Building Carbon Neutral Portfolios with Energy Planning Tools

Jeanie Chan[1], Calum Thompson[2], Austin Gallagher[1], Craig Trischuk[1], Anoja Wijayasri[1]
[1]AECOM Canada Ltd., Canada
[2]AECOM, Orange, USA

Abstract

The Government of Canada is committed to reducing greenhouse gas (GHG) emissions by 90% below 2005 levels by 2050. Government entities are undertaking strategic evaluations of their portfolios to determine the most cost-effective pathway to achieve low-carbon operations.

We have developed an energy planning analytics platform (Rosetta) to perform portfolio-wide energy/GHG evaluations. The platform uses prototype energy models to represent each building, and calibrates each model based on utility bills and building operation/condition surveys. After calibration, it estimates the energy/GHG savings and performs a life-cycle cost analysis for each proposed measure.

Rosetta was used for a Carbon Neutral Study involving a portfolio of 120+ buildings across Canada. The portfolio consists of mostly aging inspections stations and lab type buildings. Rosetta quantifies the potential for GHG reduction strategies across the portfolio to develop a clear and tangible roadmap to a carbon neutral portfolio by 2050. Potential strategies cover a wide variety of physical, operational, and policy interventions.

Introduction

The federal government introduced its first Greening Government Strategy (GGS) in 2017. In 2020, it was made a Government of Canada Directive. The GGS's emission goals are more ambitious than the Paris Agreement targets as they commit to reducing emissions from government operations by 40% below 2005 levels by 2025 and by at least 90% below 2005 levels by 2050 (with an aspirational goal of reaching carbon neutrality). On this emission reduction pathway, the government will aspire to reduce emissions by an additional 10% every 5 years starting in 2025.

Government entities are undertaking strategic evaluations of their portfolios to determine the most cost-effective pathway to achieve low-carbon or net zero carbon operations. Net zero means reducing GHG emissions from operations to as close to zero as possible and then balancing out any remaining emissions with an equivalent amount of carbon removal or credits (Government of Canada, 2021).

There are variety of different tools that support energy or carbon master planning. Ferrari et al. (2019) have done an assessment of tools for urban energy planning. They have performed a scientific review of 17 tools targeted on an urban/districts scale that can evaluate several energy services, sources and/or technologies. Among them, 6 tools were identified (energyPRO, HOMER, iHOGA, EnergyPLAN, SIREN, WebOpt) that can provide hourly energy calculations and can be considered as viable for widespread use

Hukkalainen et al. (2017) has developed a methodology, embedded to a tool called Kurke, that aims to support the planning of sustainable and energy efficient urban areas by analysing the energy performance of city plans and the impacts of their energy design alternatives on carbon dioxide emissions during planning.

Liesen et al. (2015) have developed a net zero planner software (NZP tool), which uses the building energy simulation software, EnergyPlus. The NZP tool provides energy planners with the capability to create optimized plans to meet net zero energy goals by reducing overall energy use, using renewable energy sources, reducing GHG emissions, estimating costs, and evaluating risks.

Kılkış (2014) has developed the Rational Exergy Management Model (REMM), which provides an analytical model to curb primary energy spending and CO_2 emissions by means of considering the level of match between the grade/quality of energy resources (exergy) on the supply and demand sides.

We have developed an energy planning analytics platform (Rosetta) to perform portfolio-wide energy/GHG evaluations. The platform uses prototype energy models to represent each building, and calibrates each model based on utility bills and building operation/condition surveys. After calibration, it estimates the energy/GHG savings and performs a life-cycle cost analysis for each proposed measure. With this information, we are able to create an Energy/Carbon Master Plan.

Methodology

Rosetta is a methodology – a combination of a web-based analytics platform, workshops, gameboarding, and the ideas of many experienced professionals – that results in a consensus-built roadmap to achieve energy performance goals. The analytics platform uses parametric (industry benchmarks and simulated); audited (from inspection of the site); and real utility data to model future scenarios.

The methodology first performs a strategic portfolio assessment of the existing buildings, then it evaluates energy or GHG reduction opportunities in terms of energy, GHG, and financial implications. Finally, the results inform the creation of an Energy/Carbon Master Plan.

Strategic Portfolio Assessment

A strategic plan must be built on a solid foundation, which in turn begins with first assessing energy use intensity and size for each identified facility typology.

The data collection process enables our team to better understand the performance of the existing facility portfolio, and all energy consuming and producing assets. The first step is to acquire a general understanding of the makeup and current state of the buildings in the portfolio. Building information documents (e.g., site maps, building condition reports, previous energy studies, etc.) and utility data for the last few years are requested for each building or site. This information is used to pre-populate the Energy Performance Spectrum survey.

