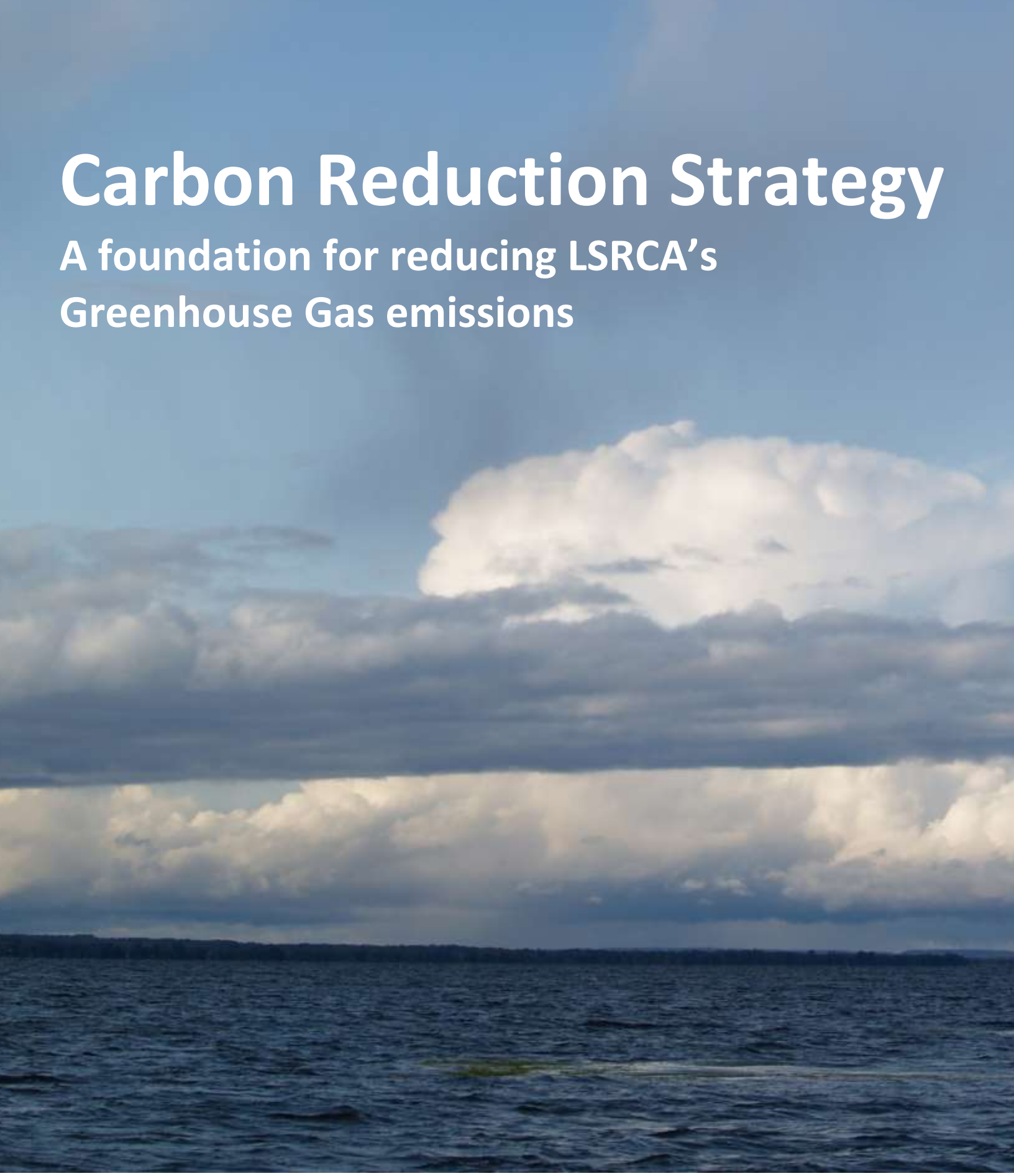
Carbon Reduction Strategy

A foundation for reducing LSRCA's Greenhouse Gas emissions



Lake Simcoe Region conservation authority

ClimateWise Business Network

Table of Contents

List of Figures

List of Tables

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Executive Summary

As a leader in environmental change, LSRCA recognizes the need to adapt its operations in order to help mitigate the effects of climate change. LSRCA has partnered with ClimateWise Business Network to develop a Carbon Reduction Strategy (CRS) in order to decrease its carbon footprint.

As per the ClimateWise framework, the CRS is structured around three different reporting categories, which are referred to as "Scopes". These Scopes were identified by the Greenhouse Gas Protocol, which is the global standard framework used by both private and public sectors, to measure and manage greenhouse gas (GHG) emissions. Scope 1 includes direct emissions from natural gas and fleet vehicles, which are produced at LSRCA facilities (Administrative Office, Scanlon Creek Operations Centre and the Scanlon Creek Nature Centre). Scope 2 includes indirect emissions from electricity which are generated at another facility and consumed at LSRCA facilities. Scope 3 emissions include all other indirect emissions that result from company activities (i.e. business travel and employee commute). Scopes 1 and 2 are mandatory reporting categories, while Scope 3 is an optional reporting category. As members of the ClimateWise program that seeks to uphold the reporting requirements and standards of the GHG protocol, these scopes have been used as the basis on which the CRS was developed.

The strategy provides various opportunities for reducing emissions from LSRCA operations including estimates of potential carbon emissions and potential financial implications. The carbon reduction and cost estimates associated with a specific opportunity are considered a guide to assist in identifying appropriate opportunities and implementation prioritization. It is fully expected that costs and carbon emission reduction opportunities will change over the course of the 10 year implementation timeframe due to factors such as changing markets, technology and subsidies.

Through the strategy, LSRCA is committed to reducing its overall carbon emissions 28% by 2026 from 2016 baseline emissions, while also experiencing a projected 15% staffing increase. LSRCA is also committed to report on its emissions annually and monitor progress throughout the 10 year timeline. An implementation plan will also be developed to assign specific activities and timelines and to determine additional resources required to achieve the carbon reduction target.

The approach to the development of the CRS was determined through a number of considerations including a thorough review of reduction options, weighing both cost and benefit of each option (i.e. calculating cost per kg of CO_2 reduced and estimated carbon reduction potential), and calculating a business as usual (BAU) and a growth projection (over the next 10 years) for the organization. This data was then compared to the baseline emissions of 2016 and run through the different carbon reduction scenarios. Carbon reduction targets were then calculated based on the difference in carbon reduction between the BAU status quo carbon levels and the reduced carbon levels after implementation of recommended emission reducing activities. This approach was taken for all scopes and a separate analysis was done for each. The calculated differences were identified as the carbon reduction targets for the Carbon Reduction Strategy.

Carbon Reduction Strategy

Scope 1 (Fleet Vehicles)

Current Status

Fleet vehicle usage is LSRCA's largest contributor to total CO_2 emissions, at 55% (excluding staff commute). LSRCA owns or leases many different types of vehicles, the majority of which consume gasoline or diesel fuel. Addressing LSRCA's fleet vehicle use represents the greatest carbon reduction opportunity.

There has been a recent shift in the automotive industry to more sustainable and renewable modes of transportation including alternative fuel vehicles. As a result of this shift, LSRCA is observing major changes in terms of availability, cost, charging station availability and government incentives. Transitioning to a more sustainable, low-carbon approach to purchasing fleet vehicles will become increasingly more feasible and not only result in carbon reductions for the organization but also savings associated with rising fossil fuel costs.

Carbon Reduction Opportunities

A thorough assessment of LSRCA's current vehicles in terms of type, intended use, fuel efficiency, and frequency of use revealed various opportunities for reducing carbon emissions. Fleet vehicle upgrades and replacements were examined using varying levels of improved efficiency with associated costs and carbon reductions. An aggressive approach to fleet upgrade was chosen in order to assist with a transition to more fuel efficient and appropriately sized vehicles in the future. This opportunity presents an estimated 55% reduction in fleet vehicle carbon emissions from 2016 baseline emissions with marginal increase in cost (Table 1). The behavioral changes associated with the strategy account for an additional 5% reduction of fleet vehicle emissions. The costs associated with this strategy include the staff time required to support and deliver programs and/or initiatives aimed at reducing the number of vehicle trips, reducing single occupancy trips, ensuring right vehicle for the trip is being used, and ensuring staff is using the vehicle most efficiently (Table 1).

Table 1: Recommended opportunities for fleet vehicles (both fleet upgrade and behavioral) and their associated costs and carbon reductions (% and tCO_2e)

Recommended Opportunity	Estimated Cost ($)	Estimated Carbon Reduction (tCO_2e/yr)	Estimated Carbon Reduction (%)*
Aggressive vehicle replacement strategy	$7,615 (per 5 year replacement cycle) $10,000 (2 new EV charging stations)	37	55%
Behavioral Change (Reduce number of trip, reduced single occupancy, right vehicle, efficient use)	$11,500 (per year)	3.6	5%
Total	**$29,035**	**40.6**	**60%**

*Compared to 2016 baseline emissions

Overall Target

LSRCA is committed to reducing absolute carbon emissions from fleet vehicles operations **60% by 2026 from 2016 baseline emissions**. This will be largely achieved through a systematic upgrade to fleet vehicles. This would result in an estimated annual emission reduction of 40 tCO_2e by 2026.

