Toronto and Region Conservation Authority

Region of Peel
working with you

Prioritizing Existing Buildings for GHG Emissions Reductions

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This report was prepared by Toronto Region and Conservation Authority. The data, analysis and information presented in this report were a product of a collaborative effort with the following stakeholders:

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Executive Summary

Climate change is one of the greatest challenges facing society. There is overwhelming evidence that climate change is having an increasingly negative impact on the environmental, economic, and social conditions of our communities. To mitigate and adapt to the effects of climate change, the Region of Peel (RoP) is preparing its Climate Change Master Plan for the organization. In its 2011 Climate Change Strategy, RoP committed to achieve an 80% reduction in greenhouse gas (GHG) emissions below 1990 levels by 2050; however, in the 2018 report released by the Intergovernmental Panel on Climate Change (IPCC) global net human-caused emissions will need to be net zero by 2050 in efforts to keep the global average temperature increase lower than 1.5 °C from pre-industrial levels[1]. Keeping in line with this trajectory, the Climate Change Master Plan is proposing an interim target for RoP to achieve a 45% reduction in GHG emissions below 2010 levels by 2030.

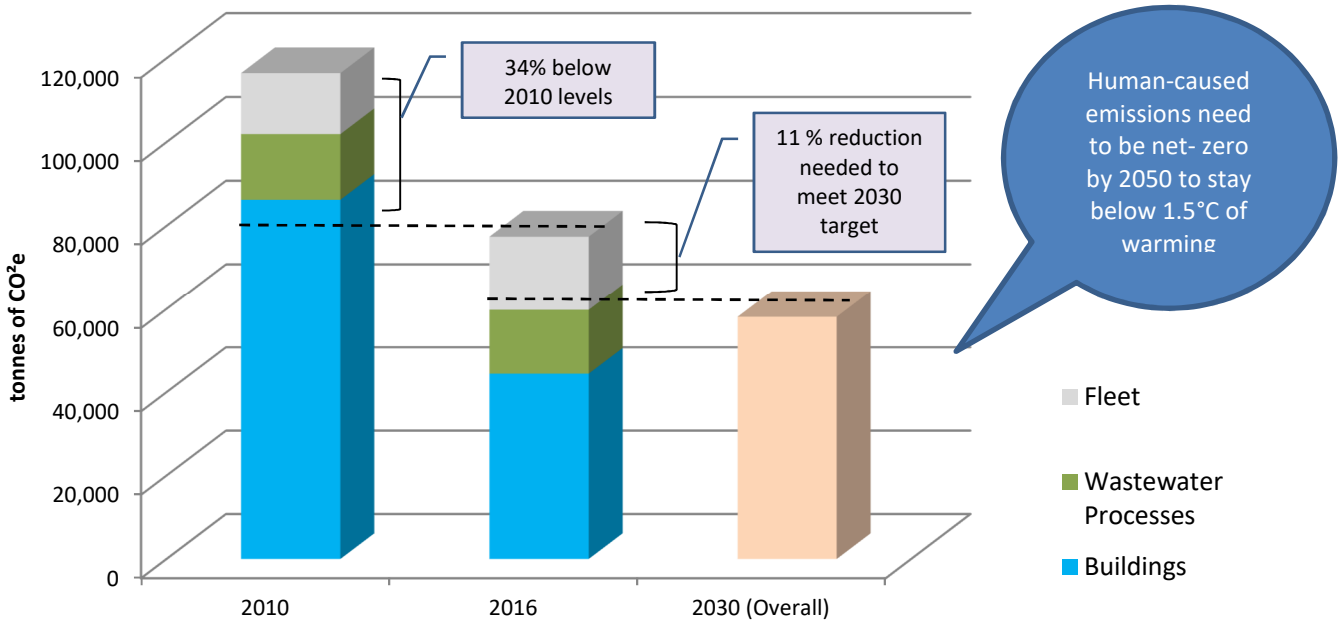

Figure 1 Region of Peel 2010 GHG emissions baseline, 2016 inventory[2], and interim 2030 target

In 2016, corporate GHG emissions were 34% below the 2010 baseline (Figure 1). Building emissions, attributed to energy use for heating, cooling, lighting, and other miscellaneous loads, accounted for 57% of the 2016 corporate inventory.

[1] Global Warming of 1.5°C, an IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. - https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/

[2] 'Buildings' includes streetlights which accounts for only 0.7% of building emissions, Fleet emissions includes employee commuting for work related purposes

This report summarizes the analysis completed by Toronto and Region Conservation Authority (TRCA) on 106 Region of Peel buildings to accomplish the following objectives.

1. Benchmark the corporate building portfolio's energy performance against an external dataset of comparable facilities;
2. Establish realistic energy performance targets and the *GHG Emissions Reduction Potential* for each building using the Performance Based Conservation methodology;
3. Analyze capital planning data and identify the allocated budget and timing for energy related capital expenditures across the building portfolio;
4. Propose a strategy, create a high-level implementation plan, and develop useful tools for how the Region of Peel can meet the proposed 2030 corporate GHG emissions reduction target of 45% below 2010 levels; and
5. outline an energy performance and GHG emissions reduction monitoring framework that can be used to continuously track and guide progress toward targets.

To accomplish these objectives, TRCA benchmarked the actual 2016 energy use intensities (EUIs)[3] of RoP buildings with an external database of similar use facilities and analyzed the 2018 capital planning data from 2019 to 2029. 106 buildings were included in the analysis from the following corporate divisions: *Long Term Care, Peel Living, Corporate Headquarters, Operations and Yards, Peel Art Gallery, Museum, and Archives, Police, Regional Housing, Paramedic Services, and Ontario Works facilities.*

Four key findings and recommendations are presented in the report:

1. The Region should strive to enhance the energy performance of all buildings but prioritize efforts in accordance with the classification system put forward in this report. If all 47 'A' and 'B' classified buildings achieve 'Top Performer' energy use targets, the Region can achieve a 4.9% decrease in emissions below 2010 levels. This represents 92% of the total *GHG Emissions Reduction Potential* of all 106 buildings included in the analysis.

2. In order to achieve the proposed 2030 corporate GHG emissions reduction target a number of buildings will have to dramatically reduce their carbon emissions over and above what can be achieved through energy conservation and efficiency measures alone. In total there are 42 buildings that would still be significant GHG[4] emitters even after achieving 'Top Performer' energy use targets. It is highly unlikely that fuel switching, and low carbon technologies will be feasible in all of these 'LC1' and 'LC2' classified buildings; however, if all 42 buildings could achieve carbon neutrality, it would result in an 11% decrease in emissions below 2010 levels.

[3] Energy Use Intensity (EUI) - Annual energy use per unit of gross floor area *(ekWh / ft2)*; this includes electricity and natural gas use

[4] *>150 tonnes eCO_2 annually*

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3. Between 2019 and 2029, capital planning data suggests the Region plans to spend REDACTED on energy related building systems and processes. This includes capital allocated to state of good repair (SoGR) work related to building envelope, heating, cooling and ventilation (HVAC), lighting and electrical, and operations and maintenance. RoP should conduct annual reviews of planned energy related SoGR work and systematically consider energy performance and GHG reductions when staging and specifying capital replacement and upgrade projects to maximize lifecycle economic and environmental returns over the next decade.

4. The Region is encouraged to collaborate with TRCA to build on its energy performance monitoring and reporting program. TRCA is offering to support the Region by annually updating the benchmarking, metrics, and tools developed in this report, provide insights into specific building systems that warrant the exploration of energy conservation opportunities, and support the roll-out of an energy performance recognition program.

It is important to stress this analysis is a prioritization exercise. It presents a data driven strategy to maximize the Region's impact by focusing efforts and resources on a manageable amount of high-value and high GHG-emitting buildings. It uses evidence to quantify a building's 'potential' savings and makes systematic recommendations for management and leadership to determine next steps on how best to achieve these potential savings in prioritized facilities. It is meant to inform the development of the Region's Climate Change Master Plan, which is targeted for completion by November 2019, and the Energy Conservation and Demand Management Plan, which was submitted to the Ministry of Energy, Northern Development and Mines by July 2019.

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Overview of Corporate GHG Emissions for the Region of Peel

In the 2011 Climate Change Strategy, the Region of Peel committed to achieving an 80% reduction in GHG emissions below 1990 levels by 2050. As a 2030 outcome of the Climate Change Master Plan, the Region of Peel is proposing an interim target of a 45% reduction in GHG emissions below 2010 levels. In 2016, corporate GHG emissions were 34% below 2010 levels (Figure 2), leaving an additional 11% reduction, or 13,365 tonnes of carbon dioxide equivalent (t CO_2e), in order to achieve the proposed 2030 corporate target.

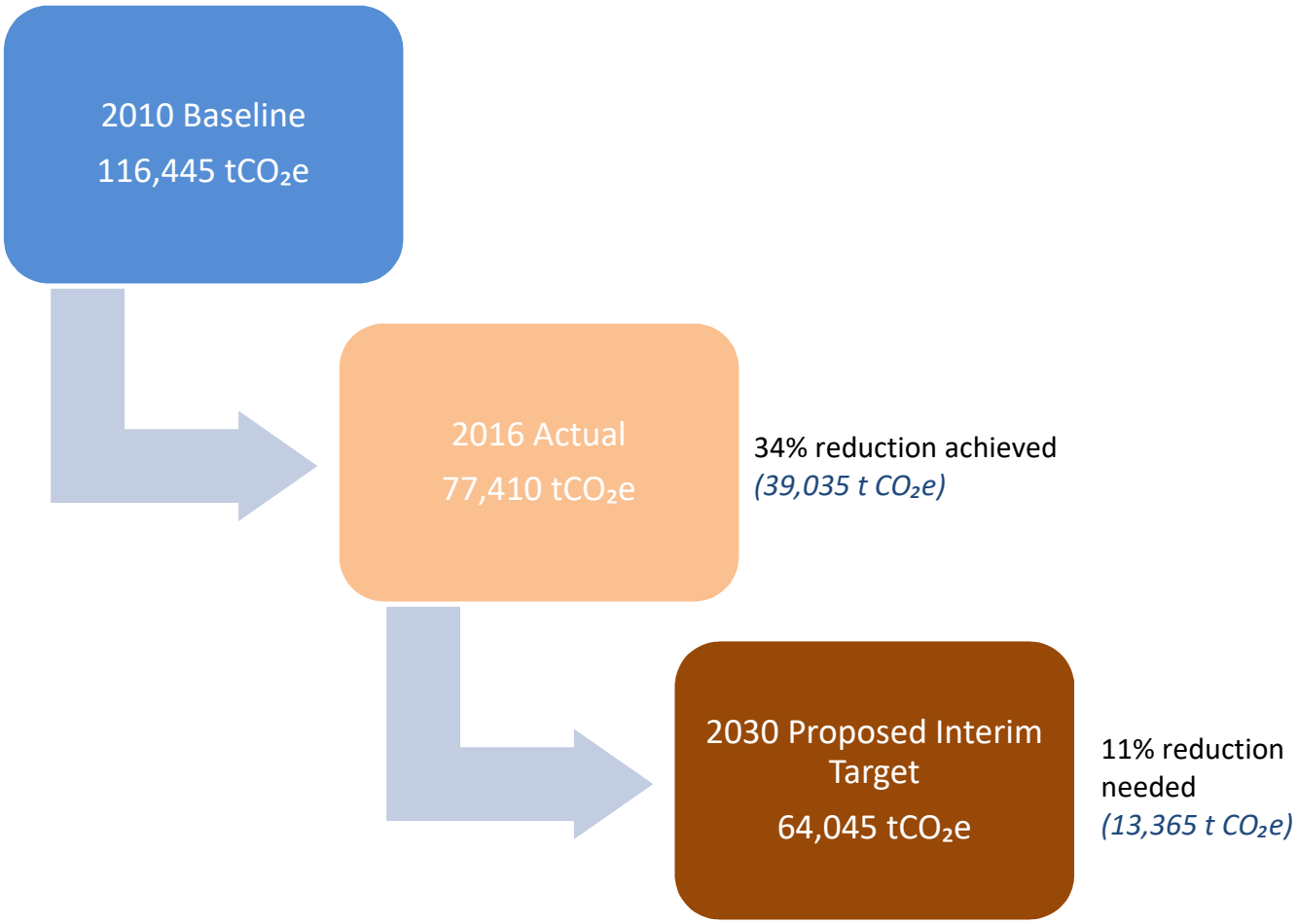

Figure 2 Achievements and Needs on Corporate GHG Emissions Reductions

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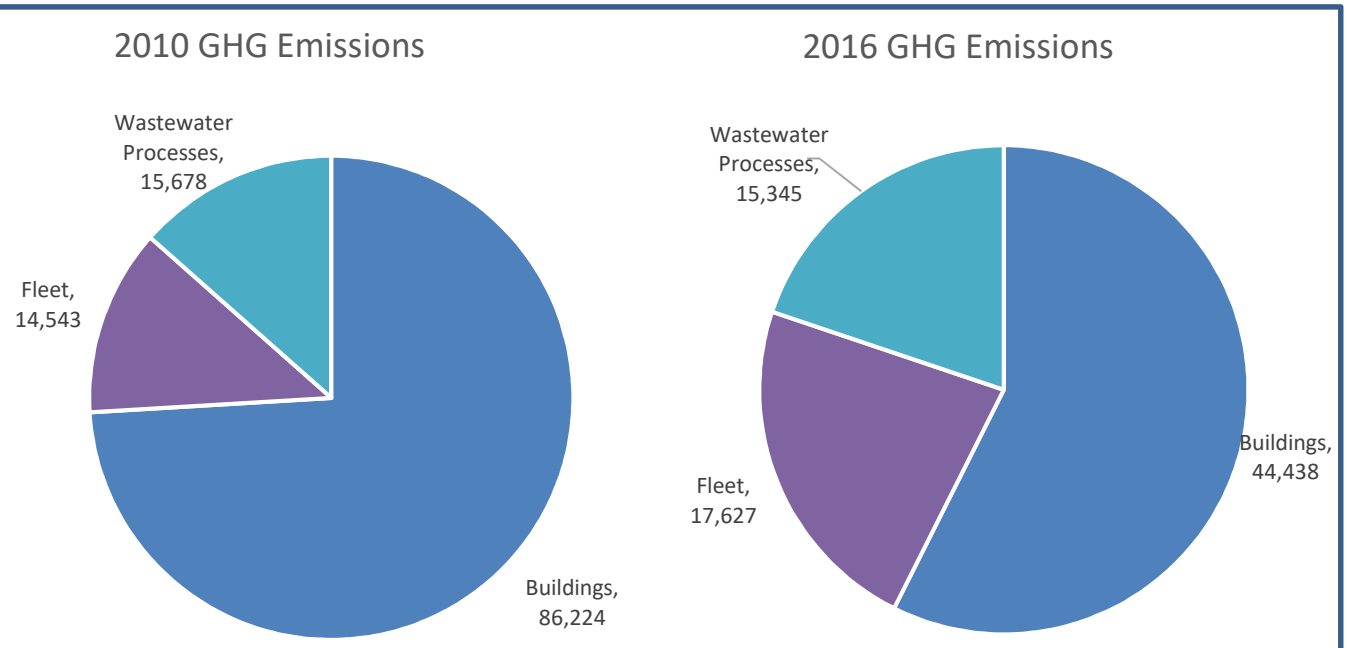