Energy managers are then asked to confirm or update the Energy Performance Spectrum survey to identify the current performance level for each building type at their site. This information is used to calibrate prototypical energy models for each building. The energy performance spectrum classifies common building systems such as envelope, lighting, heating, ventilation, and air conditioning (HVAC) equipment and control systems on a four-point technology spectrum, starting with one serving as the lowest level of performance and four as the highest level of performance.

Energy Model Creation and Calibration

The backbone of Rosetta are energy models of commercial reference and prototype buildings (US Department of Energy, 2022) developed by the U.S. Department of Energy (DOE), which are used as base models for calibration. There are 16 building types that represent approximately 70% of the commercial buildings in the U.S. These models take into consideration building age and the building code requirements at the time of construction or renovation. Rosetta also allows the integration of prototype models from other sources or even custom models for the project when there are no DOE models for that building type (e.g., laboratory).

Based on the building type, age, operation schedule, and climate zone of the actual building, a reference or prototype building is modified and simulated using a current weather file that is representative for the building's climate zone. The simulation generates the typical annual energy use per end-use (e.g., heating, cooling, lighting, etc.) for that type of building. Additional adjustments may be made based on distinct building features as shown in the Energy Performance Spectrum survey and/or Building Condition Reports. The simulation results of the prototype models are then used as a basis for calibration. Based on the answers to the building conditions survey and other available information, the energy per end-use is calibrated to represent the condition and energy consumption of the actual building.

The calibration process first matched each building with its respective prototype building. The end-use results from the prototype models were provided as Energy Unit Intensity (EUI) for each energy type (i.e., electricity, natural gas). Using EUI allows for a comparison between buildings of different areas. Then using the annual consumption from each building based off their utility bills, each end-use EUI was scaled proportionally based on the difference between the prototype energy model EUI and actual utility bill EUI. Once the model EUI was within +/- 10% of the billing EUI, the model was considered calibrated.

The resulting insight allows decision makers to understand how the buildings are performing with not only a qualitative assessment but a quantifiable gap analysis of the anticipated performance against currently identified goals. We use this phase to set our baseline and benchmark against best practices.

GHG Reduction Opportunities Evaluation

Based on the calibrated model, Rosetta generates thousands of energy/GHG reduction measures across a campus or facility portfolio. Our in-house technical experts review this initial data set and based upon the insight gained through conversations with the local facility team and available documentation, they identify those that show most potential. This filtered list is then tested against several scenarios developed based upon the goals, with the goal being to balance performance with the financial constraints, to create a balanced, prioritized roadmap that will optimize the long-term energy performance.

Exploring energy conservation, generation, storage and smart strategies, the Rosetta methodology gives comprehensive insight into how and where energy strategies could be deployed. Rosetta is used to evaluate the proposed measures and estimate their energy and GHG savings. While the scenarios are typically developed in collaboration with the client stakeholders, scenarios that are often evaluated include:

- Maximize energy performance and achieve energy goals in a particular timeline
- Maximize energy system resiliency
- Minimize carbon footprint
- Maximize energy performance within financial constraints of existing maintenance budget
- Maximize energy cost reduction

Financial Analysis

Life-cycle cost analysis (LCCA) and other financial analyses are performed for each proposed measure. The analysis will consider the opportunities, limitations and costs associated with each measure, in particular: implementation cost, net-present value, energy cost savings, simple payback period, capital cost per GHG saved, and shadow carbon pricing.

Energy or Carbon Master Plan

This final phase of the process starts with a step that is often missed – the validation that the goals are still appropriate, aligned, and achievable. With the insight gained during the

previous phase, we can inform stakeholders the information required to make informed decisions and, where necessary, refine the goals relating to long term energy and GHG performance.

Having ensured that the goals are right sized and aligned with the broader mission, we develop a draft energy/GHG deployment plan that identifies what energy projects should be implemented and what strategies should be followed; in which facilities; and in what timeframe.

Results

Rosetta was used for a Carbon Neutral Study involving a portfolio of 120+ buildings across 16 sites in Canada. The portfolio (Table 1) consists of mostly aging inspection stations and lab type buildings. The laboratories have high process loads such as incineration and waste decontamination. 80% of the buildings were built more than 25 years ago and almost 50% are deemed to be in poor or critical condition.