Financial Implications

Systematic replacement of LSRCA fleet with electric vehicles (EV) and Plug-in Hybrid Electric Vehicles (PHEV) is by far the most cost effective of all emission reduction opportunities. The cost estimates indicate that an aggressive fleet vehicle replacement strategy has a relatively small overall additional cost ($7,615) compared to a replace with like vehicle approach. The low additional cost can be attributed to reduced fuel costs over the lifespan of the vehicle and declining costs of PHEV and EVs. While additional cost is marginal when fuel savings are accounted for, the upfront purchase costs can be higher and will need to be factored into the budget process. As more fleet vehicles are replaced with PHEV and EVs, additional charging stations will also need to be installed, costing in the order of $5,000 each when considering capital and installation costs.

The behavioral components of this strategy are currently managed solely by LSRCA's volunteer SWITCH committee. To expand these efforts and ensure the reduction target is met, it is recommended that a staff person's official duties be expanded to coordinate and help implement behavioral change strategies. To implement strategies for fleet vehicle emission reductions, an estimated 10 days/year is required at an approximate cost of $2,500. Additional potential behavioral change costs identified for programs such a fleet tracking and promotion of public transit.

Scope 1 (Natural Gas)

Current Status

Natural gas consumption is the third largest contributor to LSRCA's total carbon emissions at 22%. LSRCA's Administrative Office facility currently uses natural gas for space heating and domestic hot water supply, which accounts for 54% of total energy consumed within the office. The Administrative Office facility has been designed to incorporate some Leadership in Energy and Environmental Design (LEED) standards at the silver level and is currently operating relatively efficiently in terms of its HVAC system and Building Automation System (BAS). However, the unevenness of temperature between the upper and lower floors still remains an issue. This differential heating results in staff using space heaters or opening windows to increase their comfort levels, which in turn impacts the temperature control systems. Therefore, the strategy focuses heavily on trying to rectify this issue.

Recommended Opportunities for Carbon Reduction

The carbon reduction strategy for natural gas encompasses a set of mutually reinforcing reduction opportunities with respect to facilities (mechanical and operational) and behavioral aspects of the organization to reduce overall consumption. Each opportunity was assessed based on the associated costs, savings and estimated carbon reductions. Those that were feasible and provided a great benefit to reducing carbon emissions as well as human comfort were considered as part of the strategy (Table 2).

LSRCA facilities staff have advised that the current HVAC and BAS equipment is up to date and operating as efficiently as possible; and therefore, there are no improvements to make at this time. An assessment of these temperature control systems will be conducted in 5 years' time to determine if there are more efficient models available.

The recommended reduction opportunities from a facilities perspective include maintaining mechanical efficiency and ensuring efficient operation and control of the HVAC/BAS, along with reducing air leakage by weather stripping. The recommended behavioral opportunities focus on fostering behaviours that support reducing carbon emissions from natural gas consumption and ensuring staff are reducing the load on the temperature control systems.

Table 2: Recommended opportunities for natural gas reduction (both facilities and behavioral) and their associated costs and carbon reductions (% and tCO_2e)

Recommended Opportunity	Estimated Cost ($)	Estimated Carbon Reduction* (tCO_2e/yr)	Estimated Carbon Reduction (%)*
Facilities - building envelope and BAS/HVAC	$1,800 (excluding any future HVAC upgrades)	>2	>6%
Behavioral Change	$500/year	0.3	1%
Total		>2.3	>7%

*Compared to 2016 baseline emissions

Overall Target

LSRCA is committed to reducing absolute carbon emissions from natural gas consumption **7% by 2026 from 2016 baseline emissions**. The reduction target has been set based on an evaluation of the estimated absolute emissions reductions from the recommended reduction opportunities. Estimated annual carbon reduction will be approximately 2.3 tonnes of carbon.

Financial Implications

Cost associated with implementing the identified emission reductions are low, being a one-off capital expense of $1,800 to maintain the building envelope (weather stripping) and an annual $500 cost towards staff salary for coordinating behavioral change opportunities.

The greatest future potential expense that is not costed in the strategy relates to updates to all or parts of the HVAC/BAS system. As the current system is both relatively new and employs various energy efficiency elements (e.g. heat exchange), it was advised that an assessment be completed in five years' time when the current system is older and new technologies may be available.

Scope 2 (Electricity)

Current Status

Due to the recent elimination of coal-fired generation from Ontario's electricity system, electricity consumption now contributes very little to LSRCA's overall carbon emissions, at only 12.6%. LSRCA currently uses electricity in all facilities for a wide variety of applications such as lighting, cooling, ventilation, supplemental heating, and office equipment. The Scanlon Creek Operations Centre runs largely on hydroelectric power and therefore uses electricity for these as well as for heating and domestic hot water supply. However, the reduction strategy focuses on the Administrative Office facility since the Scanlon Creek Operations Centre will be undergoing a renovation and incorporating energy efficient electricity into the new design.

Main Opportunities

It was determined that office equipment, lighting, and heating ventilation and air conditioning (HVAC) consume the most electricity; therefore, the reduction opportunities focus on these main areas. The strategy for carbon reduction with respect to facilities includes upgrades to more efficient LED lighting, more efficient office equipment, and newer and more efficient electric baseboard heating equipment. In terms of behavioral change, the strategy focuses on encouraging employees to reduce lighting, reduce energy consumption of office equipment and reduce impacts to the HVAC and BAS by limiting opening windows (Table 3).

Table 3: Recommended opportunities for electricity reduction (both facilities and behavioral) and their associated costs and carbon reductions (% and tCO_2e)

Recommended Opportunity	Estimated Cost ($)	Estimated Carbon Reduction (tCO_2e/yr)	Estimated Carbon Reduction (%)*
Facilities	(-$20,000) (one time saving)	4	25%
Behavioral	$1,500/year	0.8	5%
TOTAL		4.8	30%

*Compared to 2016 baseline emissions

Overall Target

LSRCA is committed to reducing absolute carbon emissions from electrical consumption, with a target of **30% reduction by 2026 from 2016 baseline emissions**. The reduction target has been set based on an evaluation of the estimated absolute emissions reductions from the recommended reduction opportunities. Estimated annual emission reduction by 2026 is 4.8 tCO_2e.

Financial Implications

Based on 2016 baseline electricity consumption and price, a 30% reduction in electricity use could save LSRCA an estimated $23,000 per year. This savings may be considerably higher by 2026 if the projected increases in electricity prices transpire. Savings associated with the reduced cost to LSRCA would be sufficient to offset annual expenses associated with implementing the known projects. While the ClimateWise framework prohibits LSRCA from accounting for the carbon associated with installation of the solar panels (to avoid double counting), it should be noted that the panels will generate approximately $9,000/year which can also be used to support emission reduction opportunities.

Upgrading desktop computers to virtual desktops is estimated to save the organization approximately $700 per unit equating to a total saving of $28,000 if 40 units are replaced. An estimated cost to upgrading lighting and baseboard heaters is $7,622. Overall savings to the organization through implementing the recommended opportunities is therefore approximately $20,000. However, it should be noted this does not include the unknown cost of upgrades to the HVAC system or installation of window film. Whether these particular opportunities proceed will be assessed at that time based on the cost and associated emission reduction estimates.

Scope 3 (Business Travel)

Current Status

Business travel contributes the least amount to overall carbon emissions, at only 6.52%. This emission category includes the emissions generated from staff using their personal vehicles for business travel.

Main Opportunities

The carbon reduction strategy for business travel will align with the behavioral reduction strategy for Fleet Vehicles (Scope 1) and will include opportunities such as reducing the number of vehicle trips and promoting the use of public transit. Proposed opportunities may contribute an estimated 5% reduction in business travel related emissions (Table 4).

Table 4: Recommended opportunities for business travel (behavioral) and their associated costs and carbon reductions (% and tCO_2e)

Recommended Opportunity	Estimated Cost ($)	Estimated Carbon Reduction* (tCO_2e/yr)	Estimated Carbon Reduction (%)*
Behavioral Change (Reduce number of trips & single occupancy, right vehicle, efficient use)	Accounted for under fleet vehicle scope	0.42	5%
TOTAL		**0.42**	**5%**

*Compared to 2016 baseline emissions

Overall Target

LSRCA is committed to reducing absolute carbon emissions from business travel **5% by 2026 from 2016 baseline emissions**. The reduction target has been set based on an evaluation of the estimated absolute emissions reductions from the recommended reduction opportunities. Estimated annual emission reduction by 2026 is 0.42 tCO_2e

Financial Implications

The budget and implementation will be the same as the Fleet Vehicle budget and implementation plan.

Scope 3 (Employee Commute)

Current Status

The carbon emissions generated from employee commute constitute the largest percentage of LSRCA's total carbon emissions, at 65%. To obtain a more comprehensive understanding of staff commute habits, an internal online survey was conducted. From this, it was determined that through carpooling, biking, or other modes of transportation, LSRCA has reduced its CO_2e emissions in 2016 by 30 tonnes, or 15% compared to emissions from single occupancy vehicle commute.

Main Opportunities

There exists a clear need to reduce the amount of carbon emissions associated with employee commute. However, as these opportunities (such as compressed work week and telecommuting) are more complex and require dedicated staff time from the Human Resources department, they will be thoroughly evaluated, and the strategy and target will be updated by the end of 2021.