Figure 3 2010 vs. 2016 Corporate GHG emission Inventory breakdown

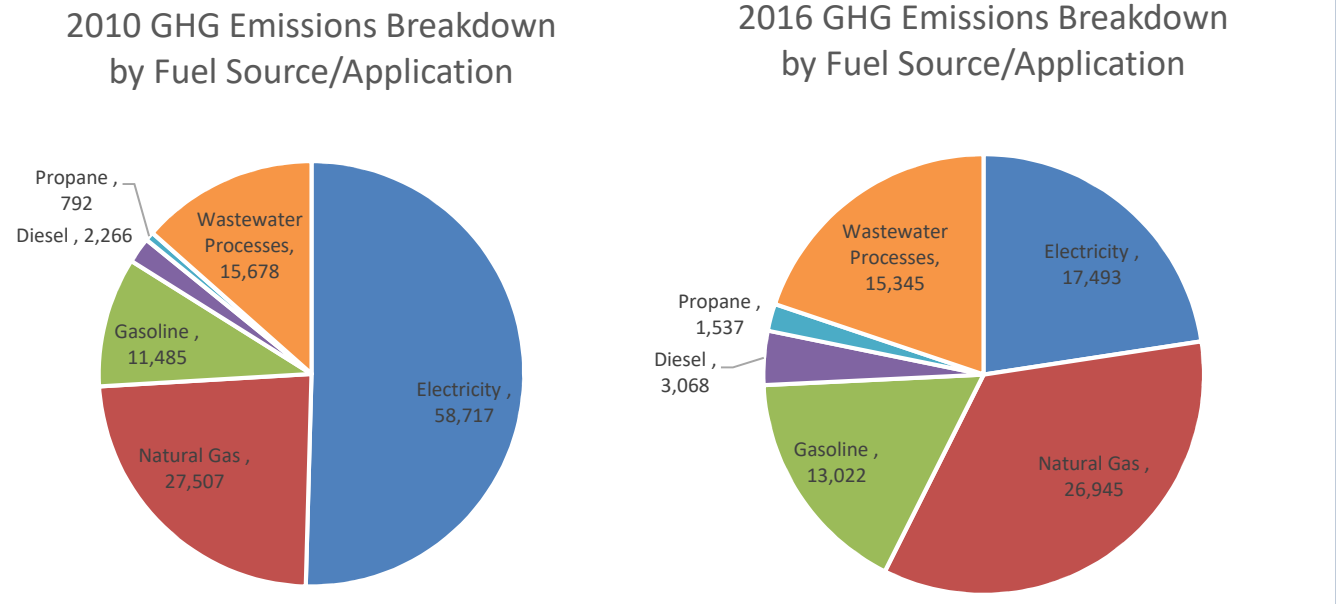

Figure 4 2010 vs. 2016 Corporate GHG Emissions by Fuel Source/Application (tCO_2e)

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Buildings currently represent the most significant contribution to the corporate inventory, accounting for 57% of GHG emissions (Figure 3) in 2016[5]. GHG emissions associated with buildings have declined by 48% since 2010. This is primarily attributed to the phase out of coal fired electricity production in Ontario, causing the GHG emissions intensity associated with electricity use to drop by more than 80%. The Region's natural gas consumption has decreased by 2%. While building GHG emissions have decreased, the Region's electricity use has increased by 12%.

[5] 'Buildings' includes streetlight, and all building including energy used in wastewater and water treatment facilities but not wastewater processes, which accounts for only 0.7% of building emissions, Fleet emissions includes employee commuting

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Principles to Enhance Energy Performance and Reduce GHG Emissions

The Sustainable Energy Pyramid (Figure 5) is a core principle of energy management and illustrates a cost-effective approach to progressively reduce a building's energy use requirements and GHG emissions. Investments focus on reducing the amount of energy needed for a building to deliver on its level of service prior to exploring cleaner sources of energy to meet the lowered energy demand.

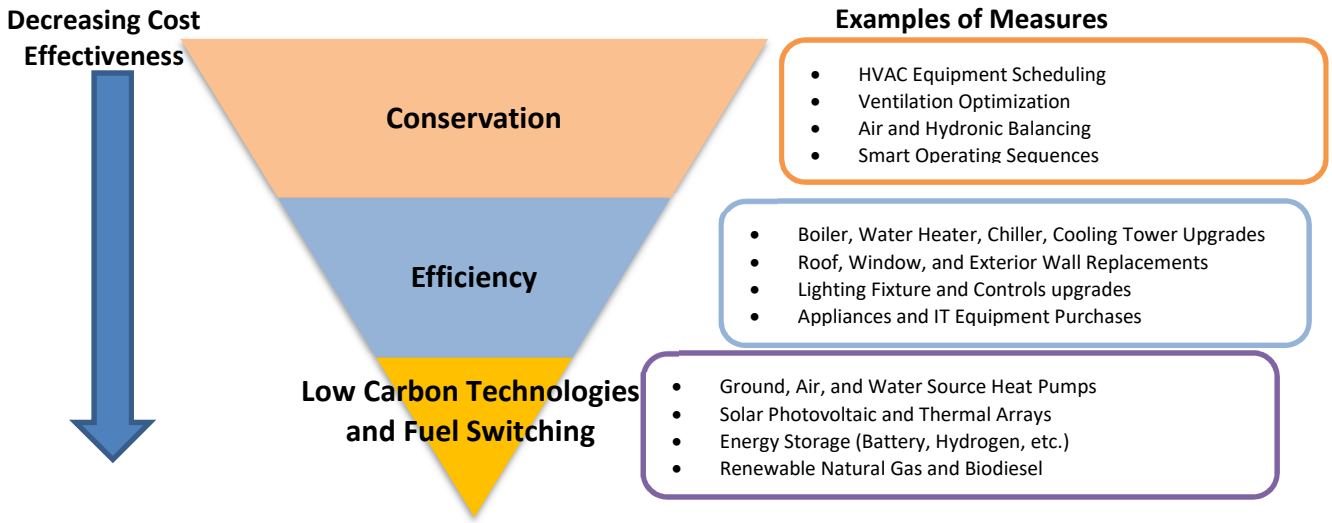

Figure 5 Sustainable Energy Pyramid

Energy conservation strategies are typically the least capital intensive and have the highest return on investment, as they involve improving the performance of existing building systems through better operations and maintenance. Efficiency strategies are typically more capital intensive, in that building system and equipment efficiencies are improved through redesign and retrofit projects. Low carbon technologies and fuel switching strategies are often the costliest, which is why it is important to minimize the amount of energy a building requires prior to sizing and investing in these systems that dramatically reduce remaining GHG emissions.

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Methodology

Establishing Energy Performance Targets and Ranking Buildings by GHG Reduction Potential

For the past 15 years, TRCA has leveraged the Performance Based Conservation approach to deliver the Mayor's Megawatt Challenge to municipalities, Greening Health Care to hospitals and Sustainable Schools to the school boards. Driven by data, realistic target-setting, competitiveness and peer-to-peer learning, these programs are helping municipal, healthcare and school buildings continuously raise the bar on their energy performance through operations and maintenance improvements, and small capital retrofits of existing building systems.

The programs rely on a robust dataset of facility energy use indices (EUIs); in other words, the annual energy use per gross floor area from buildings that have comparable operations and function (e.g. an office building would be compared with a dataset of energy use indices for office buildings). Initially, 122 RoP buildings were included in the preliminary analysis; however, a number were excluded due to insufficient data or existing plans for substantial site redevelopment. A final total of 106 buildings were categorized by building type and compared to the more robust dataset of similar use facilities as seen in Table 1. The datasets used for comparison for each building type can be found in Appendix B.

Table 1 Dataset of similar use facilities used for comparison

Building Type	Total number of buildings in benchmarking dataset	Number of RoP Buildings in benchmarking analysis
Police	*39*	*6*
Multi Residential	*298*	*61*
Offices	*84 buildings + REALpac target developed from 100's of office buildings*	*4*
Paramedics	*23*	*15*
Operations	*69*	*12*
Cultural facilities	*21*	*2*
Long term Care	*492*	*5*
Child Care	*10*	*1*

Each RoP building's energy performance is compared to the 'Best Practice' and 'Top Performers' within their respective dataset. After adjustments for weather, novel process loads or space types[6], and energy sources for heating equipment[7], a building specific energy performance target is established. Resulting targets[8] were then cross referenced with benchmarking values from other well-known

[6] Such as electric vehicle charging stations or data/call centers

[7] Electrically powered heat pumps, geo-exchange systems, and baseboards vs. natural gas fired furnaces, boilers, and heaters

[8] The Best Practice and Top Performer energy targets can be found in Appendix A

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sources, including Energy Star Portfolio Manager and Natural Resources Canada's Survey of Commercial and Institutional Energy Use (SCIEU), to ensure they are readily achievable.

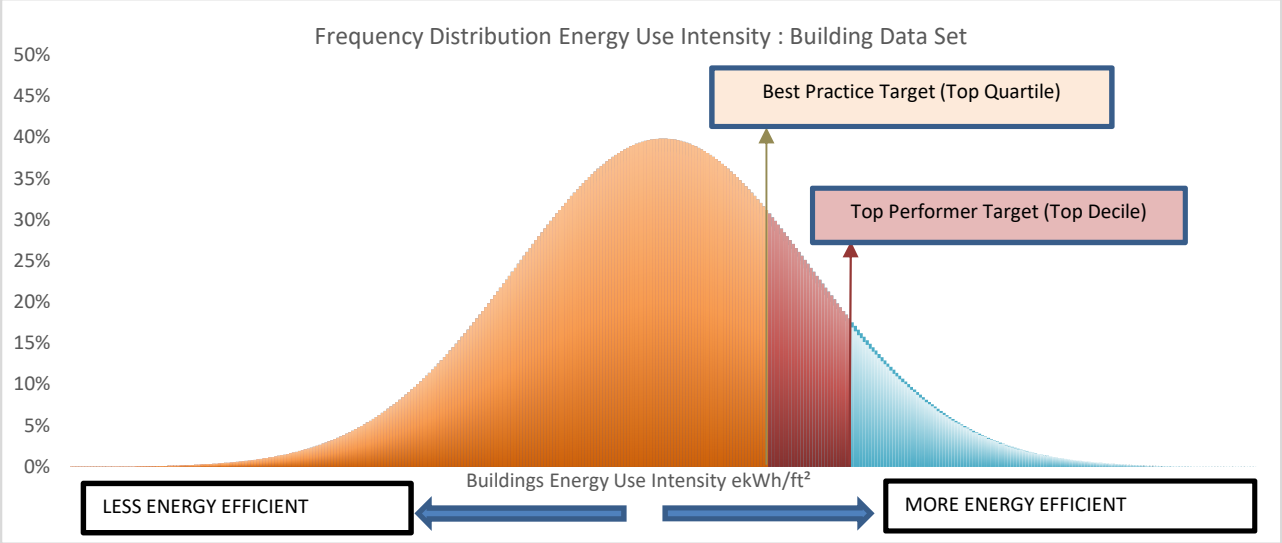

Figure 6 Best Practice and Top Performer Targets

The *Best Practice* target represents a facility having an energy performance at the 75th percentile. As 25% of the similar use facilities in the dataset already demonstrate this level of energy performance (Figure 6), it can be regarded as readily attainable with most of the progress likely being realized through lower cost operations and maintenance improvements[9].

Achieving the *Top Performer* target represents an existing building having an energy performance equivalent to or better than the 90th percentile of the comparable dataset. In order to attain this slightly more ambitious target, a greater level of effort and investment in energy efficiency will likely be required.