Table 1. Summary of Site Locations & Building Types

Site	Province	Primary Building Type
A	Newfoundland	Vehicle Inspection Station
B	British Columbia	Laboratory
C	Alberta	Laboratory
D	Prince Edward Island	Laboratory
E	Nova Scotia	Laboratory
F	British Columbia	Animal Inspection Station
G	British Columbia	Animal Inspection Station
H	Quebec	Animal Inspection Station
I	Alberta	Laboratory
J	Saskatchewan	Animal Inspection Station
K	Ontario	Laboratory
L	Newfoundland	Vehicle Inspection Station
M	Saskatchewan	Laboratory
N	British Columbia	Laboratory
O	Quebec	Laboratory
P	New Brunswick	Animal Inspection Station

The client is looking to identify and quantify the potential for GHG reduction strategies across its portfolio, building upon previous assessments, to develop a clear and tangible roadmap to a carbon neutral portfolio by 2050.

The portfolio-wide assessment leverages Rosetta to quantify the potential cost and GHG savings for GHG reduction measures. It also looks at local resources and available space for on-site generation opportunities. The assessment will analyse GHG reduction opportunities (by site and province) and identify opportunities to reach a carbon neutral portfolio by 2050. The assessment considers projected changes to the carbon intensity of provincial electricity grids.

Strategic Portfolio Assessment

Based on recent utility data and the provided emission factors, a current GHG assessment is performed to determine the current GHG emissions of the portfolio. This serves as a baseline to evaluate the impact of the proposed GHG reduction strategies. As of year 2020, the portfolio is currently responsible for approximately 15,540 tonnes of eCO_2 annually based on the current state of the buildings. The average GHG intensity of the portfolio is 0.19 tonnes of eCO_2 per m^2.

Laboratories produce the highest (96%) GHG emissions in the portfolio. Inspection stations and other building types make up the remaining 4%. Laboratory type buildings have a high energy consumption (and resulting GHG emissions) due to high ventilation requirements, process loads, and operating schedule. Therefore, GHG reduction opportunities targeted at laboratories will likely provide the best result.

Figure 1 shows the total GHG emissions broken down by fuel source. The dominant fuel source for the portfolio is natural gas, producing 59.7% of the total GHG emissions, followed by electricity which produces 32.3%, and light fuel oil at 4.3%.

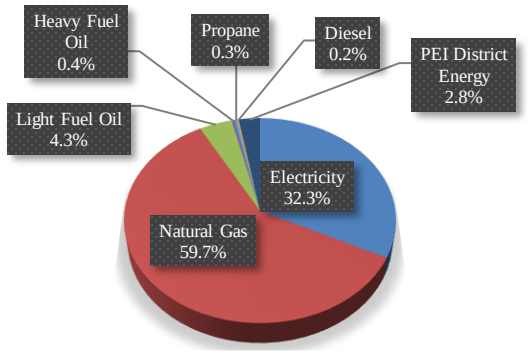

Figure 1. Portfolio GHG Emissions Breakdown by Fuel Source

There are two major factors that result in natural gas being the dominant fuel source:

- Most buildings use natural gas for heating, which is the dominant energy consumer for buildings in cold climates such as Canada.
- The GHG emission factor for natural gas is high throughout Canada (i.e. 177-187 grams eCO_2 per kWh).

This implies that measures that lower the building's heating load can have a significant impact. Furthermore, in locations where the electricity GHG emission factor is lower than the natural gas factor, fuel switching measures (e.g., replacing a gas boiler with a heat pump system) would dramatically decrease GHG emissions.

Figure 2 shows the energy breakdown by end-use of the calibrated energy models by site. As expected, heating energy is the highest energy consumer for most the sites due to the cold climate across Canada. Process loads are also significant in some laboratory sites.

Site A and L, which are vehicle inspection stations, have a high percentage of heating energy (>75%) due to their 24/7 operation schedule and the frequent opening of the main bays; this allows the heat to escape and significantly

increases the amount of fuel used for heating. Conversely, site F, G and P sites, which are animal inspection sites, have a low percentage of electric heating energy (<40%) because they have a low setpoint of 10°C in the animal inspection areas and the offices have temperature setbacks when they are unoccupied. Furthermore, these animal inspection sites are typically only occupied during August-October. Laboratories have a high usage of fans due to high ventilation requirements and high process energy due to their specialty equipment use.

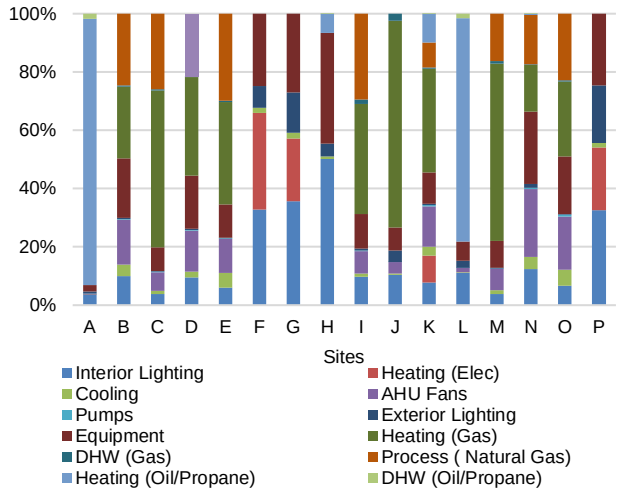

Figure 2. End-Use Energy Proportions per Site

Commodity Analysis

Choosing the right fuel source plays a key role in achieving carbon neutral at each site. Utility rates and GHG emission factors vary across fuel sources and provinces. The utility rates used in this analysis are blended (i.e., demand and consumption) utility rates as determined by the provided utility bills from year 2020.