Carbon Reduction Target

Through the opportunities set out in the strategy, LSRCA has set an absolute emissions reduction target of 28% by 2026 (Figure 1). This target accounts for projected growth of the organization and successful implementation of the various opportunities identified. A review of 10 year reduction targets of similar organizations shows a range between 30% (e.g. TRCA) to 10% (e.g. Rankin College), highlighting the aggressive nature of the target. This target may be adjusted in the future once additional information and decisions related to staff commute and upgrades to the Administrative Office HVAC/BAS are considered.

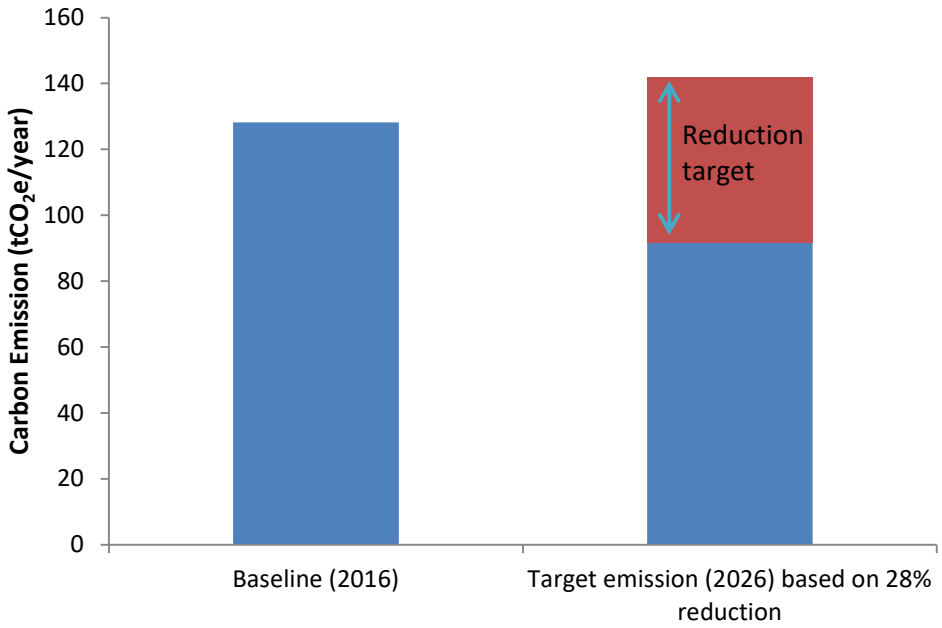

Figure 1: The overall absolute reduction target from 2016 baseline emissions to be achieved in 2026

In addition to an absolute reduction target, LSRCA is setting an intensity based target of 38% per capita. The per capita target accounts for both the absolute reduction target (28%), while also accounting for the estimated organizational increase in number of staff by 15% by 2026. In 2016 the carbon emission for each employee was an estimated 1,282 $kgCO_2e$. When accounting for a projected 15% increase in staff and the 28% absolute reduction target, the emission per person would be 796 $kgCO_2e$/year (Figure 2).

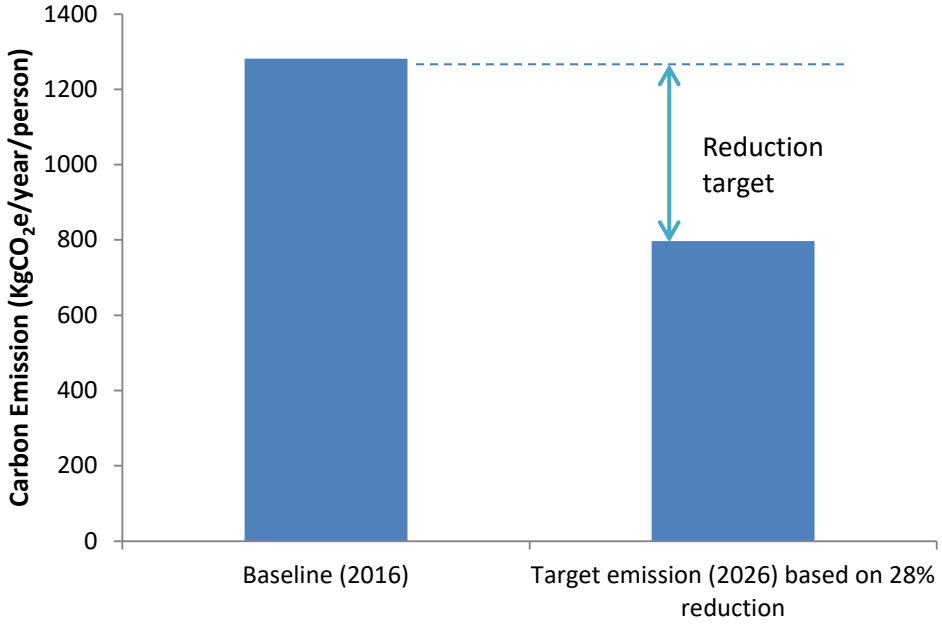

Figure 2: Intensity based target of 37% per employee by 2026

Implementation

Implementation of the carbon reduction strategy (CRS) is the crucial next step. An implementation plan will be created to address who, where, when and how LSRCA will reach the identified carbon reduction targets.

As a leader in the field of environmental conservation, LSRCA has high expectations for the carbon reduction program. The successful implementation of the CRS will require an organization wide sustained effort with a focus on governance, communication, data management, and monitoring and evaluating progress.

Introduction and Background

The Lake Simcoe Region Conservation Authority (LSRCA) is a local watershed management organization, incorporated under the Conservation Authorities Act (1946). Since 1951, LSRCA has been dedicated to conserving, restoring and managing the Lake Simcoe watershed. LSRCA jurisdiction, which began in the East Holland River with five municipalities, has grown to include the entire Lake Simcoe watershed with the exception of the City of Orillia and the Upper Talbot River subwatershed. LSRCA envisions a thriving environment that inspires and sustains us for generations to come. LSRCA's mission is to work with the community to protect and restore the Lake Simcoe watershed by leading research, policy and action.

LSRCA currently employs approximately 100 employees which occupy three main operational buildings:

- A 19,000 sq. ft. Administrative Office building located in Newmarket;
- A 16,200 sq. ft. Operations Centre located at the Scanlon Creek Conservation Area in Bradford West Gwillimbury. The Operations Centre also includes a number of outbuildings including a workshop, garage and storage area;
- A 3,000 sq. ft. Nature Centre located at the Scanlon Creek Conservation Area in Bradford West Gwillimbury.

LSRCA is committed to mitigating its impact on the climate through the implementation of a corporate Carbon Reduction Strategy. This commitment is identified as a priority action within the 2016-2020 Strategic Plan. In 2016, LSRCA became a founding member of the ClimateWise Business Network, which is a network of businesses and institutions within York Region who are setting and achieving sustainability goals. LSRCA will be using their reporting and target setting framework to set and achieve its carbon reduction goals.

Through this strategy LSRCA wants to demonstrate corporate leadership in climate change mitigation through its efforts in reducing corporate carbon emissions and carbon footprint from its current and future operations. The strategy provides priority carbon reduction opportunities based on estimated potential reductions and cost, leading to the development of an overall carbon reduction target. As mentioned above, an accompanying implementation plan will provide specific milestones and timelines to help reach the target. LSRCA will reach these goals with support from its board members, leadership team, staff, as well as from its internal SWITCH committee.

Overview of Current Emissions

Emissions and Scope Selection

The Greenhouse Gas Protocol outlines three different types of Scopes, they are as follows:

- **Scope 1 Emissions** are defined by ClimateWise as "emissions that occur from sources that are owned or controlled by the company." LSRCA specific scope 1 emissions are:
    - Fleet vehicle
    - Natural gas and furnace oil
- **Scope 2 Emissions** are defined by ClimateWise as "emissions that account for GHG emissions from the generation of purchased electricity consumed by the company. These emissions physically occur at the facility where electricity is generated." LSRCA specific scope 2 emissions are:
    - Electricity
- **Scope 3 Emissions** are defined by ClimateWise as "an optional reporting category that allows for the treatment of all other indirect emissions". They are a "consequence of the activities of the company, but occur from sources not owned or controlled by the company" (ClimateWise Action Planning Guidance document). LSRCA specific scope 3 emissions are:
    - Employee Commute (To be confirmed within 2 years)
    - Business travel

The ClimateWise program dictates that Natural Gas consumption (Scope 1), Fleet Vehicle Mileage (Scope 1) and Electricity consumption (Scope 2) are mandatory reporting categories and must be included in a Carbon Reduction Strategy. It was determined through an energy audit that Scope 3 emissions such as paper, waste, and water contributed a negligible amount to total energy use and will therefore not be included within the strategy. However, the Scope 3 emissions that present the greatest opportunity for reducing carbon emissions are those generated from employee commute and business travel, and will therefore be included within the strategy.

Emissions Baseline and Methodology

A baseline is essential in order to monitor the success of the actions outlined in a Carbon Reduction Strategy. LSRCA will use 2016 as the baseline year from which the carbon reduction targets will be based and the success of the strategy will be measured. This specific year was chosen as there was very little difference in consumption between 2014 or 2015.

The method used to calculate the baseline consisted of gathering information on usage from various sources from the years 2014 to 2016. The amount of fuel consumed from fleet vehicles (L of gasoline and diesel) was obtained from vehicle fuel bills, the amount of electricity (kWh) was obtained from Hydro One and Newmarket Hydro bills, the amount of natural gas used (m^3) was obtained from Enbridge Gas Distribution bills, the amount business travel was obtained from the distance (km) traveled by staff recorded in expense claim forms, and the amount of employee commuting (km) was obtained from an internal, company-wide survey. In order to determine carbon emissions associated with the consumption of all these activities, the appropriate emission factor was applied to each. These emission factors are based on those provided by ClimateWise and can be found in Table 5.

