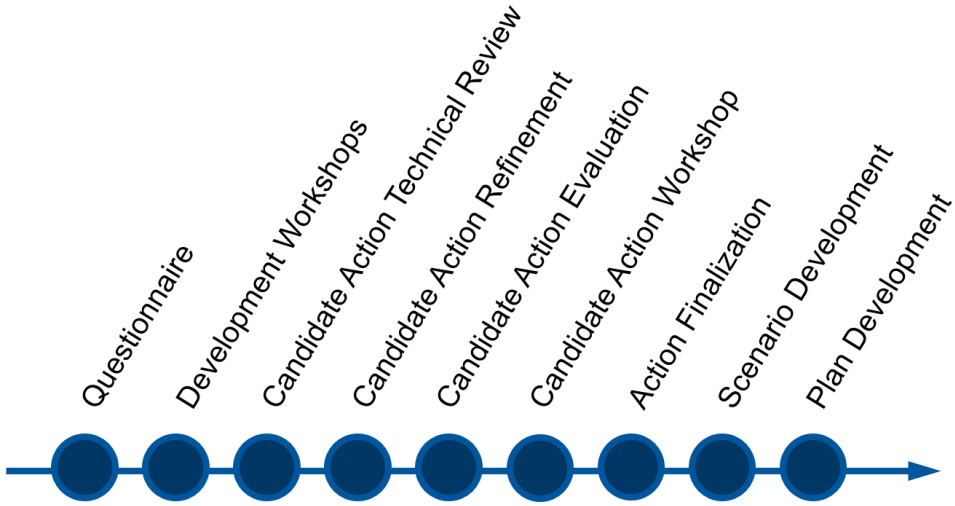


Figure B-1: Carbon Neutral Plan Development Process

The development process was designed to review the current state of emissions reporting and planning to inform the path forward, rather than taking a retrospective view to understand, in detail, past emissions. Through this, the workshops described below, and insights from the consultant a set of candidate implementation actions has been developed and reviewed with Staff. The options and scenario development have also been developed with a triple bottom line plus risk perspective, with the scenario options intended to reflect the RDN's situation and that of BC, particularly given its ample clean electricity supply.

B.1 DEVELOPMENT PROCESS

B.1.1 Workbooks

Ahead of the workshops, RDN staff were asked to complete a Workbook to help them prepare for the workshops and also provide some insights to the consultant team on aspects such as hopes and concerns for the Plan development and outcomes; potential challenges and opportunities; and to better understand guiding principles and values beyond the classic considerations of cost and technology risk.

B.1.2 Development Workshop 1

The first virtual workshop was held with RDN staff from Long Range Planning, Recreational Services, Parks, Arena Services, Aquatic Services, Transportation Services, Water and Wastewater Services, Zero Waste, Purchasing and Engineering Services. The purpose of the workshop was to review, collate, and present the group's feedback from the individual workbook responses. The discussion presented barriers and expectations from Staff for achieving carbon neutrality by 2032. A proposed Vision Statement and Guiding Principles were also presented to Staff and discussed. The RDN's current emissions and a short-

list of technology options under each of the scope categories was also presented. Furthermore, the draft scenarios and multi-criteria analysis framework were presented, discussed and feedback sought.

B.1.3 Development Workshop 2

The second virtual development workshop was held with the same RDN departments as the first, with the objectives to build on the first workshop and gain a deeper understanding of the barriers, challenges and opportunities of moving towards carbon neutrality. Attendees were asked what tools and resources would best support them to undertake the carbon neutral mandate in their work. This was built upon through the co-completion of a SWOT (strengths, weaknesses, opportunities and threats) analysis, as well as a review of potential technology option scenarios. The workshop included two detailed sessions to review how business process is currently used to deliver projects, and what may need to change to successfully deliver projects that support a carbon neutral organization.

B.1.4 Refinement

Following the workshops, the consultant team compiled a long list (70+) of candidate actions that could potentially be taken forward to be implemented as part of the Plan. Each of the candidate actions were initially evaluated by RDN staff for their technical viability.