Natural gas is the most used commodity by the portfolio. This is because most buildings use natural gas for heating, which is the dominant energy consumer for buildings in cold climates such as Canada. The utility rates for natural gas ($0.01-$0.04 per kWh) vary by geography, primarily due to tax and subsidy rates and proximity to supply lines. Natural gas is produced in Canada and is readily available, resulting in it being one of the cheapest fuel sources. It has a relatively high GHG emission factor (i.e., 177-187 grams of eCO_2 per kWh). In most provinces, electricity is a cleaner fuel source than natural gas, except for Nova Scotia and Alberta.

Electricity is the second most used commodity in the portfolio. In buildings, it is mostly used by non-heating end-uses (e.g., space cooling, fans, lighting, equipment) Electricity rates vary across geographies due to providers having a different mix of generation sources (e.g., nuclear, hydro, coal, natural gas, renewables, etc.). Pricing varies from $0.06-$0.19 per kWh.

GHG Emission rates from electricity generation are generally lower than natural gas, however, electricity is significantly more expensive than natural gas in Canada. This is a major factor to why there is such reluctance to switch to electricity as a fuel source for heating. Shadow carbon pricing provides additional incentive to fuel switch in provinces with low GHG emission factors for electricity. Like electricity rates, GHG emission factors also vary across geographies due to a mix of different generation sources. GHG Emission factors vary from 1-647 grams of eCO_2 per kWh. Figure 3 shows the current and future projections of electricity GHG emission factors by province (as provided by the client) until year 2040. It is important to note that this is a forecast and actual electrical grid GHG emissions reduction will be dependent on conversion of the existing power plants to cleaner technologies. The projections are accounted for in the analysis.

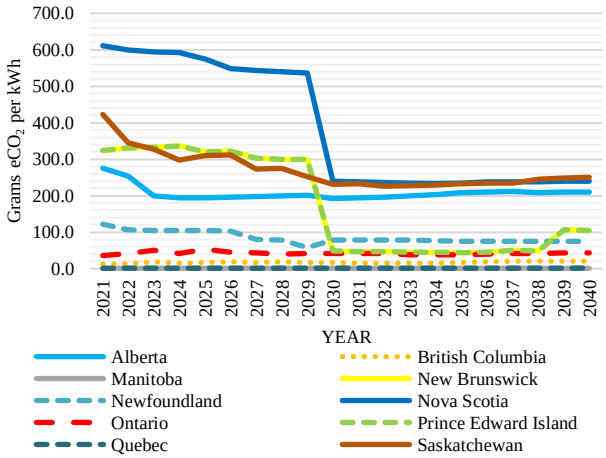

Figure 3. Current and Future Projection of Electricity GHG Emission Factors by Province

Light fuel oil, heavy fuel oil, and propane are used for heating or process equipment in some provinces where natural gas is not as readily available. Light fuel oil, heavy fuel oil, and propane costs $0.03-$0.07 per kWh, $0.11 per kWh, and $0.11-$0.17 per kWh, respectively. Light fuel oil, heavy fuel oil, and propane have GHG emission factors of 271 grams of eCO_2 per kWh, 274 grams of eCO_2 per kWh and propane has a factor 218 grams of eCO_2 per kWh, respectively.

PEI District Energy is only used by the Charlottetown Laboratory site for heating. Hot water is provided by the company. The district energy plant converts municipal solid waste and biomass (scrap wood from forest harvesting operations) to energy. It costs $0.08 per kWh. An exact GHG emission factor was not available from PEI Energy. As per (Enwave, 2019), an average of all Enwave plants throughout Canada and the United States (166 grams of eCO_2 per kWh) was used instead.

GHG Reduction Opportunities

From an operational carbon perspective, the goal is to first reduce GHG from building operations and generate energy via renewable energy sources or purchase carbon offsets to

make up for the remaining carbon emissions. The following approaches were considered and applied to develop a Carbon Neutral Plan for the portfolio.