Table 5: Emission factors used for all calculations in the carbon reduction strategy

	Emission Factor Used	Unit
Electricity	0.041	kg/kWh
Natural Gas	1.89	kg/m^3
Diesel	2.71	kg/L
Gasoline	2.30	kg/L
Heavy Fuel Oil (Furnace oil)	3.41	kg/L

An overview of LSRCA's 2016 baseline emissions for each scope can be seen in Tables 6 & 7 and Figures 3 & 4. As potential inclusion of employee commute into the strategy is being delayed until 2021, when a detailed review has been undertaken, the baseline used in this current version of the strategy does not include employee commute. However, to illustrate the importance of including employee commute due to high associated emissions both depictions with and without employee commute have been included below.

Table 6: Overview of LSRCA's 2016 Baseline carbon emissions with employee commute

Scope	Activity Type	Amount	Emissions (tCO_2e)	% of Total Emissions
1	Fleet Travel (Diesel, L)	2,058	5.58	1.53%
	Fleet Travel (Gasoline, L)	28,477	65.50	17.99%
	Furnace Oil (Heavy Fuel Oil, L)	1,095	3.73	1.03%
	Natural Gas (m^3)	15,201	28.73	7.89%
2	Electricity (kWh)	393,320	16.13	4.43%
	Employee Commute (Km)	N/A	236.13	64.85%
3	Business Travel (Km)	39,046	8.35	2.29%
	TOTAL	**N/A**	**364.14**	**100%**

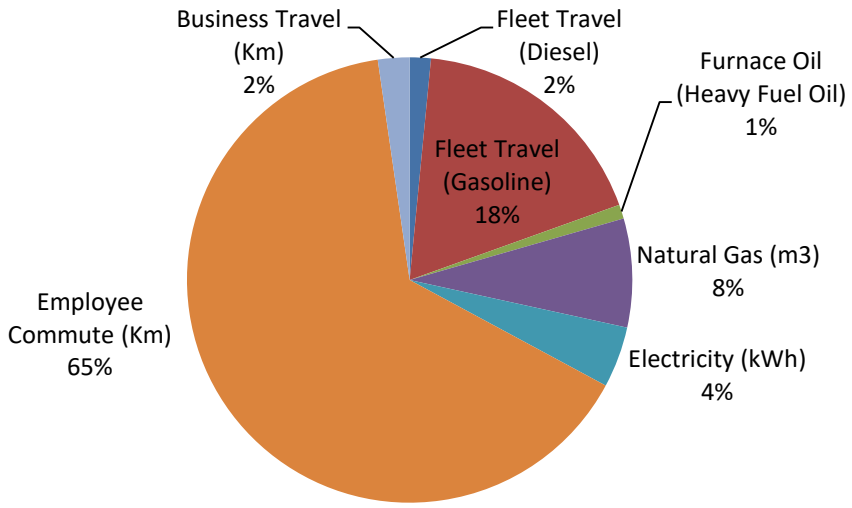

Figure 3: The contribution (%) of each emission category to total CO_2 emissions in 2016, with employee commute. Decision as to whether employee commute can be included in the strategy is pending detailed assessment.

Table 7: Overview of LSRCA's 2016 Baseline carbon emissions without employee commute.

Scope	Activity Type	Amount	Emissions (tCO_2e)	% of Total Emissions
1	Fleet Travel (Diesel, L)	2,058	5.58	4.36%
	Fleet Travel (Gasoline, L)	28,477	65.50	51.16%
	Furnace Oil (Heavy Fuel Oil, L)	1,095	3.73	2.92%
	Natural Gas (m3)	15,201	28.73	22.44%
2	Electricity (kWh)	393,320	16.13	12.60%
3	Business Travel (Km)	39,046	8.35	6.52%
TOTAL		**N/A**	**128.01**	**100%**

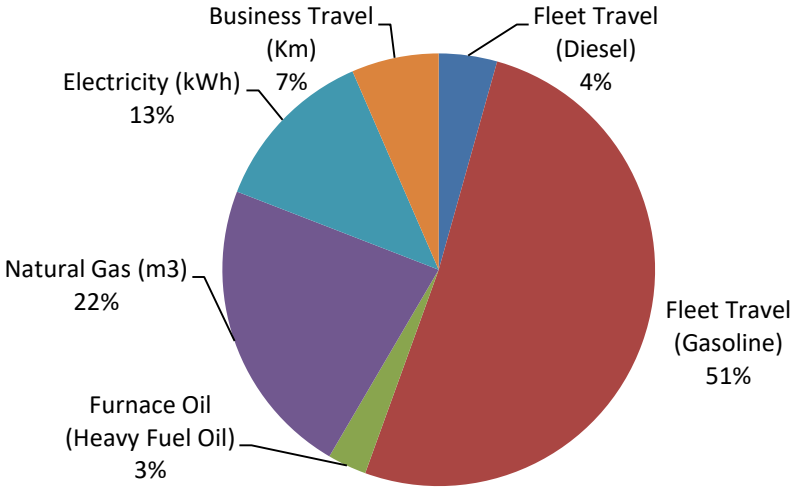

Figure 4: The contribution (%) of each emission category to total CO_2 emissions in 2016, excluding employee commute.

Carbon Reduction Strategy and Target

The carbon reduction strategy and associated target act as the bridge from the baseline year emissions to the implementation of specific projects that will reduce carbon emissions in the years to follow. For each Scope, a strategy was prepared that provides information required to reduce the emission, such as costs and resources, over a 10 year period. Within each Scope, there are reduction opportunities pertaining to changes on a behavioral and a facilities level. The strategy also ensures realistic targets are being set and emission reductions are regularly monitored so that the overall reduction target can be achieved. It should be noted that the carbon reduction and cost estimates associated with a specific opportunity are considered a guide to assist in identifying appropriate opportunities and implementation prioritization. It is fully expected that costs and emission reduction opportunities will change over the course of the 10 year implementation timeframe to due factors such as changing markets, technology and subsidies.

There are two types of targets outlined in the ClimateWise program, absolute and intensity based. Absolute targets are defined as “a reduction in the total amount of GHGs emitted, waste generated or water used by the target year relative to the baseline year” on a company wide scale. Intensity based targets are defined as “a reduction in the total amount of GHGs emitted, waste generated or water used per unit of a particular metric, such as square footage of operational space, production unit, or number of employees” (ClimateWise, n.d.). Projected growth within the organization over the next several years will ultimately result in a continued increase in energy consumption, which makes achieving an absolute reduction in GHG emissions more difficult.

Although intensity based targets allow an organization to account for future growth, LSRCA will be using absolute targets for the carbon reduction strategy but also some targets using intensity targets, in order to illustrate change on an individual staff basis. Estimating future growth of the organization is an inherently difficult task as past growth is not always representative of future growth, due to changes in funding, programs and services provided, and overall economy. For the purposes of this strategy a growth of 15% has been set, however, this will have to be periodically revaluated depending on actual growth rates.

Scope 1 Emissions

Fleet Vehicles

Current Status

Fleet vehicle usage is LSRCA's largest contributor to total CO_2 emissions when staff commute emissions are not factored (Figure 5). In the 2016 baseline year, LSRCA owned or leased around 16 corporate vehicles of varying types including a boat, large pick-up trucks, and mid-size cars/SUVs and an electric vehicle (EV). It should be noted that since the 2016 baseline year LSRCA has leased three plug-in hybrid electric vehicles (PHEV), updated the EV and made other vehicle changes. These vehicles are used by staff in all departments for various work related activities.

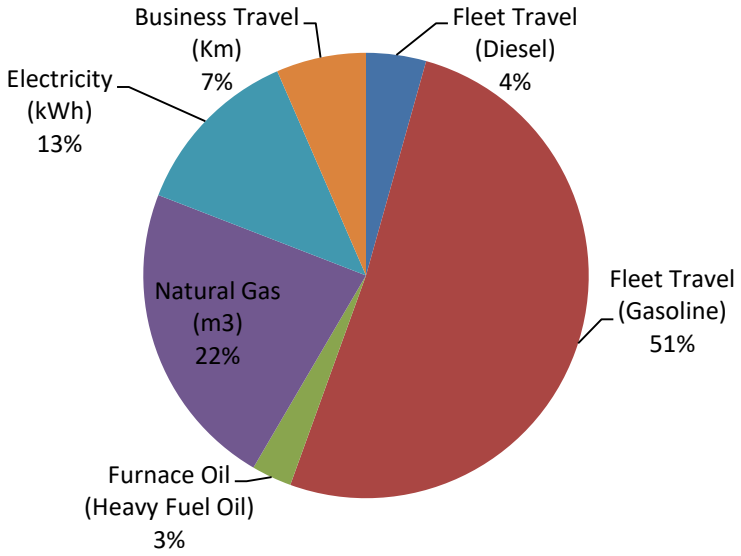

Figure 5: The contribution (%) of each emission category to total CO_2 emissions in 2016

The small to mid-size vehicles are suited for staff requiring travel for site visits, meetings, events, workshops, etc. While the EV (Nissan Leaf) used during the 2016 baseline year had a limited range of 150km, the new EV leased in 2018 has a range of 300km, eliminating some of the range anxiety issues associated with the first EV. The large pick-up trucks are suited for the transportation of large quantities of materials/equipment on and off-site. However, the large capacity trucks that are currently used for monitoring may not necessarily need to be as large as the current vehicle to deliver the same job. This presents an opportunity for right sizing vehicles and replacing current fleet vehicles with ones that are more suitable.