[9] Town Hall Challenge 20 by '15 Achieving the Energy Target of 20 kWh/sq.ft./year by 2015 in Town and City Halls, co-authors Enerlife Consulting and TRCA

The difference between a building's current energy performance and *Top Performer* target is established as its *Conservation Potential*, in units of natural gas and electric energy (Figure 7).

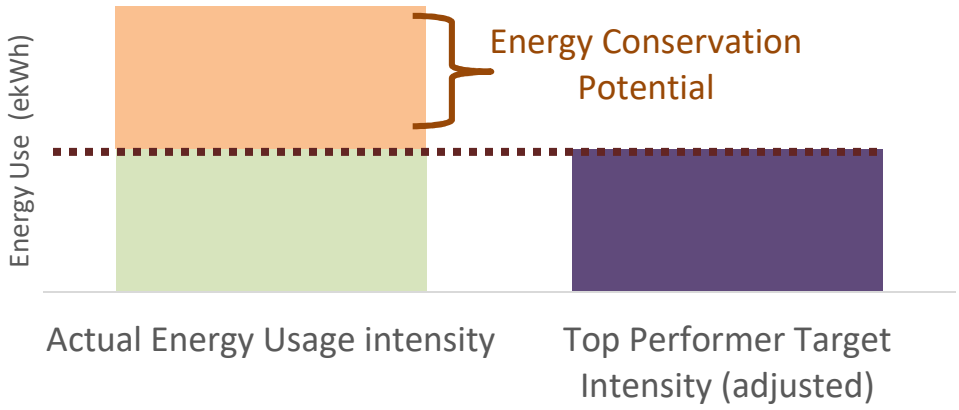

Figure 7 Conservation Potential Methodology

Energy Cost Savings associated with realizing the *Conservation Potential* is quantified by multiplying the building's electricity and natural gas utility rates by their respective potential savings. Accordingly, ***GHG Emissions Reduction Potential*** is quantified by multiplying the electricity and natural gas *Conservation Potential* by their respective GHG emissions intensities, as sourced from the most current National Inventory Report[10].

$$\boldsymbol{Energy\ Conservation\ Potential} = Actual\ Energy\ Use - Adjusted\ Energy\ Target$$

$$\boldsymbol{Energy\ Cost\ Savings} = Energy\ Conservation\ Potential\ \ X\ \ Utility\ Rates$$

$$\boldsymbol{GHG\ Emissions\ Reduction\ Potential} = Energy\ Conservation\ Potential\ X\ Emissions\ Factors$$

A larger *Conservation Potential* generally indicates a greater opportunity for *Energy Cost Savings* and *GHG Emissions Reduction Potential*[11]. Ranking buildings by these metrics provides the Region of Peel with a strategic prioritization on where to investigate opportunities to save energy, costs, and emissions.

[10] National Inventory Report 1990-2016: Greenhouse Gas Sources and Sinks in Canada, Table A13-7 Page 69.
[11] Differences in energy rates (electricity being more expensive than natural gas) and GHG emissions intensities (natural gas having a higher associated GHG emissions per unit of energy than electricity) results in a relationship that is not directly proportional between the metrics.

In order to meet the 2030 target, RoP will need to reduce emissions an additional 13,365 tCO_2e below 2016 levels. If Top Performer energy targets were achieved for all 106 RoP buildings in this analysis, it would result in more than 6,200 tCO_2e of reductions, or 30% of the reduction needed to meet the 2030 target.

Applying the principles of the Sustainable Energy Pyramid, it is often most cost-effective to minimize a building's energy requirements prior to sourcing or generating cleaner energy that typically comes at a cost premium. With the sizable magnitude of overall GHG emissions reductions required to achieve the proposed 2030 target, innovative approaches, through fuel switching and renewable energy generation/procurement, will have to be explored in the existing building portfolio.

Therefore, the ***GHG Emissions Net of Top Performer*** metric **was developed** to quantify each building's annual GHG emissions footprint post-realization of its *GHG Emissions Reduction Potential* (Figure 8). This was calculated by subtracting each building's *GHG Emissions Reduction Potential* from its total GHG emissions in 2016.

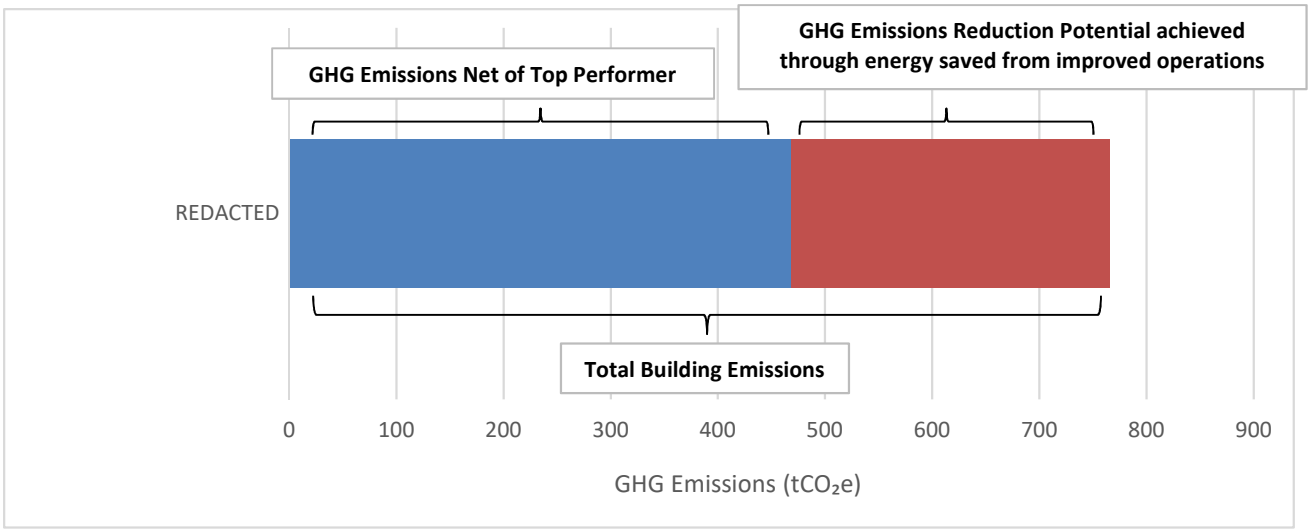

Figure 8 Tall Pine's GHG emissions net of Top Performer Target

This metric proved useful in prioritizing buildings with large emissions footprints to explore opportunities for greater energy use reductions and cleaner fuel sources.

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Accounting for Planned Investments and Ranking Buildings by Energy Related Cap-Ex Intensity

A strategy to improve a building's energy performance cannot be employed without considering the current condition of its infrastructure, timelines and budgets allocated for state of good repair work, and projected variations in future facility use.

The Region of Peel employs a comprehensive and long-term approach to capital planning. Scheduling and budgeting for replacement and upgrade projects is enabled through integrated planning processes, continuous tracking, and regular building condition assessments. Capital planning data on the existing building portfolio provided insights into the types of projects, estimated timing for implementation, and the level of funding allocated to ensure building infrastructure and equipment are maintained in a state of good repair. In alignment with the 10-year timeframe of the Climate Change Master Plan, capital planning data from 2019 to 2029 was included in this analysis. Capital projects that have the potential to impact a building's energy performance were categorized into four measures[12]:

I. **Lighting and electrical** –Lighting retrofits, plug loads (washers, dryers, stoves), elevators, electrical panels, transformers

II. **Operations and maintenance improvements** - Cold /hot/domestic water distribution systems, recirculation piping, sump pumps, BAS programming, controls strategies

III. **Heating, air conditioning and ventilation (HVAC)** - Heat pumps, PTACs, Boilers replacements, heating/cooling pumps, exhaust fans, ventilation, chillers, makeup air units, BAS re-programing.

IV. **Building envelope improvements** – Fenestration, glazing, caulking/sealant, roofing, wall assemblies

For each of the 106 buildings, the allocated energy related capital expenditures by measure were summed for each year. Then each building's energy related capital expenditure was divided by the gross floor area to determine the ***Energy Related Capital Expenditure Intensity.***[13]

$$\textbf{\textit{Energy Related Capital Expenditure Intensity}} = \frac{\textbf{2019} - \textbf{2029 \textit{Energy Related Capital Expenditures} (\$)}}{\textbf{\textit{Building Gross Floor Area}} (ft^2)}$$

[12] Sorting was facilitated by selecting the "UNIFORMAT CODES and DESCRIPTIONS" that aligned best with one of the four categories

[13] It is important to note that that are some limitations within the analysis using the capital planning approach. Capital planning data was not available for all 106 facilities and where data was missing, the analysis was not completed for those buildings. In addition, some projects in the capital plan involve replacement of end of life equipment and system. The replacement life cycle for building systems is based on industry standards (ASHRAE 90.1, RSMeans) and in many cases equipment can run effectively and efficiently beyond these expected life spans.

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Cap-Ex Intensity metrics can be used to help the RoP better prioritize and align planned capital investments with energy and GHG reduction efforts in the existing building portfolio.

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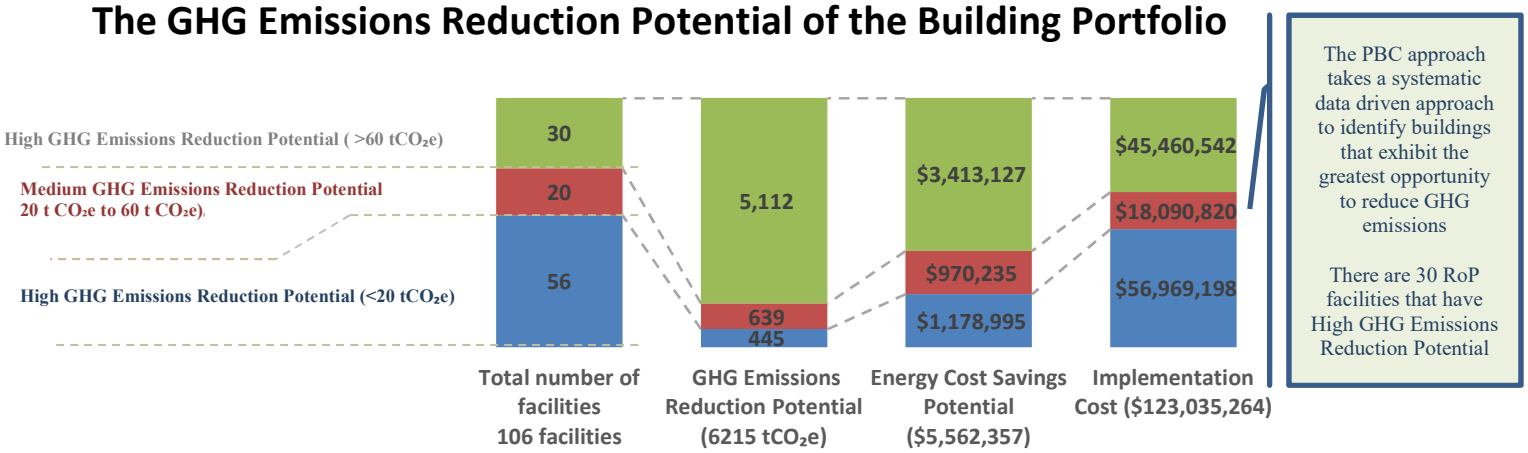

Figure 9 GHG Emissions Reduction Potential and Cost Savings Summary

Focusing on buildings with the highest GHG emissions reduction potential can help the RoP progress towards their 2030 GHG emissions reduction targets. The RoP's top 20 buildings with the highest GHG emissions reduction potential represents approximately 70% of the total potential emissions reduction (Figure 9).