- Carbon Management
- Grid Decarbonization
- Energy Demand Reduction
- HVAC Upgrades & Fuel Switching
- Renewables
- Clean Energy Procurement

Table 2 shows emission reduction measures (ERM) that were investigated in this study. Measures were chosen based on their ability to reduce GHG, as well as feasibility, cost-effectiveness, availability, and ease of implementation.

Table 2. GHG Reduction Measures

No.	Measure Name	Description	Plan*
ERM-1	Interior Lighting Efficiency	Upgrade to LEDs	ST
ERM-2	Interior Lighting Controls	Daylight and occupancy sensors	ST
ERM-3	Retro-Commissioning	Re-commission equipment	ST
ERM-4	Energy Management Control System	Smart control	ST
ERM-5	Variable Frequency Drives (VFDs)	Install VFDs	ST
ERM-6	Envelope Sealing Improvements	Envelope sealing and door weather-stripping	ST
ERM-7	Domestic Hot Water (DHW) Boiler Replacement	Increased efficiency	LT
ERM-8	Heating System Upgrade	Increased efficiency	LT
ERM-9	Chiller/Package Unit Replacement	Increased efficiency	LT
ERM-10	Wall & Roof Insulation	Upgrade to code standards	ST
ERM-11	Solar Thermal DHW	Install solar DHW system	ST
ERM-12	Exterior Building Lighting	Upgrade to LEDs	ST
ERM-13	Solar Wall	To preheat outdoor air	ST
ERM-14	Upgrade Fenestration	Upgrade to code standards	ST
ERM-15	Duct/Pipe Sealing and Insulation	Repair and/or upgrade to code standards	ST
ERM-16	Upgrade to Heat Pump (Heating)	Increased efficiency and fuel switch	LT
ERM-17	Upgrade to Heat Pump (DHW)	Increased efficiency and fuel switch	LT
ERM-18	Electric Boilers for Process Loads	Increased efficiency and fuel switch	LT
ERM-19	Photovoltaic (PV) Panels	Install PV	ST

*ST=Short Term, LT=Long Term

In the Carbon Neutral Plan, the ERMs are implemented in a phased approach. Short term measures are implemented immediately, whereas long term measures are implemented in the next 10-20 years. For this analysis, the target year of 2036 is used for long term measures. Measures that cause minimal disturbance to building operation and are relatively cost-effective are implemented in the short term. Conversely, more disruptive and expensive measures (e.g., fuel switching, HVAC plant upgrades) are implemented in the long term when existing equipment is due for replacement.

Measures were applied to sites – where appropriate – based on the Energy Performance Spectrum survey. For example, if there no cooling, a chiller replacement would not be implemented. Fuel switching measures are applied to all sites (where possible) to prepare for the eventual decarbonized electricity supply. Other considerations include replacement schedules, project implementation and construction time, GHG savings, and financial metrics.

The ERMs above assumed an upgrade to the most energy efficient option (i.e., upgrade to triple pane windows). The affect each ERM had on each building was based on the building condition surveys. If the difference between the current technology in the building was much different than the most energy efficient option, greater savings would be achieved. For example, a building noted with only single pane windows would have a greater energy savings upgrading to triple pane then a building already noted to have double pane windows. For the window scenario, the energy improvement is based insulation value difference.

GHG Reduction Strategies Performance

Figure 4 show the GHG savings for each ERM. Upgrade to Electric Heat Pump (Heating), Upgrade Process Boilers to Electric, and PV Panels achieve the highest GHG savings. This is because it impacts heating and process loads, which are the highest energy consumers. PV Panels achieve high savings because they are generating a significant amount of electricity across the sites. Lighting efficiency, retro-commissioning, EMCS, and duct/pipe sealing/insulation also achieve significant energy and GHG savings. Envelope measures have a minor impact since most of the portfolio consists of laboratories, which have high ventilation rates. This means that heat loss from ventilation is much higher than heat loss from the envelope; therefore, envelope improvements will have smaller impact on heating energy.

Upgrade Process Boilers and PV Panels achieve the highest GHG savings. Upgrading Process Boilers and the heat pump options greatly increases the energy cost because the fuel source is switched from fossil-fuel to electricity. Electricity rates are typically higher than fossil-fuel rates. However, there are benefits to electrification for these sites such as reducing the shadow carbon pricing (in some provinces) and preparing the building for net-zero as renewables are implemented and the electricity grid decarbonizes over the next few decades.

Other measures achieve energy cost savings since there is no fuel switching involved. Notice that ERM-8 and ERM-9

was not recommended for any sites and therefore, there are no GHG savings. Electric heat pump measures were recommended instead as they are an efficient way of preparing the sites for a decarbonized electricity grid.