Figure 6 shows the fuel efficiency of existing vehicles in L/100km (amount of fuel used per unit distance). The fuel efficiency rating data comes from 2016, 2017 and 2018 "Fuel Consumption Guide" documents created by Natural Resources Canada. It is evident from this graph that the Nissan Leaf EVs and hybrid vehicles (Ford C-Max and Ford Fusion Energi) have the least amount of L/100km, meaning that they consume the least amount of fuel and are therefore the most fuel efficient out of all the current fleet

vehicles. In contrast, the large pick-up trucks have the highest amount of L/100km and are therefore the least fuel efficient.

Although the Nissan Leaf does not consume fuel, it has a fuel efficiency rating of 2.1 L_e/100km, to account for the electricity equivalent of gasoline (one litre of gasoline contains the energy equivalent of 8.9 kWh of electricity).

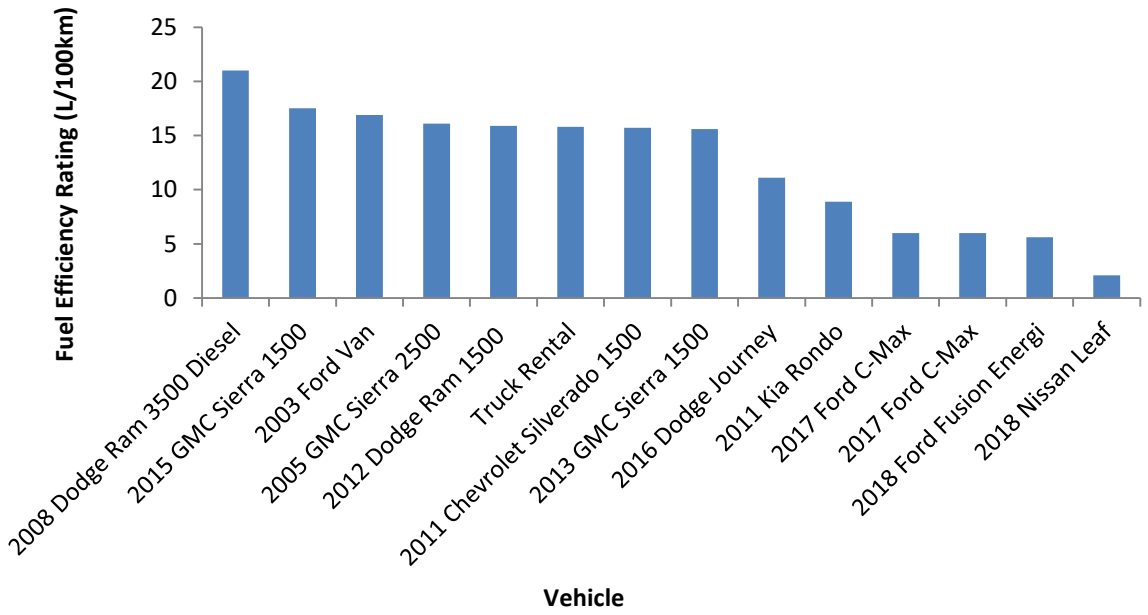

Figure 6: Fuel efficiency ratings (L/100km) of all current LSRCA fleet vehicles

A breakdown of fleet vehicle usage (in km) for 2016 is shown in Figure 7. The figure shows a broad spectrum of vehicle use across the organization, with some vehicles having a very high annual usage while others such as the Nissan Leaf travelling very few kilometers each year. It should be noted that the newly leased hybrid vehicles and EV are not shown in this figure as they were only recently purchased and therefore there is no usage data available yet.

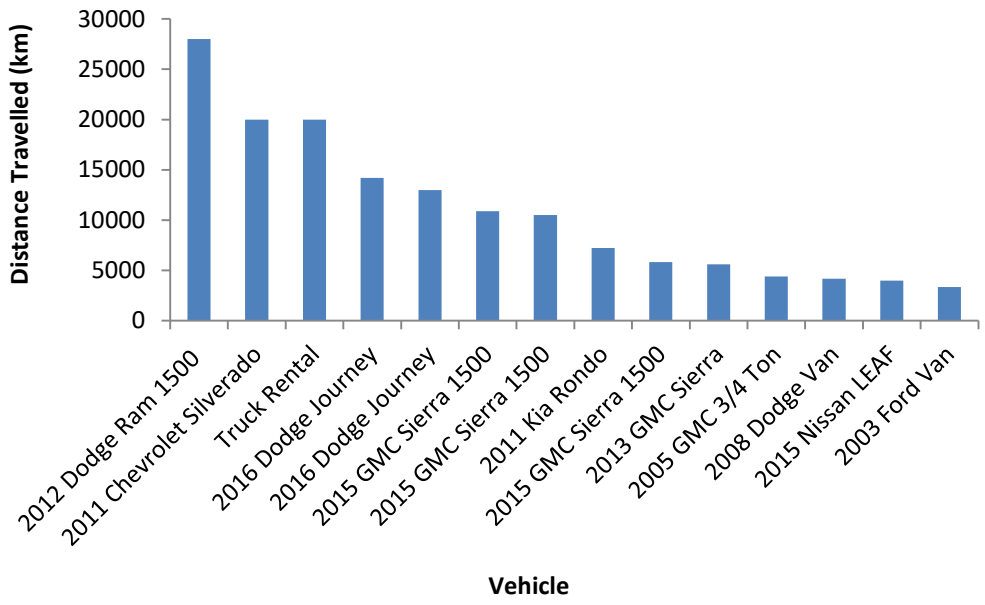

Figure 7: Distance travelled (km) in 2016 by all current LSRCA fleet vehicles

Overall, the Nissan Leaf is the most fuel efficient among all the current fleet vehicles and is used the least often. Therefore, increasing the number and use of EVs and PHEVs, along with right sizing vehicles presents the greatest opportunity for reducing carbon emissions from fleet vehicles.

It should be noted that the contributions to total emissions from the research vessel operations are negligible as it is currently operating at maximum efficiency.

Emission Forecasting

It is important to recognize which factors will influence carbon emissions in the future in order to set achievable targets. It is expected that over the next 10 years, LSRCA will experience growth within the organization, resulting in an increase in the number and use of fleet vehicles and an increase of the overall Scope 1 fleet vehicle emissions (Table 5). Based on best available information, LSRCA is projecting a 15% growth rate over the next 10 years. This growth rate was applied to the 2016 baseline to determine the Business As Usual (BAU) emissions for 2026. During the 10 year lifespan of the strategy it may be necessary to reassess the growth rate and adjust forecast emissions and target accordingly.

Table 5: 2016 Baseline emissions from fleet vehicles (diesel and gasoline) and 2026 Business As Usual (BAU) emissions

	Baseline Emissions 2016 (tCO_2e)	BAU Emissions 2026 (tCO_2e)
Total Emissions from Fleet Vehicles	71.08	81.74

Carbon Reduction Opportunities

In order to create a strategy that will offset the increase in carbon emissions as a result of growth, various reduction opportunities were explored from both a fleet upgrade and a behavioral perspective. Within each reduction opportunity, cost, savings and estimated carbon reduction potential were determined. These can be viewed in further detail in the following sections.

Facilities

Fleet Upgrade

The automotive industry is rapidly changing and evolving as the world becomes less dependent on fuel and more dependent on sustainable resources. Manufactures are continuing to explore emerging technologies and incorporate them into alternative fuel vehicles such as full or hybrid electric vehicles. As these changes continue into the next 10 years, the world is going to observe major changes in cost structure as costs of batteries decrease, and the network of charging stations and government incentives increase. Moving forward, it is important to recognize that the strategy is likely to change to reflect these changing conditions.

Previously, decisions regarding fleet vehicle purchases have been made based on current needs of job requirements. This proposed "Fleet Upgrade" approach presents new criteria to take into consideration and proposes a more stringent process when making fleet vehicle purchasing evaluations and final decisions. The overall strategy of the fleet upgrade is to replace current fleet vehicles and any future additional fleet vehicles with ones that are of the highest fuel efficiency, the appropriate size and type for the intended use, and within the budget. This has the potential to cause the most profound and measurable impact on carbon emission reductions.

For the purposes of maximizing carbon reductions, there are three factors that need to be assessed when a new or replacement vehicle is required: (1) right size vehicle for task; (2) right type of vehicle for task: gas, hybrid, full electric; (3) most fuel efficient type of vehicle for task. These factors serve as a new process and/or policy from which to follow when purchasing new or replacing retired vehicles.

1. *Right size vehicles and utilization management*

All current fleet vehicles will be evaluated in terms of their size and function to reveal which are subject to downsizing without compromising work requirements. For example, it may be determined that certain departments are using large pick-up trucks when they could be using a small to mid-size car to deliver the same job. Right sizing vehicles will allow for more suitable fleet vehicles to be incorporated into current operations and an increase in overall vehicle efficiency.

2. *Purchase right class of vehicle for the task*

Once the right size of current fleet vehicles has been determined, the appropriate class of vehicle for the task will then be determined. Where applicable, current gasoline/diesel fleet vehicles will be replaced with hybrid or electric vehicles. As it will be difficult to replace fleet vehicles that are required for towing or transporting heavy loads with electric vehicles, the fleet vehicles used for local travel to meetings and/or site visits will be replaced with electric or hybrid vehicles.