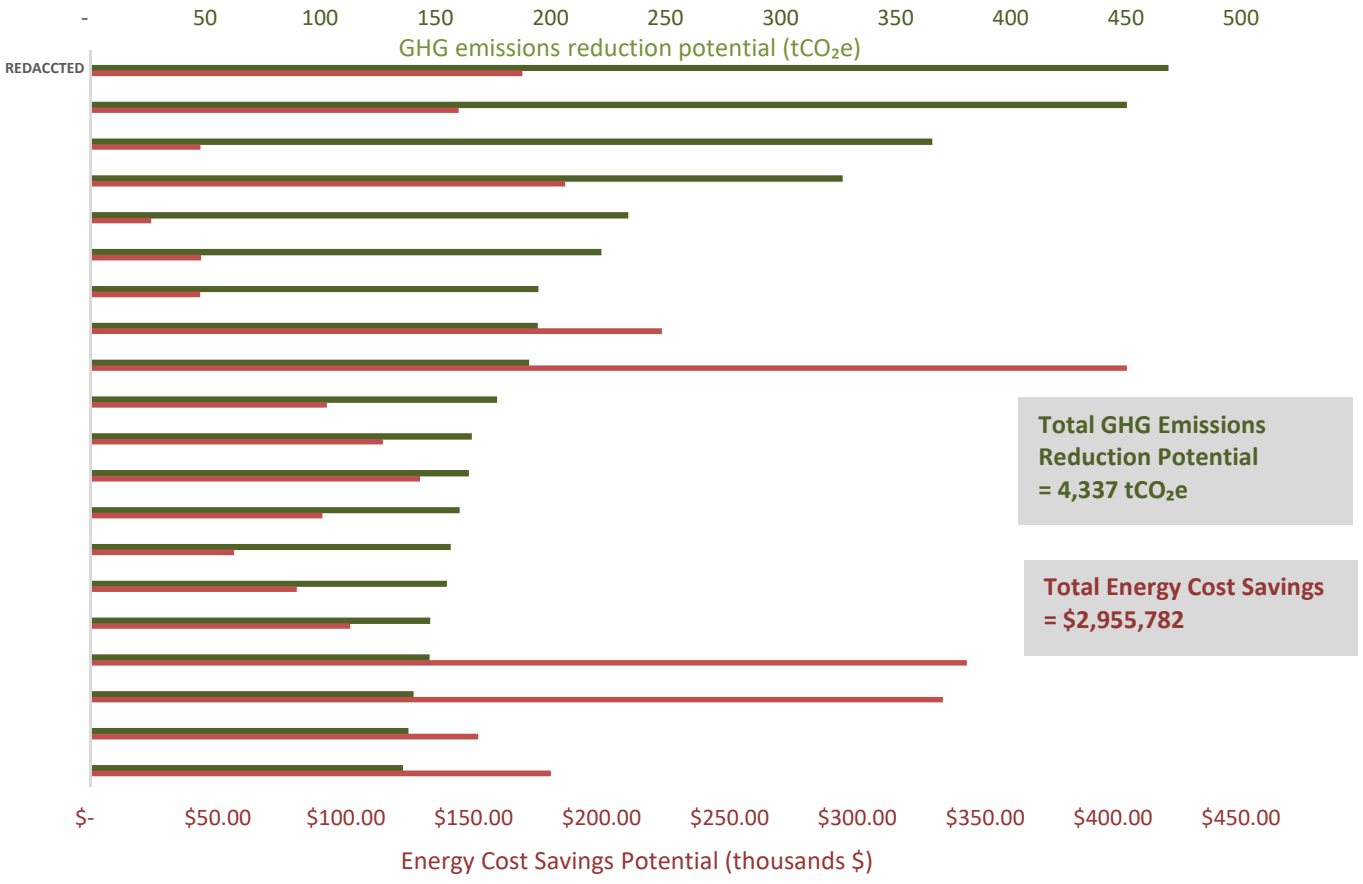

Figure 10 RoP Top 20 GHG Emissions Reduction Potential

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Overview of 2019-2029 Region of Peel Capital Planning

Energy Related Capital Expenditures between 2019 and 2029 represent 38% of the total budgeted state of good repair (SoGR), FASP, and any other capital needs for buildings. Between 2019 and 2024, the Region of Peel has allocated over REDACTED on capital upgrades, and approximately REDACTED of this can be attributed to energy related measures. Projects related to HVAC and Building Envelope account for nearly 70% of energy related capital needs. From 2025 to 2029, an additional REDACTED is needed to maintain the building portfolio; REDACTED of which is allocated to energy related measures.

Figure 11 shows the annual values of planned Energy Related Capital Expenditures across all 106 buildings between 2019 and 2029. Annual values are broken down by measure including: Building Envelope, Heating Ventilation & Air Conditioning, Lighting and Electrical, and Operations and Maintenance. The green series at the top of the area chart, labelled "Non-Energy Related Capital Expenditures," accounts for planned capital expenses that will not directly affect energy use. Examples include roadway paving parking lot resurfacings, carpet and floor replacements, and fire detection and containment systems.

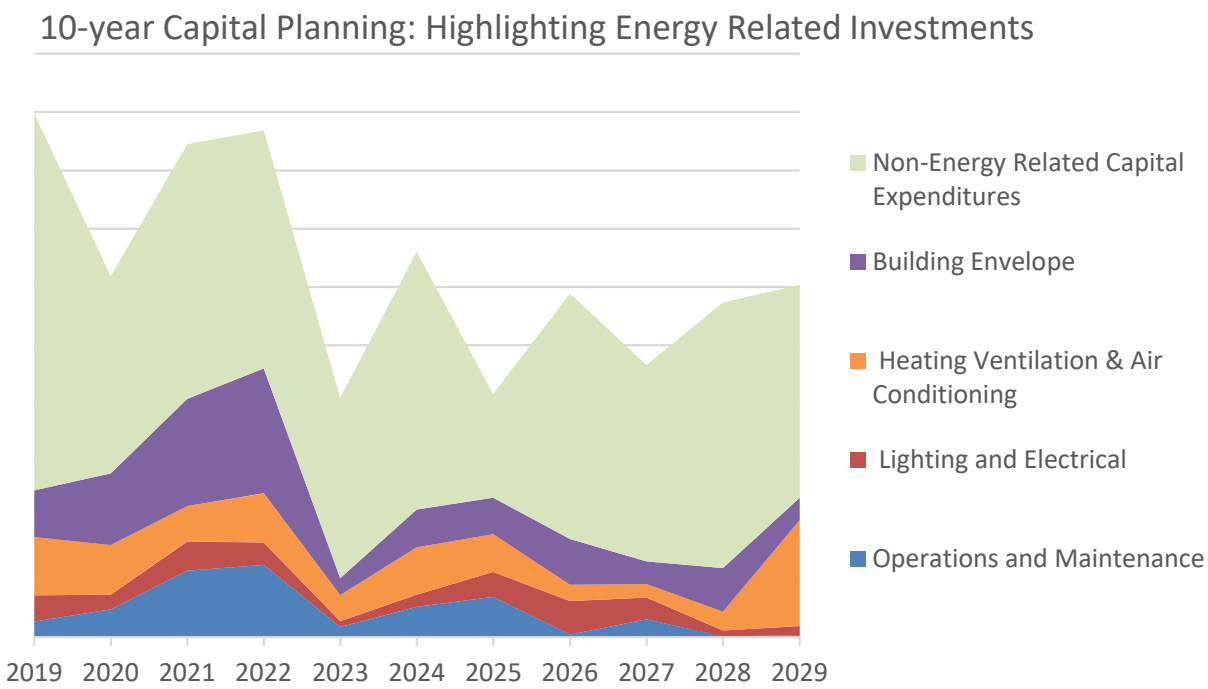

Figure 11 RoP's 10-year capital plan

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Prioritization of GHG Emissions Reduction Efforts through Building Classification

Three key metrics were established for each building as part of the Performance Based Conservation and Capital Planning analyses. The thresholds defined below in Table 2 were used to classify buildings.

Table 2: Metrics, Importance, and Thresholds used for Building Classification

METRIC	IMPORTANCE	THRESHOLDS
Greenhouse Gas Emissions Reduction Potential: Shows the amount of GHG emissions that can be avoided annually if a building's energy use per unit of gross floor area reached the 'Top Performer' Target (top 10%) among similar use facilities in the dataset ***(Annual tonnes of carbon dioxide equivalent avoided [t CO_2e])***	**Higher =** A poorer performing building that uses a lot of energy and has a greater opportunity to reduce GHG emissions	**High:** >60 t CO_2e **Medium:** 20 t CO_2e to 60 t CO_2e **Low:** <20 t CO_2e
Energy Related Cap-Ex Intensity: Indicates the value of planned investments in state of good repair (SoGR) work between 2019 and 2029 that have the potential to affect a building's energy performance.[14] ***(2018 Canadian Dollars [$])***	**Higher =** Greater cost-effectiveness to enhance energy performance by making incremental investments on already planned capital projects	**High:** ≥$15/ft² [15] **Low:** < $15/ft²
GHG Emissions net of Top Performer Target: Shows the remaining annual GHG emissions of each building after optimizing its energy performance to 'Top Performer' Targets. ***(Annual tonnes of carbon dioxide equivalent avoided [t CO_2e])***	**Higher =** More opportunity to make significant progress towards corporate GHG reduction targets through low carbon energy sources *(e.g. providing heating via electricity and/or generating energy on-site via renewables)*	**High:** ≥ 150 t CO_2e [16]

[14] Resulting from the analysis, the Region of Peel has the ability to sort planned energy related capital expenditures by project type and year scheduled for enhanced granularity when exploring strategies to optimize project phasing
[15] ($15/ft² represents 80th to 90th percentile of the energy related cap-ex intensity for RoP buildings)
[16] (150 tCO_2e represents the median GHG emissions net of Top Performer Targets for the portfolio)

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Each of the 106 facilities included in the analysis was classified for the purpose of prioritizing the exploration of GHG emissions reduction opportunities in a focused, cost-effective, and action-oriented manner. A summary of this classification process and how it can be used to guide next steps is presented in Table 3 and the paragraphs that follow.

Table 3 RoP Building Classification

Building Classification	Number of buildings	GHG Emissions Reduction Potential	Energy Related Cap-Ex Intensity (2019 to 2029)	GHG Emissions net of Top Performer Target
A	15	High / Medium	High	
B	32	High /Medium	Low	
C	17	Low	High	
D	42	Low	Low	
LC1	8 X Class A 9 X Class C		High	High
LC2	9 X Class B 16 X Class D		Low	High

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Building Classifications: LC1 and LC2

'LC', or 'Low Carbon', classified buildings have high GHG emissions net of Top Performer Target achievement and are RoP's prime candidates to explore the viability of fuel switching and low carbon technologies. Ultimately, these facilities will still have significant carbon footprints even after enhancing their energy performance to the top 10% of their peers.

Fuel switching: Transitioning end uses within buildings from using fuels that have high GHG emissions intensities to cleaner fuels *(e.g. using electricity to fulfill space and water heating energy demands as opposed to natural gas)*

Low carbon technologies: Technologies that generate or allow for the efficient use of less GHG intensive energy within buildings *(e.g. energy generation through renewables such as solar photovoltaics and solar thermal, and electricity powered and efficient heating and cooling using air, water, and ground source heat pumps)*

'LC1' buildings have high Energy Related Cap-Ex Intensity, likely indicating building systems are reaching end of life. If this is the case, these buildings present a great opportunity for RoP to leverage capital needs for SoGR work and make incremental investments to significantly increase building energy efficiency. 'LC2' buildings have low Energy Related Cap-Ex Intensity; however, they are still significant sources of corporate GHG emissions and present a good opportunity for substantial GHG reduction impacts should financial and human resources be allocated to these buildings.

Each 'LC' classified building also has an 'A' through 'D' classification based on their GHG Emissions Reduction Potential and Energy Related Cap-Ex Intensity. This allows for a shift in GHG emissions reduction strategies to employ, should it be infeasible to implement fuel switching or low carbon technologies at a site.

Building Classifications: A and B

'A' and 'B' buildings have medium to high GHG Emissions Reduction Potential and should be a priority for energy efficiency projects and low and no-cost conservation opportunities. 'A' buildings present a greater opportunity to drive emissions reductions as they have high Energy Related Cap-Ex Intensity; whereas 'B' buildings do not, thus capitalizing on operational improvements may be a more suitable approach to achieve emissions reductions in these buildings.

Building Classifications: C and D

'C' and 'D' buildings have low GHG Emissions Reduction Potential and are classified as low priority. 'C' buildings still have high Energy Related Cap-Ex Intensities, so it is advisable to explore energy performance enhancing measures when making significant capital investments. 'D' Buildings do not have significant Energy Related Cap-ex Intensities and minimal GHG Emissions Reduction Potential.

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Quantifying the Opportunity: GHG Emissions Reduction Potential in relation to Overall Corporate Reduction Targets

Table 4 illustrates potential reductions on the corporate GHG emissions inventory if 'Top Performer' targets are achieved for each of the building classifications 'A' to 'D,' and if GHG emissions footprints are completely negated post 'Top Performer' target achievement for both 'LC1' and 'LC2' buildings. Estimated annual energy cost savings and the average planned energy related cap-ex intensities from 2019-2029 are also presented for consideration where applicable.

Table 4 Summary of potential impacts on GHG emissions based on building classifications

Classification	Prioritization	GHG Emissions Reduction Potential (tCO2e)	Average Energy Related Cap-Ex Intensity (2019-2029)	Annual Energy Cost Savings[17]
LC1	Highest Priority	*5,723*	$25.30	n/a
LC2	High Priority	*7,057*	$4.74	n/a
A	High Priority	*2,270*	$34.88	$1,274,000
B	Medium Priority	*3,406*	$3.89	$2,908,000
C	Lower Priority	*176*	$45.16	$480,000
D	Lowest Priority	*344*	$4.44	$980,000
TOTALS		**18,976 tonnes**		**$5,642,000**

Figure 12 on the next page summarizes the magnitude of the GHG emissions reduction potential of the 106 buildings included in this analysis in relation to the organization's recently established interim target of 45% below 2010 levels by 2030.