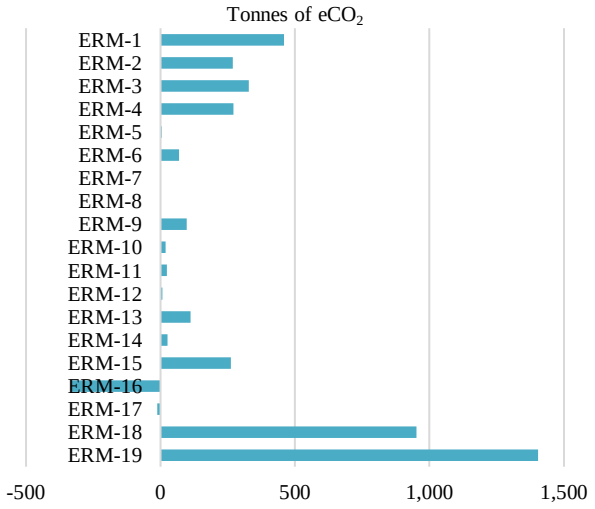

Figure 4. Annual GHG Savings per Measure

Figure 5 shows the most cost-effective measures (i.e., between -10 and 350 simple payback years). The size of the bubbles represents their GHG emission reduction potential. ERM-2 and ERM-19 have the lowest simple payback. ERM-12 has the lowest capital cost.

Some measures (ERM-16/17/18, not shown in Figure 5) have a negative simple payback and will never pay back since there are no savings to justify the capital costs if only energy savings are considered. These negative payback measures, however, will still reduce GHG emissions. Switching from current cost-effective fuel utilities to electricity will increase energy efficiency but not cost savings. Switching to electricity although more expensive, may provide additional financial benefits if other costs such as maintenance, replacement, and shadow carbon pricing are considered in a LCCA.

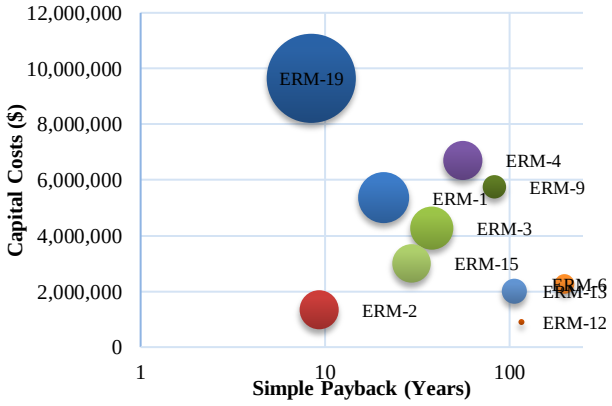

Figure 5. Financial Implications and GHG Reduction Potential of Cost-Effective Measures

Costs per square foot for each of the ERMs were developed for this analysis. These capital costs are either full capital costs or incremental costs. Incremental costs are used for ERMs that involve replacing existing mechanical systems and are defined as the additional cost rather than just replacing the current mechanical system with an in-kind model. Due to the mechanical systems requiring end of life replacements, the incremental cost considers the additional cost beyond just the regular replacement to upgrade to more high efficiency option. By using incremental costs, we recommend that the ERM upgrades are completed when the existing mechanical equipment requires end-of-life replacement. The ERMs that use incremental costs are ERM 7, 8, 9, 16, and 17.

It should be noted that switching fundamental energy systems from traditional boilers to heat pump options are expensive endeavours for existing buildings. The heat pump options are estimated to be 11 times more expensive compared to subbing out a typical fuel boiler for an electric boiler equivalent (if the fuel switch is still desired). However, heat pumps have the potential to be much more energy efficient and good investments in the long run given that the price of carbon in Canada is rising.

GHG Reductions by Site

Figure 6 show the GHG reduction potential by site. Site K has the highest savings, followed by site O and B. This is to be expected since the electricity GHG emission factor is relatively low for those sites. Conversely, for sites like E, C, I, D, and C, high energy savings do not translate to high GHG savings due to the "dirty" electricity grid at those sites.

Figure 7, Figure 8, and Figure 9 show the financial implications of the measure by site. Sites that have negative simple payback will never pay back (if only capital cost and energy cost savings are considered) due to a negative energy cost savings. The negative energy cost savings are mostly due to fuel switching measures. Particularly where it costs more to operate the heat pump or electric boiler using the more expensive utility (electricity). It will, however, produce high GHG savings in most cases. Site L and H have the lowest simple positive payback. These two sites are in provinces with an electricity rate that is approximately double when compared to the fossil fuel rates. For these sites, fuel switching, as well as other measures, are cost-effective. In other provinces, the gap between fossil fuel and electricity rates are much higher. In some provinces, fuel switching does not cause a large amount of GHG savings due to the grid being about as clean as burning natural gas.