One of the biggest obstacles LSRCA currently faces with respect to electric vehicles is range anxiety. Therefore, when choosing an electric vehicle, it is important to consider that it takes approximately 300km to drive around the watershed. A replacement vehicle must have at least this range or it will not work within the organization.

3. *Purchase best in class for fuel efficiency*

For each class of vehicle, it is important that fuel efficiency options are assessed. If it is determined that a hybrid or electric vehicle is not a feasible option, a vehicle that is best in class for fuel efficiency will be chosen instead.

Fleet Replacement Options

Internal research and an in-depth comparison between LSRCA's current vehicles and their replacement options revealed that up to a 55% reduction in emissions could be achieved through replacement of more suitable and efficient vehicles. Currently, and depending on the specific situation, LSRCA either purchases or leases fleet vehicles. For the purposes of estimating costs and emission reductions, the scenarios presented are based on purchasing vehicles.

The following Tables 6 and 7 depict fleet replacement options, their associated costs and carbon reductions. A summary of each replacement efficiency option (minimum, moderate and aggressive) compared to the "replace with like" scenario is captured in these tables. Estimated capital cost includes cost to purchase new vehicle, while life cost includes cost of fuel for the presumed give year life of the vehicle. It should be noted that the annual increase in fuel efficiency of vehicles and the depreciation of vehicle values have not been factored into the listed calculations. See Appendix A – Fleet Vehicle Opportunity Tables for details.

Table 6: Fleet replacement cost, 5 year life cost (fuel) and estimated annual carbon reductions for four different replacement scenarios (See Appendix A – Fleet Vehicle Opportunity Tables for details).

Replacement Option	Estimated Capital Cost ($)	Estimated Total Life Cost ($)*	Estimated Carbon Reduction (tCO_2e/yr)	Estimated Carbon Reduction (%)**
Replace with like	$451,560	$607,476	8	12
Most suitable vehicle type and minimal replacement efficiency	$461,100	$606,649	12	18
Most suitable vehicle type and moderate replacement efficiency	$473,820	$585,170	32	47
Most suitable vehicle type and aggressive replacement efficiency	$544,840	$615,091	37	55

*Includes estimated capital cost and fuel cost over five year life of vehicle
** Compared to 2016 baseline year
Note: capital costs do not include government rebates

Table 7: A summary of the additional cost and carbon reductions of fleet replacement options compared to the "Replace with like" scenario.

Replacement Option	Estimated total life cost /savings compared to "Replace with like" scenario ($)	Estimated Carbon Reduction (tCO_2e/yr)	Estimated Carbon Reduction from "Replace with like"	Estimated Carbon Reduction (%)*
Most suitable vehicle type and minimal replacement efficiency	-$828	12	4	18
Most suitable vehicle type and moderate replacement efficiency	-$22,307	32	23	47
Most suitable vehicle type and aggressive replacement efficiency	$7,615	37	29	55

* Compared to 2016 baseline year

Note: All values in this table are derived or repeated from Table 6. e.g. Costs were calculated by subtracting "replace with like" option from cost of either the minimal, moderate or aggressive replacement opportunity.

Behavioral

Providing adequate infrastructure is one focal area, but examining and influencing staff choices is another area where LSRCA can have an impact in reducing carbon emissions from fleet vehicles. The behavioral strategy focuses on reducing fuel consumption through reducing the number of trips required and ensuring any trips that are taken are as efficient as possible. This can be achieved through various smaller scale campaigns targeting incremental changes in employee behavior that will be carried out by the SWITCH Committee. However, that being said, it is difficult for the SWITCH committee to dedicate enough time required to successfully implement and obtain the desired results of these initiatives. Support for behavioral change initiatives could be realized through a combination of (1) an additional task under existing communications staff portfolio; and/or (2) additional funds to support a portion of an individual's position from other departments.

A summary of the behavioral carbon reduction opportunities, including associated costs and carbon reductions per year, can be found in Table 8. A more detailed explanation of each opportunity follows. It should be noted that the salary costs are based on an estimated staff time of 10 days per year at a salary of $65,000, which would cost approximately $2,500 per year. Any additional costs are included in addition to the incidental and annual costs of the specific opportunities.

Table 8: Behavioral reduction opportunities and their associated costs and carbon reductions (tCO_2e)

Behavioral Strategy	Salary Cost ($)*	Incidental Costs ($)	Total Annual Cost ($)	Estimated Carbon Reduction (tCO_2e/yr)	Estimated Reduction (%)**
Reduce number of vehicle trips	$2,500	$1,000 (to support behavioral change strategies)	$3,500	3.55	5%
Reduce single occupancy trips					
Right vehicle for the trip					
Most efficient use of the vehicle		$8,000 (Annual license for fleet tracking software)	$8,000		

*Based on average salary cost of $65,000 and a 0.04 full time equivalent
**Aspirational behavioral change target

Opportunity 1: Reduce number of vehicle trips

LSRCA believes that one of the main issues with respect to reducing vehicle trips is that staff may be unaware of the alternative options available to them, or unwilling to make use of alternatives. These include such technologies as webinars, Skype, FaceTime, conference calling, etc., all of which act as virtual meetings and reduce the need to physically travel for meetings. Encouraging staff to participate in or set up virtual meetings with external clients or internal staff presents a simple yet effective way to reduce the number of fleet vehicle trips. Changing the expectations around prioritizing vehicle trips through policies or practice is another simple, cost-effective way to influence staff behaviour. The strategy therefore needs to determine what factors may be limiting use of these technologies (i.e. equipment, knowledge, awareness, complacency, etc.) and how to proceed with overcoming these barriers. A brief assessment towards this end is suggested as a first step in the strategy. One identified cost that may relate to this strategy item is that LSRCA currently has one license for webinar software which costs $500 annually and allows for up to 100 attendees/participants. Assuming that within the next 10 years, LSRCA will acquire at least one more license, it will cost at least $1,000 annually.

Opportunity 2: Reduce single occupancy trips

Often, there are meetings, events and/or workshops that staff are required to attend inside of work hours. It has become clear that staff are not carpooling to internal meetings and events as often as they could be, and some are using fleet vehicles for single occupancy trips. The aim of this initiative follows that if a trip is required, staff will reduce the number of separate vehicles by carpooling. This may involve a mandate that requires off-site meeting/trip organizers to be responsible for setting up a car pool list as part of the invite. The only cost associated with this opportunity is the cost of staff time to execute.

Opportunity 3: Ensure the right vehicle for the trip is being used

It is evident from the distance travelled by each vehicle (Figure 6) that the electric vehicles are not currently being used as often as other gasoline/diesel vehicles. Increasing the use of electric vehicles will

reduce the use of gasoline/diesel fleet vehicles, the amount of fuel consumed and ultimately, LSRCA's carbon footprint. A first step will be to get staff to become more comfortable with driving this type of vehicle through in-vehicle training, a better understanding of the vehicles range, and location of charging stations at common destinations. A second step will be to establish a new protocol for signing out fleet vehicles to ensure that staff are choosing the right vehicle for their trip. This objective might also take into consideration evaluating hiring requirements for new staff who will be using fleet vehicles (i.e. previous electric vehicle driving experience, or willingness to learn would be considered an asset). The only cost associated with this opportunity is the cost of staff time to execute.

Opportunity 4: Ensure staff are using the vehicle most efficiently

An annual driver efficiency program will help to ensure that staff are operating the vehicles in the most efficient manner. This includes in class and in car education on such things as accelerating gently, maintaining a steady speed, anticipating traffic, planning and choosing the most direct route and avoiding speeding. The City of Edmonton has implemented a mandatory on-road and classroom training course on fuel efficient driving practices, which saw a 10% reduction in annual fuel consumption.

Installing a fleet tracking software program will also help to increase driving efficiency by monitoring and managing driver behaviours. For example, the *Fleetmatics* software includes GPS tracking, which would optimize routes and allow for decreased travel time. It is likely that such software would help to reduce fuel costs by decreasing idle times, reducing speeding and harsh driving behaviours. *Fleetmatics* also produces fuel reports, activity reports, and driving style reports which would help to better control and manage fleet vehicles. By adopting an approach to vehicle tracking through like software it may also lend an objective assessment and enforcement of corporate driving practices. Specifically, the *Fleetmatics* software costs approximately $33 per vehicle per month for a total of approximately $8,000 annually, or $80,000 over 10 years (assuming 20 vehicles).

As the installation of fleet tracking software is a broad reaching initiative, a more in depth discussion on the pros and cons of adopting such a program is warranted. Depending on the specific functions and tracking capabilities/offerings of the chosen program, necessary adjustments to carbon reduction data tracking will be required.

Opportunity 5: Promote appropriate use of public transit

While use of public transit may not be practical for many destinations, there are certain situations where public transit is most appropriate in terms of the time saved and carbon emission reduced. The most obvious destination where public transit should be promoted is Toronto CBD where trains and buses provide fast easy access. To promote use of public transit, the organization could arrange for provision of prepaid Presto cards which staff can sign out when needed.

Carbon Reduction Opportunities Summary

Based on the above analysis of reduction opportunities, Table 9 outlines the recommended reduction opportunities to be included in the strategy. Replacing current vehicles at the end of their current lease/life with more appropriately sized and energy efficient models is by far the best opportunity to reduce fleet vehicle emissions. This should also be paired with behavioral change strategies aimed at reducing number trips, using the appropriate vehicle for a trip and using vehicles efficiently.