[17] Based on average blended 2017 utility rates and rounded to nearest 1,000

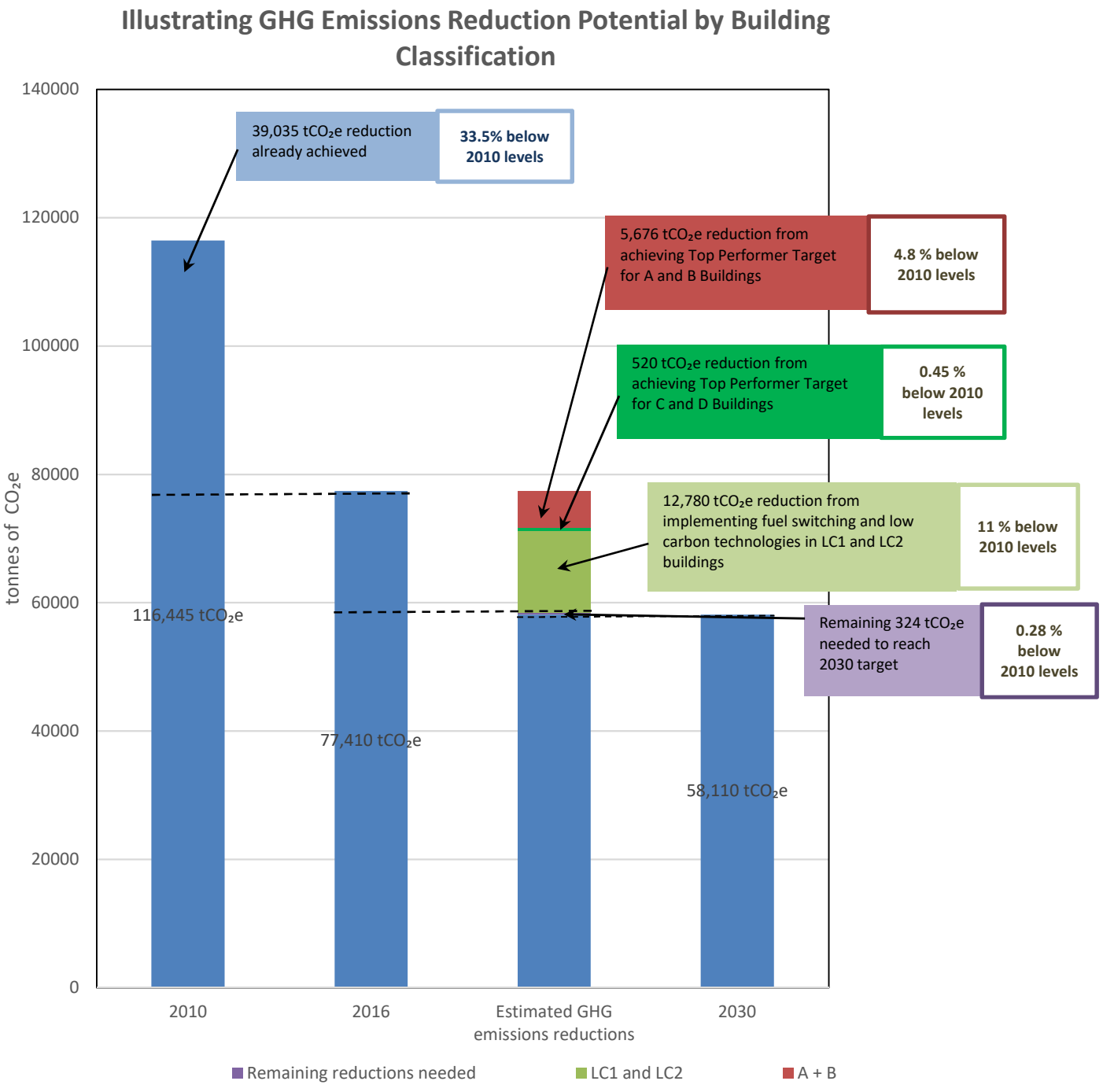

Figure 12 RoP GHG emissions reductions summary

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Key Takeaways

- If RoP achieved 'Top Performer' targets for all 47 Class 'A' and 'B' buildings, a reduction of 5% of the 2010 emissions baseline would result. In addition, $4.2 million in annual energy costs could be avoided.

- If RoP holistically strived to reduce energy use requirements, and then negated the entire carbon footprint of the 17 'LC1' and 25 'LC2' buildings, an additional 5% and 6% GHG emissions reduction from the 2010 baseline would result respectively[18].

Quantifying the potential impacts from these best-case scenarios represents the first step in a process to prioritize GHG emissions reduction measures in the existing building portfolio. Recommendations for next steps are outlined in the following section.

[18] These GHG emissions reductions would be in addition to GHG emissions reductions achieved if all LC1 and LC2 buildings reached their Top Performer target, or had an energy use index equivalent to the top 10% of their peers

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Proposing an Implementation Plan: Providing Tools and Outlining Next Steps

Eliminating the carbon footprint of all 'LC1' and 'LC2' facilities presents RoP's best opportunity to make progress towards GHG reduction targets, however, it is unlikely that fuel switching and implementing low carbon technologies will be technically, operationally, and/or financially feasible in all of these facilities. Therefore, it is recommended that both 'LC1' and 'LC2' buildings undergo an initial screening to explore recent condition assessments, timing and scopes of planned SoGR work, and technical and operational barriers to implementation.

'LC1' and 'LC2' buildings that pass this initial screening would then undergo a detailed engineering study (DES) to devise a holistic strategy to significantly reduce energy requirements and evaluate different options for fuel switching and low carbon technologies for their operational applicability and total cost of ownership.

'LC1' and 'LC2' buildings that do not pass the initial screening can be reclassified according to their *GHG Emissions Reduction Potential* and *Energy Related Cap-Ex Intensity* metrics; with 'FS1' buildings being reclassified as 'A' or 'C', and 'FS2' buildings being reclassified to lower priority 'B' or 'D'.

Achieving the Top Performer energy targets should be a goal for <u>all</u> buildings by implementing best practice operational improvements and ensuring efficiency is maximized when undertaking capital upgrades. However, it is recommended that investment and effort put towards GHG emissions reduction activities should follow the proposed prioritization from 'A' buildings *(high conservation potential and planned investment*) through to 'D' buildings *(low conservation potential and planned investment).*

Black Creek Pioneer Village Case Study

(Appendix C)

A Detailed Engineering Study was undertaken on this 48,000 ft² office, museum, and wedding hall with kitchen facilities, to evaluate options to redesign and replace HVAC system consisting of 36 water source heat pumps that were approaching the end of life.

When evaluating business as usual versus low carbon technology options, it was determined $1.4 million would be required for a like for like replacement, and an additional $635,000 would be required to replace the existing equipment with high efficiency air source heat pumps with variable refrigerant flow (VRF). The business case indicated that the incremental investment in the VRF system had a simple payback of 7 years and a 20-year Net Present Value of $526,000.

The decision was made to install the higher efficiency air source heat pump with VRF system, which reduced the reliance on natural gas boilers to deliver the majority of heating to the building and is expected to yield a 74% reduction in the facility's GHG emissions.

'A' and 'B' buildings should undergo an initial screening beginning with a more granular interrogation of capital project scopes, timing, and budgets to assist with prioritizing efforts and solidifying timelines

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to implement energy conservation and efficiency measures. For example, two buildings could both be classified as 'A,' but a deeper dive into the capital planning data might reveal that a $1 million investment in Building 1's HVAC system is planned for 2021, whereas Building 2 has its HVAC replacement scheduled for 2029. This would justify prioritizing exploration, and action if feasible, in Building 1. Also, Building 1 might have significant investments in its walls and roof that are scheduled to take place after its HVAC replacement. In this case, reconsideration of phasing these two projects would involve investigating the reduction of heating and cooling loads if the building envelope project was undertaken *prior to* the HVAC system replacement.

In the case of 'C' buildings *(low conservation potential and high planned investment)*, capital planning data should be reviewed in conjunction with recent condition assessments (BCAs). If BCAs indicate systems/equipment slated for replacement are in a state of good repair, strategic consideration can be given to the re-allocation of capital to energy performance enhancing work in buildings classified as 'A' or 'B', that have higher GHG Emissions Reduction Potential.

Two *'Building Prioritization Tools'* have been developed to help RoP staff prioritize the exploration of GHG reduction opportunities in buildings under their purview. Additional details are included on the following two pages.

1. Process Flow Chart

Developed to guide the decision making process beginning with a building's classification *(as outlined in Appendix D)* through to project planning initiation.

2. Metrics Spreadsheet Tool

Allows user to rank, sort, and filter all 106 buildings included in the analysis based on their metrics (*as outlined in Appendix E*) and classification. In addition, information on cost savings potential and categorized Energy Related Capital-Ex *(as outlined on page 14)* is available by year from 2019-2029

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Taking the Next Step: Energy Charrettes for Prioritized Buildings

Toronto and Region Conservation and RoP have begun putting the analyses and tools to use and have identified four facilities to undergo Energy Charrettes.

Division	Building	Classifications	GHG Emissions Reduction Potential *(@ Top Performer Target)*
Headquarters	Suite B+C	LC2, B	64 tCO2e
Headquarters	7120 Hurontario	LC2, B	161 tCO2e
Peel Living	Weavers Hill	LC1, A	147 tCO2e
Peel Living	Chelsea Gardens	LC1, A	136 tCO2e

The objective of these Charrettes is to identify, evaluate, and recommend a list of actionable measures to enhance energy conservation and efficiency within each facility, and determine the potential for renewable energy generation on-site. Outputs are outlined in Figure 13 below.

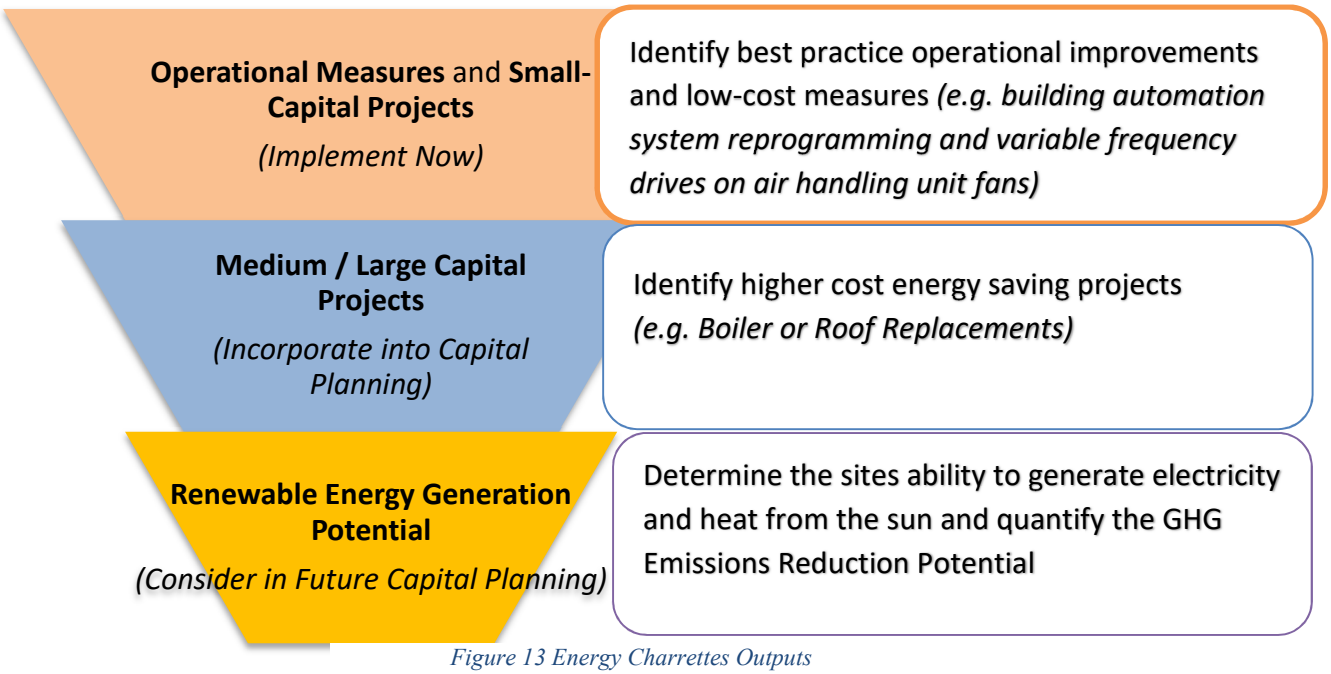

Figure 13 Energy Charrettes Outputs

After analyzing building system and energy use data, performing on-site inspections, and interrogating control systems, all personnel who have a stake in the facility's energy use will be convened to expedite the identification and validation of prospective energy savings opportunities. Participating stakeholders will likely include building operators, engineers, property managers, asset management, service contractors and utility company representatives. The Energy Charrettes will focus on the

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identification of operational improvements and small retrofit projects, which typically have the best return on investment.

TRCA has had success facilitating and delivering these workshops in the past and should the piloting of Energy Charrettes at the four sites in 2019 prove successful, TRCA recommends they are conducted for all 'A' and 'B' buildings over the next 3-5 years.

TRCA believes that the RoP can achieve substantial emissions reductions if the four activities listed below are pursued simultaneously.

1. Implementing best practice and operational improvements within buildings
2. Building the medium/ large capital projects into the capital planning process
3. Exploring opportunities to implement renewable technologies in existing buildings
4. Pursuing opportunities for Fuel Switching and Low Carbon Technologies where applicable

Sustaining Performance: You Cannot Manage what you Cannot Measure

Monitoring performance is a critical component of any GHG reduction and energy conservation strategy. The Region is in a strong position to lead in this regard, having a robust suite of energy metering equipment and powerful software for data analytics and communications. However, the use of reporting can be enhanced to prescribe investigation into targeted building systems that can lead to actionable GHG emissions reduction measures.

In a well-designed energy performance monitoring program, the data and the metrics generated should be continuously used to:

- track and compare the energy performance of RoP buildings;
- quantify the GHG Emissions Reduction Potential and progress towards targets;
- identify usage trends and building systems that warrant further investigation;
- inform capital planning and energy related strategies, programs and projects;
- recognize and apply best practices from top performers; and
- set the stage for broader comparative analysis and reporting with other municipalities in the GTHA and across the province.

To achieve these objectives, TRCA recommends the following:

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1.Data collection and storage

RoP should continue to collect and store energy related data using existing metering and Energy Hippo software. Retscreen Expert is an additional tool that can be used in conjunction with Energy Hippo to help the RoP monitor energy usage and to help develop measures and monitor savings after energy savings measures are implemented in RoP facilities. Retscreen Expert has the capability of benchmarking buildings, building feasibility analysis and financial analysis for different measures and managing building energy and water data at a large portfolio scale.