The ΔNPV is the incremental net present value (NPV) of the recommended measures. The energy cost and shadow carbon pricing savings are positive in the calculation and any incremental capital, maintenance, and replacement costs are negative. Once the ΔNPV goes from negative to positive, that means payback is achieved and the measures are a cost-effective within the analysis period. No site has

achieved positive ΔNPV within the analysis period (i.e., 40 years). The discount rate, inflation rate, and utility escalation rate were set as 2.0%, 1.9%, and 3.0%, respectively, in this 40-year analysis.

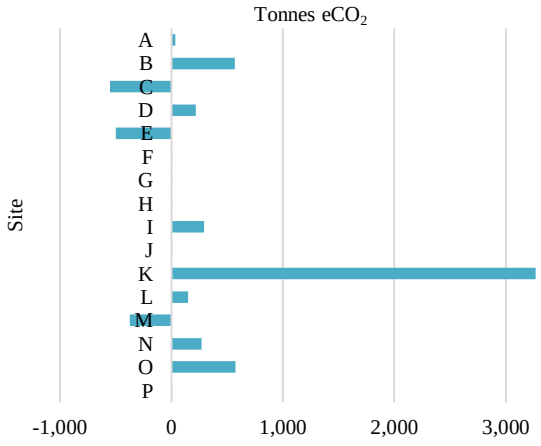

Figure 6. Annual GHG Savings per Site

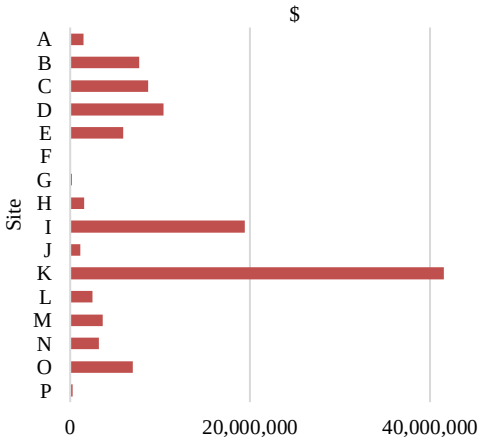

Figure 7. Capital Cost per Site

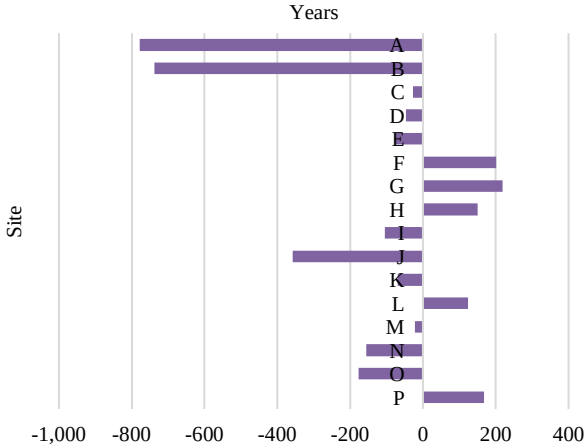

Figure 8. Simple Payback per Site

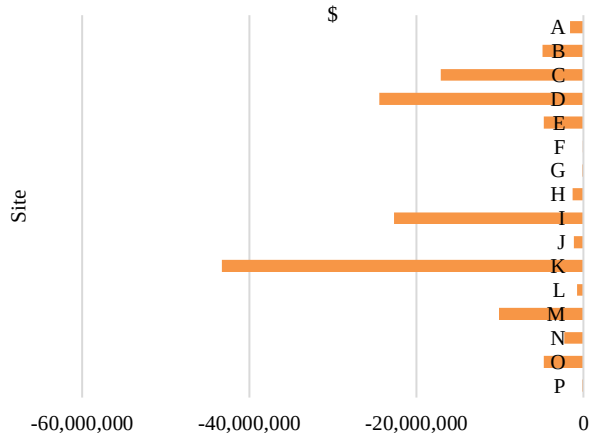

Figure 9. ΔNPV per Site

The estimated capital costs are conservative due to the fact older laboratories are a main component of this portfolio, and historically require more dollars per square foot then other building categories. Due to the high-level nature of this study, a more accurate analysis on a heat pump upgrade on just one of the existing laboratories should give a better idea of how much capital would be required to make this change. It would be suggested to complete this exercise on one of the labs showing a ΔNPV that has a positive slope, which means it would eventually pay back. For example, sites located in British Columbia, where the electricity grid is almost carbon neutral, would give a stronger business case due to the large savings in shadow carbon tax pricing.

Carbon Neutral Plan

Figure 10 shows the estimated GHG emissions of the following scenarios. The "Do Nothing" trendline shows the annual GHG emissions of the portfolio if no action is taken, and the electricity grid is not decarbonized. The "Greening of the Electricity Grid" trendline shows the impact of grid decarbonization alone, with no actions taken. Grid projections up to year 2040 are used in this analysis; after 2040, the emissions factors are assumed to be constant.