Table 9: Summary of recommended opportunities (both fleet upgrade and behavioral) and their associated costs and carbon reductions (tCO_2e) – based on opportunities presented in tables 7 and 8.

Recommended Opportunity	Estimated Cost ($)	Estimated Carbon Reduction (tCO_2e/yr)	Estimated Carbon Reduction (%)*
Aggressive vehicle replacement strategy	$7,615 (per 5 year replacement cycle) $10,000 (2 new EV charging stations)	37	55%
Behavioral Change (Reduce number of trip, reduced single occupancy, right vehicle, efficient use)	$11,500 (per year)	3.6	5%
Total	**$29,035**	**40.6**	**60%**

*Compared to 2016 baseline emissions

Carbon Reduction Target

LSRCA is committed to reduce absolute carbon emissions from fleet vehicles operations **60% by 2026 from 2016 baseline emissions** (Figure 8). The reduction target has been set based on an evaluation of the estimated absolute emissions reductions from the recommended reduction strategies. However, as LSRCA's BAU fleet vehicle use is projected to increase due to additional staff by 2026, the actual 2026 estimated annual carbon reduction will be 39 tonnes, representing a 45% reduction from 2016 baseline.

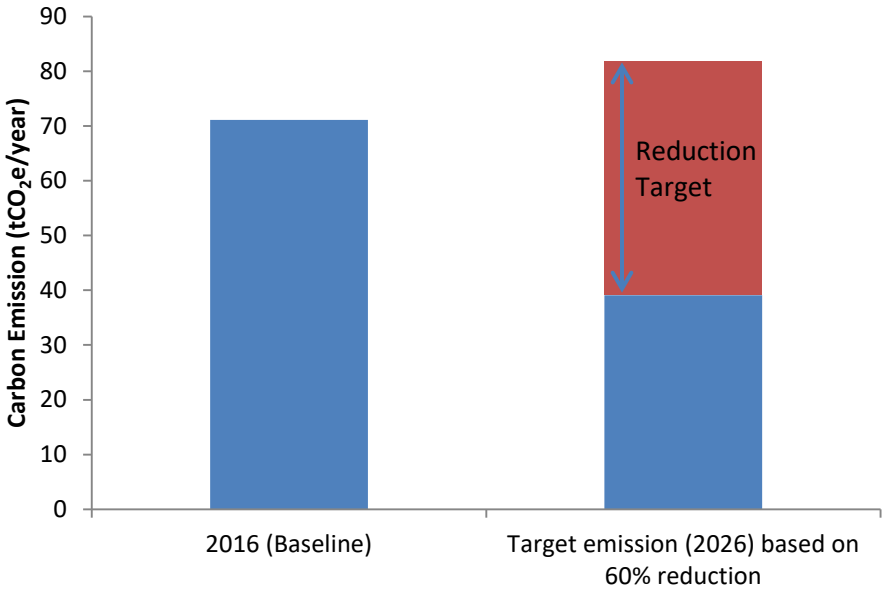

Figure 8: Absolute fleet vehicle carbon emission reduction target based on reducing 2016 consumption 60% and also considering increase demand on fleet vehicle due to growth of the organization

In addition to an absolute reduction target LSRCA is also establishing an intensity based target of 48% per employee. In 2016 the carbon emission for each employee was 710 $kgCO_2e$. When accounting for a projected 15% increase in the number of staff and the 60% reduction target, a 48% reduction target would reduce emissions to 339 $kgCO_2e$/person/year (Figure 9).

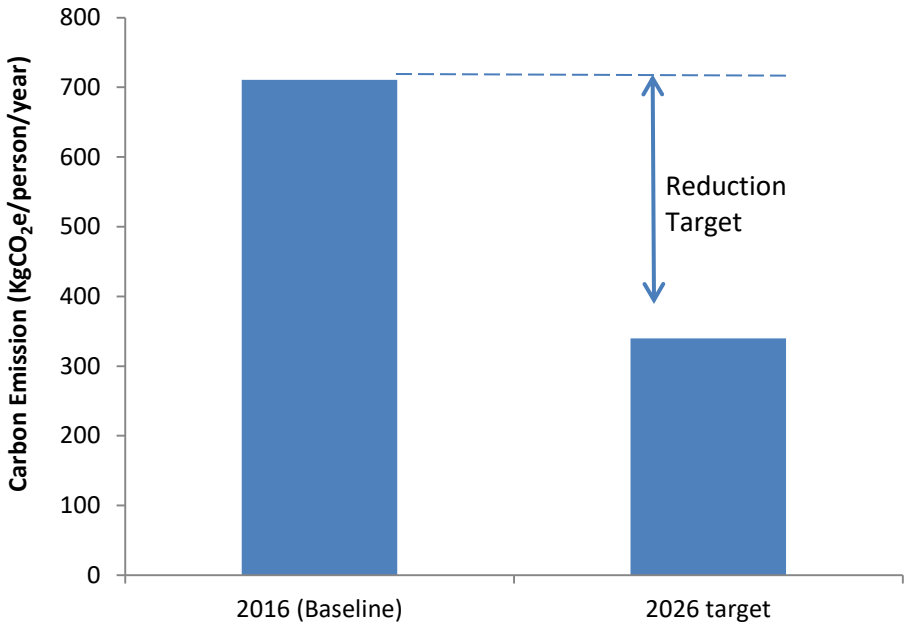

Figure 9: Intensity based fleet vehicle emission reduction target of 48% for each employee by 2026

Financial Implications

The high-level cost estimates indicate that an aggressive fleet vehicle replacement strategy has a relatively small overall additional life time cost of $7,615 compared to a replace with like approach. The low additional cost can be attributed to reduced fuel costs over the lifespan of the vehicle and declining costs of PHEVs and EVs. While additional cost is marginal when fuel savings are accounted for, the upfront purchase costs can be higher and will need to be factored into the budget process. As more fleet vehicles are replaced with PHEVs and EVs, additional charging stations will need to installed, costing in the order of $5,000/each when considering capital and installation costs.

There currently exists a financial mechanism for managing the fleet vehicles, which consists of the utilization of chargeback rates based on vehicle (km) usage. These rates may need to be adjusted depending on the requirements of the strategy and changing price structure of fuel efficient vehicles. For example, the chargeback associated with EV/hybrids could be reduced compared to gas vehicles to promote their use while still remaining financially sustainable.

The behavioral components of this strategy are currently managed solely by the volunteer SWITCH committee. To expand these efforts and ensure the reduction target is met it is recommended that a staff persons official duties be expanded to coordinate and help implement behavioral change strategies.

Natural Gas

Current Status

Natural gas consumption was determined to be the third largest contributor to LSRCA's total carbon emissions, at 22%, as shown in Figure 10. As determined from an Energy Audit, LSRCA currently uses natural gas at the Administrative Office building for space heating and domestic hot water supply, which accounts for 54% of total energy consumed within the building. Natural gas is also used for fueling the back-up generator and a barbeque; however, these are not used on a regular basis. Please note that for simplicity, the furnace oil (used at the workshop), which accounts for only 2.92% (3.73 tonnes) of the total carbon footprint, will be grouped in with the total emissions generated from natural gas.

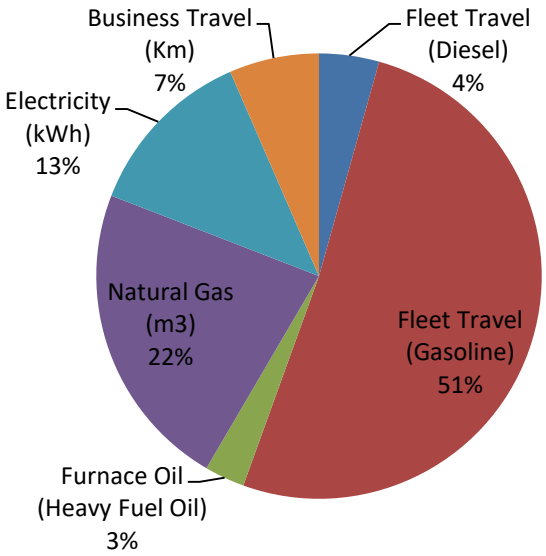

Figure 10: The contribution (%) of each emission category to total CO_2 emissions in 2016

A breakdown of seasonal variance of natural gas consumption is shown in Figure 11, which indicates that consumption is significantly higher during the winter and spring months than during the summer and fall months. The consumption during the summer months can be attributed to domestic hot water supply while the majority of the natural gas consumption during the other months can be attributed to space heating.