2.Data analysis, diagnostics and reporting

TRCA can annually update the targets, metrics and tools generated for this report, and provide additional data driven insights to provide strategic considerations for future GHG emissions reduction work across the portfolio. For this, TRCA encourages RoP to share the following data on an annual basis:

- Monthly building energy use data
- Updates to building profiles and uses
- Major projects completed
- Updated capital planning forecasts

Using monthly energy use data, a building's overall energy performance *(total energy use / square foot of gross floor area)* can be broken down into components such as baseload electric, cooling electric, baseload thermal, and space heating thermal. The same can be done for performance targets, where component level targets can be powerful tools to help isolate specific building systems where energy and GHG reduction opportunities are likely to be found.

Figure 14 shows 7120 Hurontario's breakdown of actual and targeted energy performance from building to component levels.

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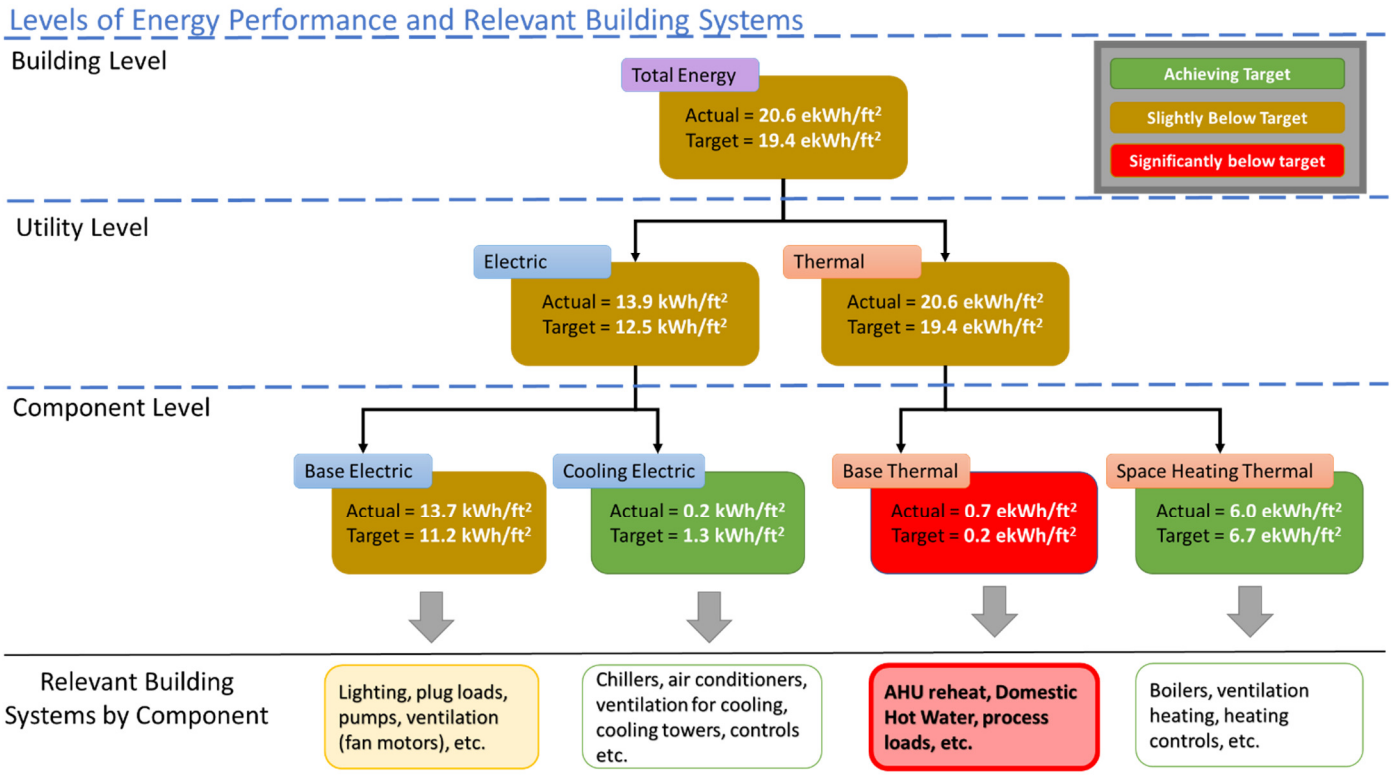

Figure 14 Breakdown of actual and targeted energy performance at the component level

In reference to Figure 14, an investigation into building systems associated with baseload electric and thermal would be recommended for 7120 Hurontario.

In addition to this component target analysis, TRCA can continue to externally benchmark RoP facilities with similar use facilities from the broader database to illustrate the relative energy performance ranking of each facility. Individual facility data can also be aggregated so departmental GHG emissions reduction potential can be reported. TRCA recommends working with RoP to develop a reporting structure that will help monitor and guide progress towards the 2030 GHG emissions reduction targets.

3. Performance recognition

TRCA can support the creation of a recognition program to acknowledge RoP representatives who played a role in achieving significant improvements in energy performance at the building and/or departmental levels. Recognition plays a key role in keeping staff engaged and providing motivation to strive for high performance.

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Appendix A: Best Practice and Top Performer Energy Targets

	Best Practice Targets (top quartile) normalized to weather in the year of 2017							
	Electricity				Natural Gas			Total energy
Building Type	Base	Cooling	Heating	Total	Base	Heating	Total	Total
Admin offices	10.9	0.6	0.4	**11.9**	1.0	8.0	**9.0**	**21.0**
Ambulance stations	7.7	0.2	2.6	**10.6**	0.9	17.1	**18.0**	**28.6**
Children Services	11.3	0.5	0.5	**12.3**	3.1	8.6	**11.6**	**23.9**
Cultural facilities	8.1	0.7	0.4	**9.2**	2.2	13.4	**15.6**	**24.8**
Long-term care facilities	14.1	0.9	0.0	**15.1**	7.8	9.5	**17.3**	**32.4**
Police Stations	12.9	1.1	0.3	**14.3**	1.0	8.7	**9.6**	**24.0**
Residential	5.1	0.6	0.4	**6.0**	5.3	11.0	**16.3**	**22.4**
Shelters	9.8	0.9	0.2	**10.9**	6.9	14.0	**20.8**	**31.7**
Transit facilities	8.5	0.2	1.3	**10.0**	0.9	14.9	**15.8**	**25.8**
Waste Operation	18.4	0.0	0.0	**18.4**	0.9	14.9	**15.8**	**34.2**

	Top Performer Targets (top decile) normalized to weather in the year of 2017							
	Electricity				Natural Gas			Total energy
Building Type	Base	Cooling	Heating	Total	Base	Heating	Total	Total
Admin offices	8.2	0.5	0.3	**9.0**	0.6	4.8	**5.4**	**14.4**
Ambulance stations	5.8	0.2	2.0	**7.9**	0.6	10.3	**10.8**	**18.7**
Children Services	8.5	0.4	0.4	**9.2**	1.8	5.1	**7.0**	**16.2**
Cultural facilities	6.1	0.5	0.3	**6.9**	1.3	8.0	**9.4**	**16.3**
Long-term care facilities	13.4	0.8	0.0	**14.2**	3.4	9.0	**12.4**	**26.6**
Police Stations	10.2	0.9	0.2	**11.3**	0.6	5.9	**6.5**	**17.7**
Residential	4.3	0.5	0.2	**5.0**	4.3	9.0	**13.2**	**18.2**
Shelters	7.4	0.7	0.2	**8.2**	4.1	8.4	**12.5**	**20.7**
Transit facilities	6.4	0.1	1.0	**7.5**	0.5	8.9	**9.5**	**17.0**
Waste Operation	13.8	0.0	0.0	**13.8**	0.5	8.9	**9.5**	**23.3**

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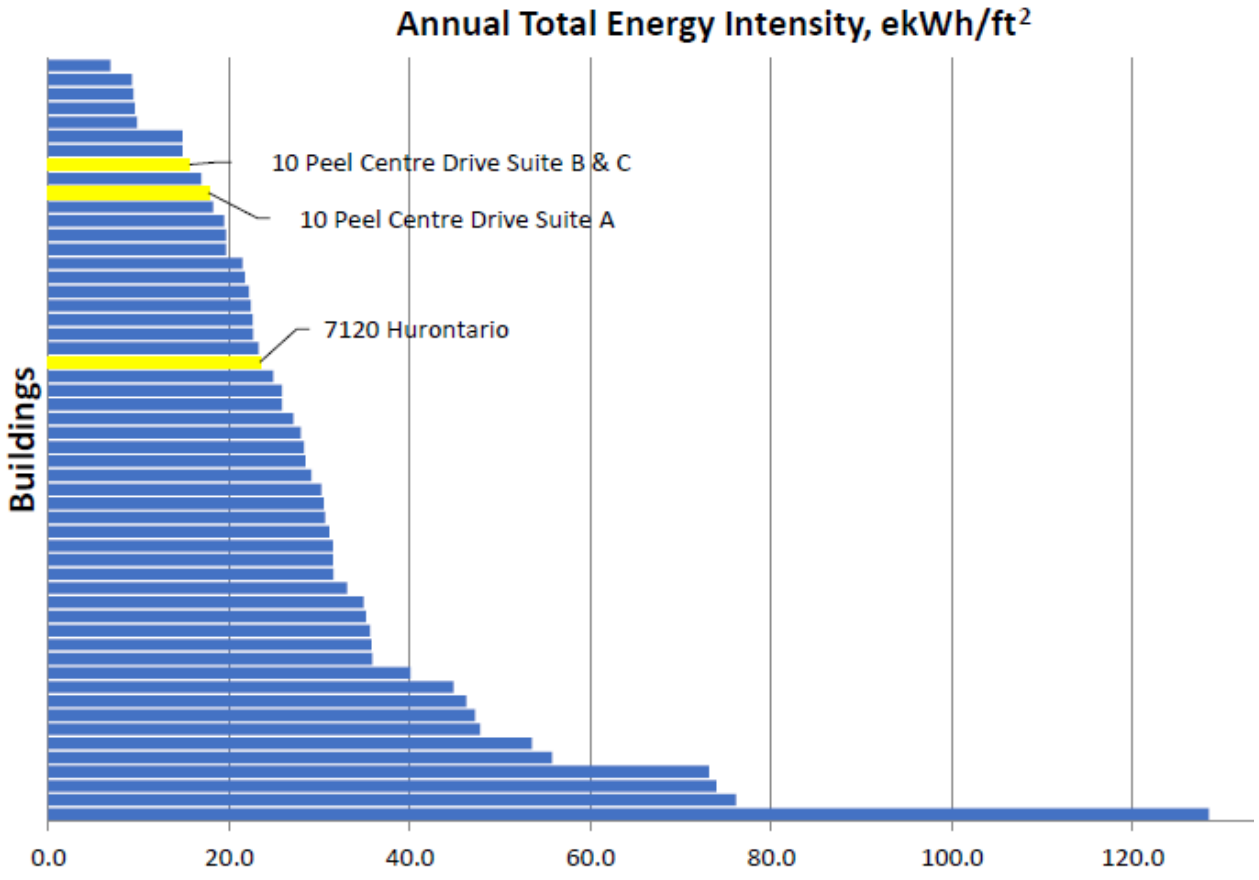
Appendix B: Energy Targets Datasets

Region of Peel Admin Office facilities vs. dataset benchmark

Admin Office	Electricity Intensity (kWh/sf)	Thermal Energy Intensity (ekWh/sf)	Total Energy Intensity (ekWh/sf)
7120 Hurontario	15.63	7.76	23.38
10 Peel Centre Drive Suite A	11.31	6.38	17.70
10 Peel Centre Drive Suite B & C	9.61	5.99	15.60



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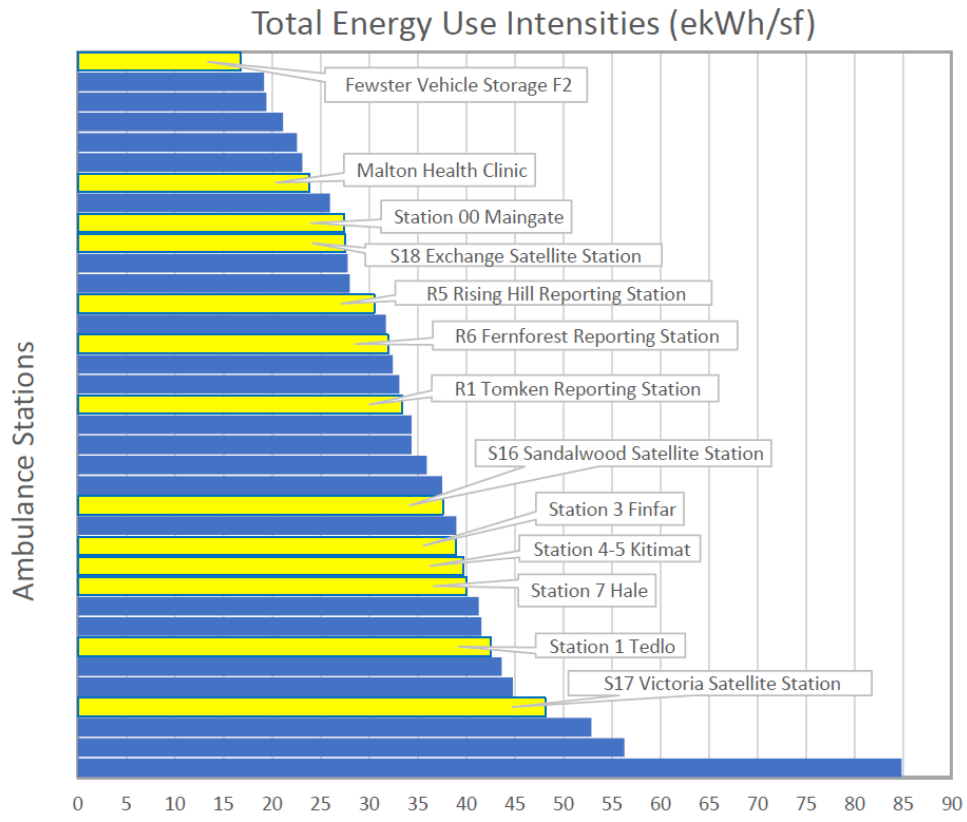
Region of Peel Admin Ambulance Stations vs. dataset benchmark