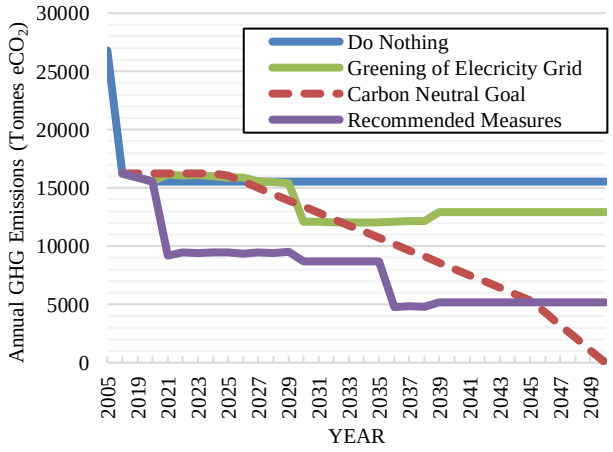

Figure 10. Carbon Neutral Plan – GHG Emissions

The "Carbon Neutral Goal" trendline shows the target annual GHG emissions of the portfolio if it wants to meet Canada's current Carbon Neutral goals (i.e., 40% below 2005 levels by 2025 and by at least 90% below 2005 levels by 2050) and carbon neutral by 2050. The "Recommended Measures" scenario represents the GHG emissions if the ERMs are implemented in a phased approach. Short term measures are implemented immediately, whereas long term measures are implemented in the next 10-15 years. In this analysis, the target year of 2036 is used.

Figure 11 shows the GHG impact of the recommended measures by category at different years. The 2005 Baseline is the GHG emissions of all sites at year 2005. Based on recent utility data, the GHG emissions have drop by 42% at year 2020. Short-term measures will drop the GHG by another 24% and long-term measures will drop another 16%. Once the long-term measures are applied, all the sites will be fully electrified. Between 2036 and 2050, there is a slight net increase in the electricity GHG emissions factors; therefore, GHG emissions are increased by 2% by 2050. Finally, at year 2050, there is 20% of the total GHG emissions remaining. Due to the high ventilation and process load requirements of the labs in this portfolio, it is difficult to decrease the GHG emissions related to building demands any further without changing the usage of the buildings.

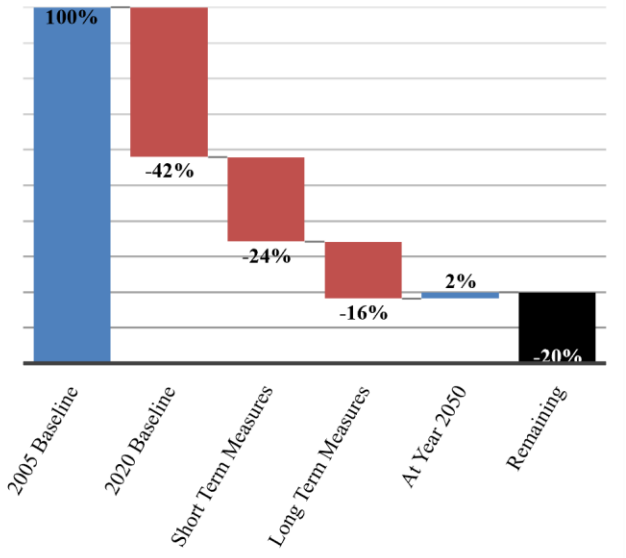

Figure 11. Carbon Neutral Plan – GHG Reduction Waterfall

The remaining GHG emissions can be reduced by investigating and implementing deep retrofits for the laboratories as they have the highest GHG emissions. Other methods of reducing GHG include wind turbines (where feasible), switching to renewable natural gas or biogas (where feasible), purchasing unbundled renewable electricity certificates (RECs), power purchase agreements (PPAs) and other renewable power instruments that allow the purchaser to claim the environmental benefit of off-site renewable energy.

The client plans to purchase 100% clean electricity for all their sites by 2022. If that is accomplished, it would eliminate the remaining GHG emissions caused by the portfolio by 2050 since all building systems would be electrified.

Conclusion

In this paper, the Rosetta methodology has been used successfully to perform a strategic evaluation of a building portfolio. Namely, it has been used for a Carbon Neutral Study involving a portfolio of 120+ buildings across Canada. The portfolio consists of mostly aging inspections stations and lab type buildings. Rosetta quantified the potential for GHG reduction strategies across the portfolio to develop a clear and tangible roadmap to a carbon neutral portfolio by 2050.

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