Based on the comments from RDN staff, the consultant team refined, consolidated and started to categorize the candidate actions into some core themes. The refined list of candidate actions was then distributed to RDN staff for scoring (on a "High, Medium, Low" scale) against measures of 'impact' and 'level of effort' to implement. The combined score, see *Figure B-2*, for the candidate actions was then used to evaluated which actions should be carried forward, with the lowest scoring actions being removed form consideration. In some select cases the consultant team retained some core actions which were deemed foundational, and despite being hard to implement, should be retained.

		Effectiveness		
		Low	Medium	High
Level of Effort	Low	3	6	9
	Medium	2	4	6
	High	1	2	3

Figure B-2: Scoring Matrix for Each Candidate Action

B.1.5 Development Workshop 3

A third virtual workshop was held with RDN Staff to review, collate, and discuss the refined list of candidate actions which has been reduced to about 45 distinct items. The comments and feedback from the different departments were reviewed in aggregate, the intent being to find synergies between departments in the actions under consideration and build consensus around the overall direction being pursued.

The second half of the workshop focussed on the four emissions scenarios that have been developed. Building on the energy and emissions analysis previously completed, the scenarios presented in Scenario Briefs of Appendix A were presented graphically and discussed with Staff.

B.2 IMPLEMENTATION ACTIONS

In consultation with the Energy and Sustainability team at the RDN, the final list of implementation actions presented in *Section 5* were developed, and included the refinements informed by discussions during Workshop #3, and subsequent interviews Jessica Beaubier held with staff from each Department.

B.3 DEPARTMENTAL REPRESENTATION

The following RDN staff were included in the plan development.

Long Range Planning, Sustainability and Energy	
Kim Fowler	Manager, Long Range Planning, Energy and Sustainability
Jessica Beaubier	Coordinator, Climate Change and Resilience
Water and Wastewater	
Sean Depok	Director, Water and Wastewater
Duncan Taylor	Manager, Engineering Services
Community and Recreation	
Dean Banman	Manager, Recreation Services
Mike Chestnut	Superintendent, Aquatic Services
John Marcellus	Superintendent, Arena Services
Parks	
Yann Gagnon	Manager, Parks Services
Fleet and Transit	
Brandon Miller	Superintendent, Fleet and Transit Service Delivery
Solid Waste	
Larry Gardner	Manager, Solid Waste
Jane Hamilton	Superintendent, Landfill Operations
Vivian Schau	Coordinator, Zero Waste
Purchasing	
Kurtis Felker	Manager, Purchasing

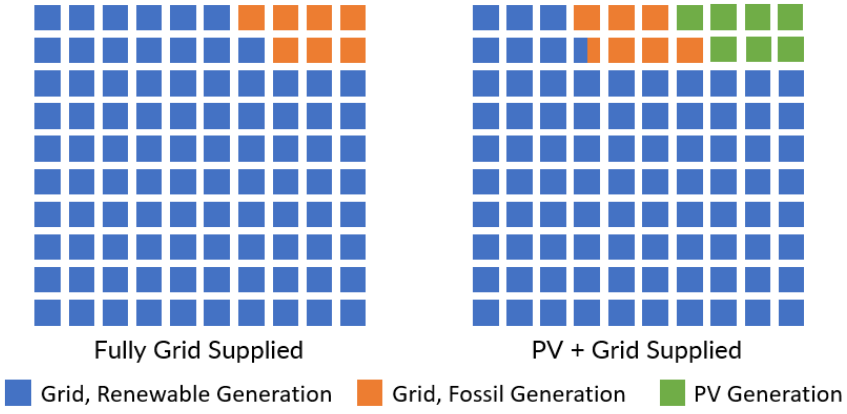
C APPENDIX C: ELECTRICITY GENERATION IN BC & ITS GHG IMPLICATIONS

BC Hydro grid supplied electricity is required by the Clean Energy Act to be at least 93% clean, while in recent years BC Hydro has been producing about 96-98% of its electricity from clean sources[8]. A core consideration for the RDN is whether this fraction is high enough to deem grid-supplied electricity as fully renewable. This consideration is significant since it will heavily influence where the RDN puts its resources in trying to attain net-zero emissions. If grid supplied electricity is deemed 100% renewable it is only facilities' space heating demands that need to be addressed; otherwise the fraction of grid supplied electricity that is non-clean must be addressed (at some point) in addition to space heat.