Ambulance Station	Electricity Intensity (kWh/sf)	Thermal Energy Intensity (ekWh/sf)	Total Energy Intensity (ekWh/sf)
S17 Victoria Satellite Station	8.60	39.53	48.13
Station 1 Tedlo	10.64	31.93	42.57
Station 7 Hale	7.14	32.94	40.07
Station 4-5 Kitimat	5.97	33.70	39.67
Station 3 Finfar	10.77	28.21	38.99
S16 Sandalwood Satellite Station	9.97	27.62	37.59
R1 Tomken Reporting Station	13.61	19.83	33.45
R6 Fernforest Reporting Station	22.08	9.90	31.97
R5 Rising Hill Reporting Station	14.58	15.96	30.54
S18 Exchange Satellite Station	7.62	19.95	27.57
Station 00 Maingate	12.79	14.60	27.39
Malton Health Clinic	13.57	10.24	23.81
Fewster Vehicle Storage F2	1.82	14.96	16.78



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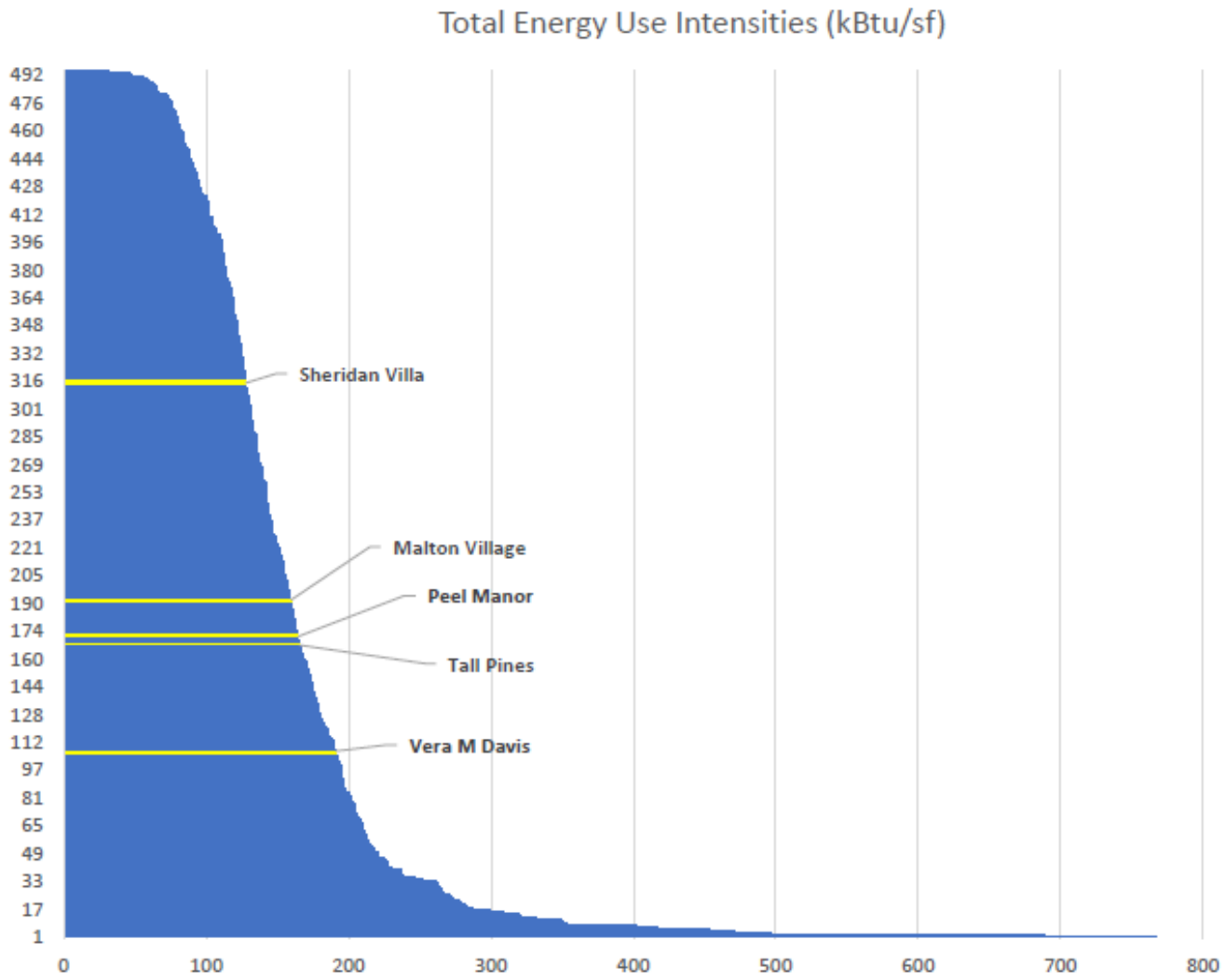
Region of Peel Long Term Care Facilities vs. dataset benchmark

Row Labels	Electricity Intensity (kWh/sf)	Thermal Energy Intensity (ekWh/sf)	Total Energy Intensity (ekWh/sf)	Total Energy Intensity (kBtu/sf)
Vera M Davis	18.82	37.14	55.96	190.94
Tall Pines	19.76	28.85	48.61	165.86
Peel Manor	18.78	29.41	48.19	164.42
Malton Village	18.37	28.32	46.69	159.30
Sheridan Villa	19.00	18.36	37.36	127.49



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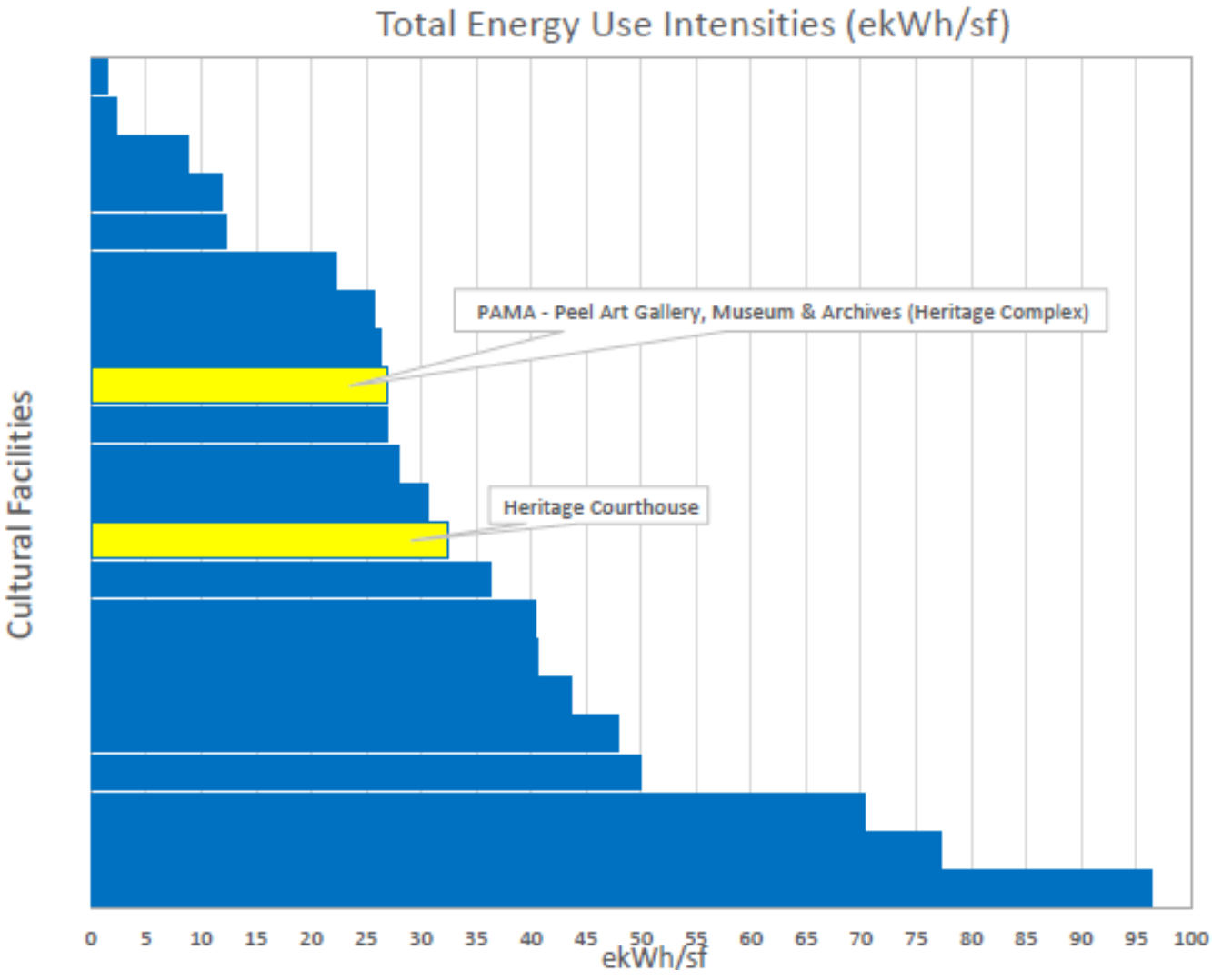
Region of Peel Cultural Facilities vs. dataset benchmark

Cultural Facility	Electricity Intensity (kWh/sf)	Thermal Energy Intensity (ekWh/sf)	Total Energy Intensity (ekWh/sf)
Heritage Courthouse	16.68	15.79	32.48
PAMA - Peel Art Gallery, Museum & Archives (Heritage Complex)	20.24	6.63	26.87



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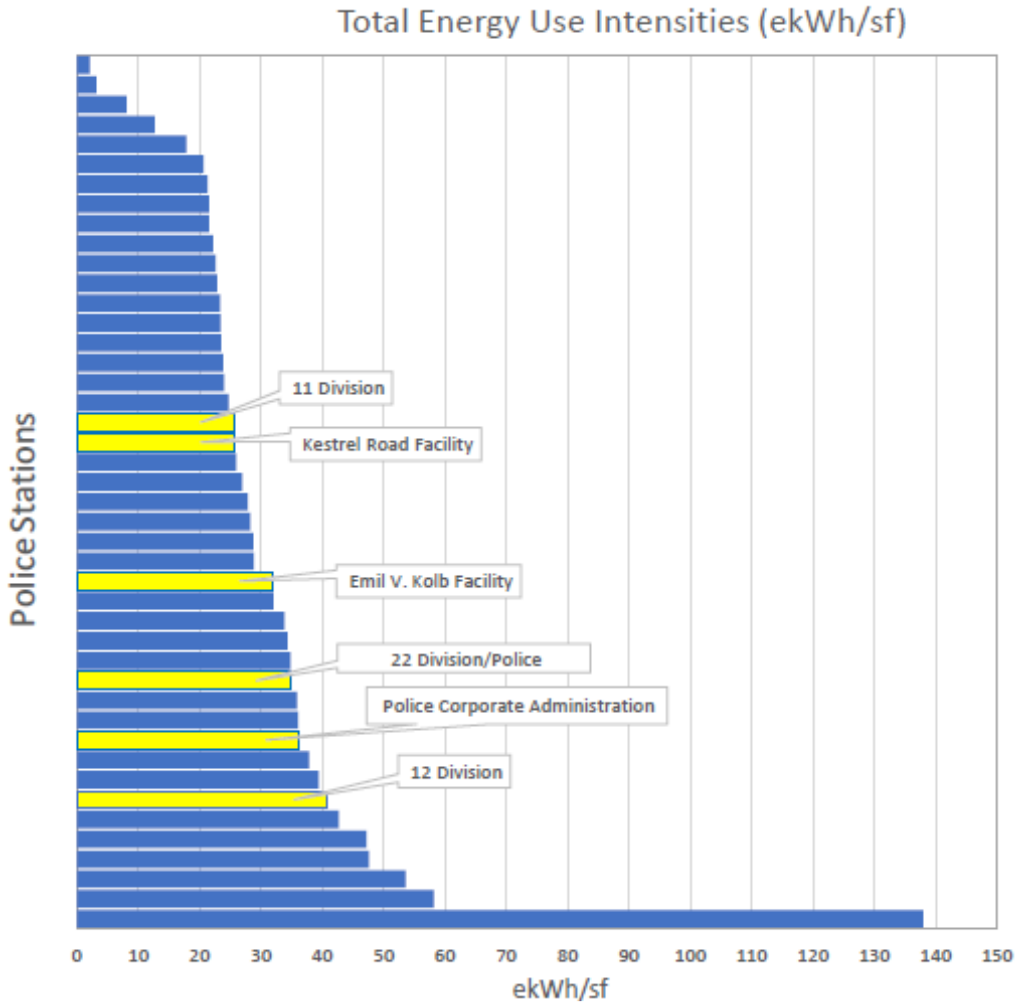
Region of Peel Police Stations vs. dataset benchmark