Looking to the future, under the 2016 Provincial Clean Leadership Plan, BC Hydro is actively moving towards 100% clean or renewable energy by 2025. The Plan does commit to "100 per cent of the supply of electricity acquired by BC Hydro in British Columbia for the integrated grid must be from clean or renewable sources, except where concerns regarding reliability or costs must be addressed."[9] This speaks to electricity acquisition only, not BC Hydro's own assets, and the space for fossil fuels to provide grid reliability is open to interpretation, which is intended to be addressed by BC Hydro's integrated resource planning effort, which is currently underway but not expected to be complete until 2023.

On-Site Energy Generation, Energy and Emissions Accounting Practices

It is important to note how renewable energy and GHG emissions are linked and accounted for at the building scale. BC Hydro supply is by law 93% clean or renewable. So long as a building uses any grid supplied electricity it will have some fossil fuel emission from the 7% of supply that is not renewable. By extension, the only way to go fully 100% renewable is to not use any grid supplied electricity, i.e. use only on-site electricity generation. This is impractical in almost all situations. As such, the City of Vancouver for its net-zero emissions building policy allows buildings to source 7% of their total annual electrical demand



from on-site generation, and be deemed net-zero, or 100% renewable[10].

Figure C-1: Renewable Energy Fraction Accounting Methodology

[8] From StatsCan, Table 25-10-0020-1
[9] Climate Leadership Plan, https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/clp/clp_booklet_web.pdf, p.28
[10] City of Vancouver, Energy Modelling Guidelines, https://vancouver.ca/files/cov/guidelines-energy-modelling.pdf

As shown in *Figure C-1*, the reality is that the 7% on-site generation simply serves to reduce annual energy use by 7%; however, 7% of the remaining energy use still comes from the fossil fuel portion of grid supplied electricity, such that the fossil fuel fraction is reduced to 6.51%, i.e. renewable energy use is only increased by about 0.5%. As much as this is the reality until 100% on-site generation becomes viable (most notably by reducing building energy demand to such a large extent that it can be met through on-site generation), definitions such as that used by the City of Vancouver in their energy modelling guidelines will be required. Under this accounting approach, a building that is deemed 100% renewable may still have GHG emissions associated with it.

The implication of BC Hydro's clean electricity mix is that decarbonization efforts should focus on natural gas use (used for space heating and hot water) since this is where the majority of the facilities' emissions come from. With natural gas use displace by RNG (which is assumed carbon neutral) or electricity in the clean scenarios modelled, the details of how net-zero is defined become material. As described above, so long as a facility uses grid supplied electricity there will be some, no matter how little, GHG emission associated with that supply. Significant effort and money can be spent to tackle the final few percent of emissions reductions that result from this grid fraction, although they cannot be fully eliminated without going "off-grid" (or through the purchase of renewable energy credits or offsets). The marginal cost for such reductions is very large, and has, in real terms, a negligible impact on emissions (7% of annual demand from rooftop PV reduces emissions by approximately 0.5%, as described above). Furthermore, in recent years BC Hydro has been generating electricity at 96-98% clean (not the legally mandated minimum of 93%), so the real emissions impact from the installation of PV is further diminished. The final consideration to be taken in account is the future carbon intensity of the BC grid. It is not unreasonable to assume that grid intensities will remain low with the development of the Site C dam. For the lifetime over which investment decisions are to be made there is little evidence to suggest that BC electricity will become more polluting. BC Hydro is currently developing its Integrated Resource Plan (IRP) that will outline the future of the provincial electrical grid, however it is not due for release until 2023.