Police Stations	Electricity Intensity (kWh/sf)	Thermal Energy Intensity (ekWh/sf)	Total Energy Intensity (ekWh/sf)
12 Division	22.08	18.71	40.79
Police Corporate Administration	15.60	20.65	36.25
22 Division/Police HQ/Annex	22.00	12.69	34.69
Emil V. Kolb Facility	19.51	12.45	31.97
Kestrel Road Facility	10.44	15.24	25.68
11 Division	17.02	8.57	25.60



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Region of Peel Residential Buildings vs. dataset benchmark

Residential Building	Electricity Intensity (kWh/sf)	Thermal Energy Intensity (ekWh/sf)	Total Energy Intensity (ekWh/sf)
100 Garden Gate Circle	39.31	27.61	66.92
Brampton Queen St. Youth Shelter	49.51	0.00	49.51
Angelas Place	16.16	29.97	46.13
Cawthra Shelter	27.32	18.66	45.98
Peel Family Shelter	25.78	19.41	45.19
Queen Frederica	17.67	20.65	38.32
Chelsea Gardens	17.34	16.92	34.25
McHardy Place	7.28	24.20	31.48
Nance Horwood Place	9.55	19.58	29.13
14A Graham Court (Office)	29.06	0.00	29.06
East Avenue	14.95	13.68	28.63
Cliff Rd Grouped	7.74	20.39	28.13
Norton Lake	10.36	15.99	26.35
Westwood Place	12.22	13.28	25.51
Caroline Street	10.13	14.95	25.08
Creditvale Mills	11.28	13.79	25.07
Summerville Pines	7.17	17.50	24.68
Central Park	20.68	3.91	24.59
Stavebank	14.56	9.87	24.43
Surveyors Point	7.51	15.91	23.42
McHardy Crt Grouped	6.67	16.45	23.12
Weavers Hill	8.20	14.59	22.79
Manorbridge	10.83	11.88	22.71
Knightsbridge	15.49	5.98	21.46
Etude Drive	11.70	9.39	21.09
Maple Grove Road	20.82	0.00	20.82
Wilkinson Road Shelter	8.65	10.82	19.48
King Street	11.18	8.25	19.43
Maple Avenue	6.66	12.57	19.24
South Common Court	6.78	12.35	19.13
Gardenview Court	6.16	12.84	19.00
Fletchers View	8.65	10.09	18.73
Ridgewood Court	9.64	8.76	18.40
Pinnacle View	15.21	2.98	18.18
Fair Oaks Place	7.81	10.35	18.15
Whillans Gate	8.33	9.81	18.14
Derrybrae Place	5.90	12.13	18.03
Lakeview Promenade	10.60	7.05	17.65
William Street	12.22	5.38	17.60
Redmond	6.54	10.76	17.30
Riley Court	7.90	9.29	17.19
Bella Vista	6.53	10.62	17.15
Jane Street	16.83	0.27	17.10
Wedgewood Court	9.91	7.03	16.94
Springfield Gardens	10.00	6.86	16.86
Castlebrooke	5.81	9.91	15.71
Britannia Place	8.41	7.02	15.43
Conover	7.65	7.76	15.41
Millbrook Place	5.64	9.73	15.37
Lakeside Court	6.12	9.05	15.17
Hillside Place	10.06	4.91	14.97
Meadows	9.02	5.75	14.77
Sydenham Place	10.02	4.49	14.51
Fairview Place	8.26	6.23	14.49
Confederation Place	5.19	9.01	14.21
Riverview Terrace	9.13	4.49	13.63
Erindale Terrace	7.42	5.88	13.30
Arcadia Glen	7.46	5.81	13.27
Newhaven Manors	9.34	3.91	13.25
Colonial Terrace	12.30	0.12	12.43
Masons Landing	12.36	0.00	12.36
Snelgrove Place	5.03	7.32	12.35
Chapelview	5.40	4.57	9.97
Twin Pines	9.91	0.00	9.91

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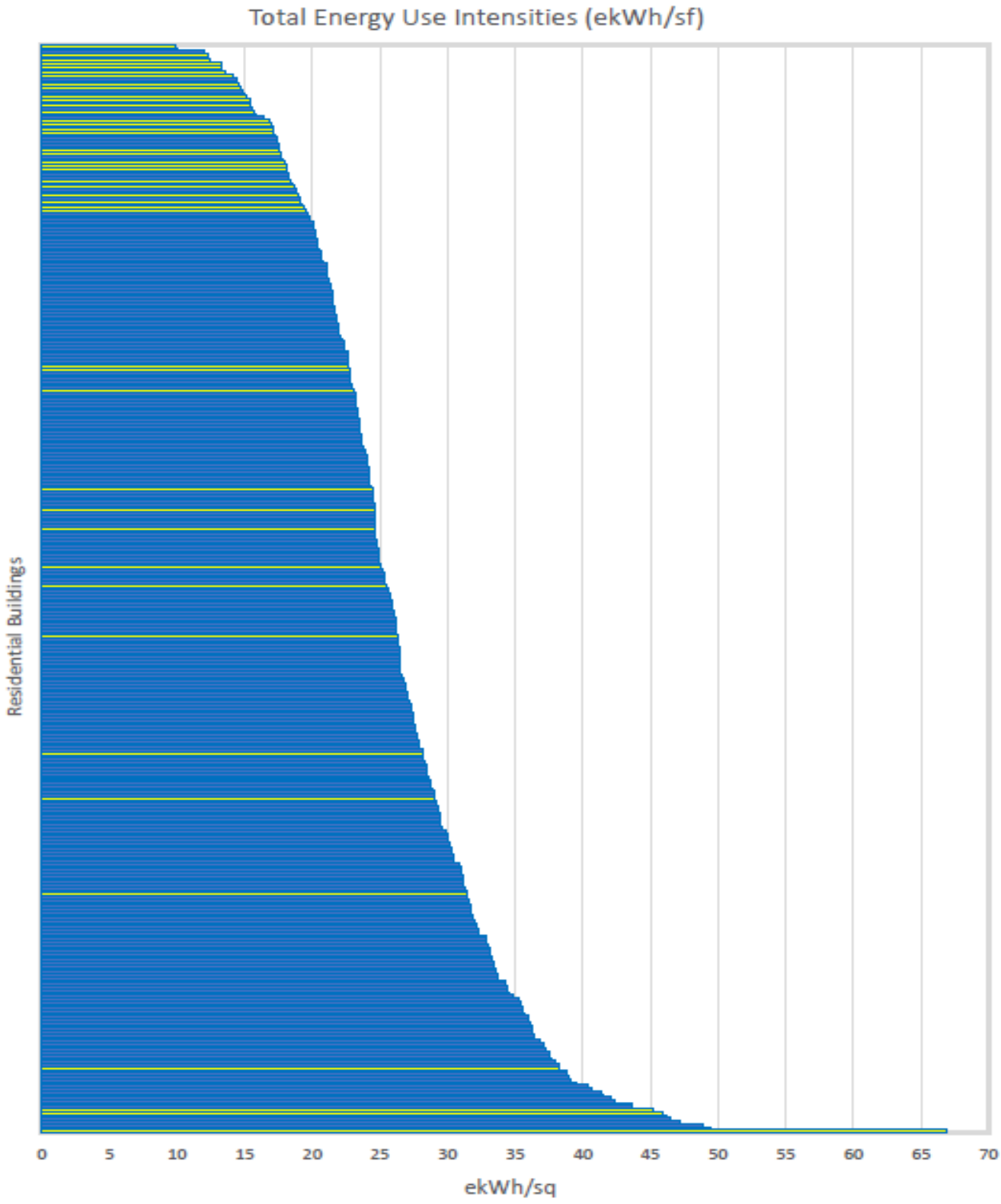

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Appendix C Fuel Switching Project at TRCA's Black Creek Pioneer Village

Figure 15 Black Creek Pioneer Village

Black Creek Pioneer Village (Figure 12) is an open air heritage museum located in Toronto that underwent the Performance Based Conservation analysis. It was originally opened in 1960 and is operated by TRCA. Black Creek Pioneer Village was identified as a high energy conservation potential building. Through subsequent site visits from engineers and consultants it was found that most of the major equipment was at or past end of life and due for replacement. As a result, Black Creek Pioneer Village was identified as a candidate for fuel switching from natural gas to electricity. The existing HVAC system consisted of water source heat pumps heated by an atmospheric natural gas boiler and cooled by a cooling tower. TRCA hired a consulting engineering firm to undertake a detailed assessment, develop alternative HVAC design options and associated business cases. The consultant submitted a business case that indicated that $1.4 million of capital investment would be required to replace the existing equipment like for like. An additional $635,000 investment would be required to replace the existing equipment with high energy efficiency VRF (Variable Refrigerant Flow) air source heat pumps.

Figure 16 Installed VRF Heat pump system

The business case for the VRF heat pumps indicated that the incremental investment in capital that would be required had a simple payback of 7 years and a 20-year net present value of over $526,000. The project details are shown in Table below. TRCA opted with replacing the existing system with VRF heat pumps which would produce an estimated GHG emissions savings of 123 tCO_2e.

	Electricity Use (MWh)	Natural Gas Use (MWh)	GHG Emissions (tCO_2e)
Pre Retrofit	734	771	167
Post Retrofit- Modelled	513	131	44

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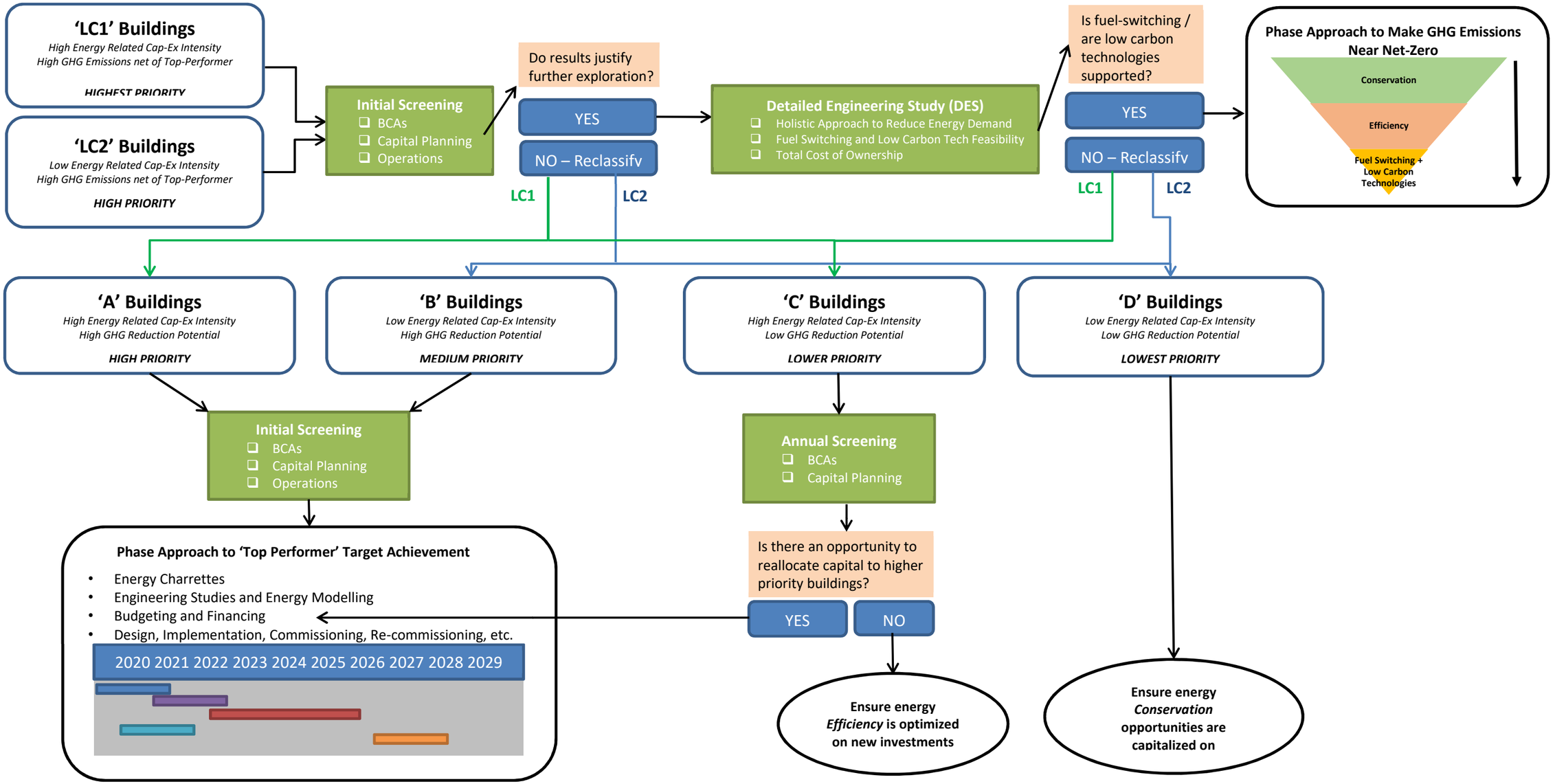
Appendix D: Building Prioritization Tool 1- Process Flow Chart



Appendix E: Building Prioritization Tool 2- Metrics Spreadsheet REDACTED