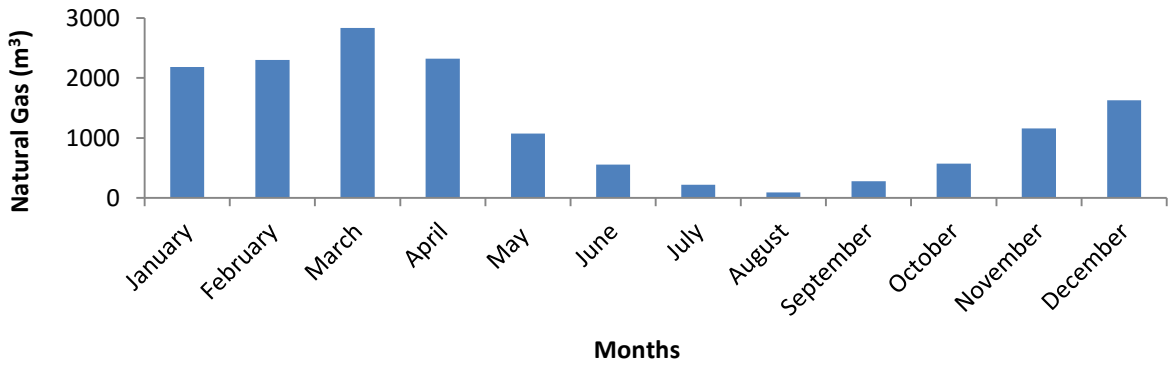

Figure 11: A breakdown of natural gas consumption (m^3) by month in 2016 at the Administrative Office building

At present, the Scanlon Creek facilities (Operations Centre and Nature Centre) run solely on electric power, with the exception of the workshop which uses furnace oil (heavy fuel oil) for heating. Therefore the Administrative Office building is the only LSRCA facility that consumes natural gas.

The Administrative Office building is already making strides towards energy efficiency and natural gas reduction. First of all, the new part of the building (16,000 sq. ft. of total space) was designed to the international Leadership in Energy and Environmental Design (LEED) standard at the silver level. These energy efficient technologies have and continue to help conserve natural gas within the building. They include:

- A high efficiency conventional boiler and heat exchange systems that are computer controlled and free of HCFC and Halons.
- A ducting system that has independently controlled vents connected to zone controlling thermostats and moves large amounts of air slowly, which reduces the energy required to push the air around.
- A basement that is below grade and also has radiant heat in the floors, which helps to reduce the cost and energy associated with heating.
- A green roof that covers the roof of the vestibule which provides increased insulation.

In addition to the above mentioned efficiencies, the Administrative Office building also has a high efficiency HVAC system that is controlled by a Building Automation System (BAS) for optimized control. With respect to the building envelope, in 2013 all of the windows were upgraded to high efficiency windows (double glazed), weather stripping has been recently completed on all windows and doors, and the insulation of the interior and exterior walls are in good condition.

The main issue with respect to heating is the unevenness of temperature throughout the building, which causes the upper floors to be much warmer than the lower floors. This is in large part due to the fact that there are three different systems controlling the temperature within the building. This differential heating forces staff to use space heaters or open windows to increase their comfort levels, which in turn, impacts the temperature control systems. Therefore, the strategy will focus heavily on trying to rectify this issue.

Emission Forecasting

It is evident from Table 10 that the 2016 baseline emissions and the 2026 business as usual (BAU) emissions are the same. As the Administrative Office building is currently at capacity and all anticipated staff growth is to occur at the Scanlon Creek Operations Centre, the heating requirements at the Administrative Office building will not increase significantly in 10 years. Similarly, the heating requirements at the Scanlon Creek workshop and therefore furnace oil consumption are not expected to increase significantly in 10 years.

Table 10: 2016 Baseline emissions and 2026 Business As Usual (BAU) emissions for natural gas at the Administrative Office facility and furnace oil at the Scanlon Creek workshop

	Baseline Emissions 2016 (tCO_2e)	BAU Emissions 2026 (tCO_2e)
Natural Gas	28.72	28.72
Furnace Oil (Heavy fuel oil)	3.73	3.73
Total Emissions	**32.45**	**32.45**

Carbon Reduction Opportunities

Facilities

Heating within the new portion of the Administrative Office building is provided using a dual deck air handling system, one for cold and one for hot air. Energy recovery from the return air is accomplished using an energy recovery wheel. The old portion of the facility is conditioned using a gas/electric roof top packaged unit (RTU) and a condensing furnace, both of which burn natural gas to generate heat. Supplemental heating is provided using a series of electric baseboard heaters and therefore the opportunities associated with the baseboards are discussed within the Scope 1 strategy.

The Energy Audit reported that the BAS has glitches that are limiting the degree of control over the HVAC system and recommended to have it recommissioned in order to optimize its efficiency. This has since been rectified by internal facilities staff, and LSRCA currently has a contract with Siemens Canada Ltd. to quarterly monitor the HVAC system to ensure it is operating at maximum efficiency.

It has been determined that the main deficiencies of the building in terms of natural gas consumption involve the HVAC/BAS and the building envelope. Therefore, the overall strategy will focus on these areas for increasing the efficiency of the current system and incorporating new technologies that will help to reduce natural gas consumption and carbon emissions. This can be accomplished by upgrading outdated equipment, adjusting building operations, and implementing retrofits.

In order to create a strategy that will decrease carbon emissions as a result of natural gas consumption, various reduction opportunities were explored from both a mechanical, operational and a behavioral perspective. Within each reduction opportunity, cost, savings and estimated carbon reduction are determined. The proposed reduction opportunities are based on recommendations from the energy audit and the SWITCH committee, as well as from internal research. A full summary of each of these reduction opportunities and their associated costs and reductions can be found in Table 11. A detailed explanation of each opportunity follows.

Table 11: Natural gas facility reduction opportunities (mechanical, operational) and their estimated costs and carbon emission reductions

Action	Estimated Cost	Estimated Carbon Reduction (tCO_2e/yr)	Estimated Annual Carbon Reduction (%)*
Maintain mechanical efficiency of HVAC and BAS	Unknown at this time. Will be reassessed in 5 years.		
Ensure efficient operation and control of HVAC/BAS (e.g. Enbridge's RunItRight Program)	No cost for initial investigation – potential costs depending on recommendations from investigation	1.6	5%
Reduce air leakage by weather stripping	$1,800	Maintenance - no additional carbon reduction	0%**
Use side door for emergency use only	$0	0.4	1%
Total	TBD	2	6%

* Compared to 2016 baseline emissions
**To maintain current emission level

BAS/HVAC

There are various mechanical and operational improvements that can be implemented to ensure optimal efficiency of the temperature control systems in order to reduce carbon emissions. The first step would be determining if the current equipment is being utilized as efficiently as possible and if not, identifying what equipment could be replaced or upgraded to increase the efficiency. Ultimately, the goal is to maintain an efficiently working system to eliminate the need for staff to take additional actions to maintain a comfortable work environment.

Opportunity 1: Maintain mechanical efficiency of the HVAC and BAS

The objective of this carbon reduction opportunity is to ensure that the mechanical equipment used to heat the facility is the most efficient in terms of its natural gas consumption. As previously mentioned, the building currently uses an integrated Building Automated System (BAS) which allows for more effective control and efficient operation of the buildings main HVAC equipment within the new portion of the facility. As these temperature control systems are new and efficient models, they don't need replacing or upgrading at this time. However, in order to maintain the efficiency of these systems, LSRCA will have an audit completed in 5 years that will specifically focus on potential improvements to the mechanical efficiency of the systems. This will allow for LSRCA to keep up to date with technological advancements or upgrades that can assist with reducing carbon emissions through natural gas reduction. At that point, it will also allow for LSRCA to determine if there are large capital replacement costs associated with these upgrades and what the return on investments would be. In order to obtain a different perspective/opinion, the audit will be completed by a different contractor than Siemens.

Opportunity 2: Ensure efficient operation and control of HVAC/BAS

The objective of this carbon reduction opportunity is to ensure that the mechanical equipment is being operated and controlled as efficiently as possible so that the temperature of the building can become uniform. An equipment audit specifically involving the operation of the current HVAC equipment for improvements in efficiency and their associated potential carbon reductions would be useful to help rectify this issue. The information gathered from this audit would then be used to set reduction targets and, therefore, the strategy would be updated accordingly.

Enbridge's *RunitRight* Operational Improvement Program helps commercial buildings identify and implement no cost/low cost operational improvements, and provides continuous monitoring to increase and maintain efficiency, lower operating and maintenance costs, improve occupant comfort and improve functionality of building systems. Enbridge guarantees a minimum of 5% energy reduction through this program. If the investigation is done through Enbridge by a third party organization it will be free of charge, and if it is completed by LSRCA's current contractor, Enbridge will cover up to $1,000 of the costs.

Opportunity 3: Improve air circulation through use of fans

The objective of this opportunity is to reduce the demand on the HVAC/BAS by improving air circulation. As previously mentioned, one of the main issues experienced at the Administrative Office facility is the unevenness of temperature throughout the building. Fans can compensate for this by promoting circulation and distribution of air, which reduces the need for space heaters, opening windows, or blocking vents, all of which increase the load on the HVAC system.

However, in order to see significant reductions in natural gas use, fans must be large enough to move a high volume of air at a low velocity to push warm air down and circulate it throughout the building. After a site visit with *Big Ass Fans*, it was determined that the only suitable area for a fan would be the boardroom. This approximately 900 sq. ft. area has the space required for an 8-10 ft. fan to be installed. However, the ceiling in this room does not have anything in place to mount the fan to and therefore additional costs are required to have a structural engineer design and fabricate such a structure.

The typical reduction in natural gas use observed from the Essence Fan is 10-30%, which when applied to the board room only would amount to a carbon reduction of approximately 1.2-3.1 tonnes over 10 years. As the ceiling in the boardroom does not have the proper structural requirements for mounting a fan to, a structural engineer from *Big Ass Fans* would need to conduct a site visit and design a structure. This would cost an additional $1,100-1,200 on top of the $9,600 cost of the fan. Therefore, it was determined that this is not a viable option from a financial perspective as the return on investment was calculated to be many hundreds of years.

Building Envelope

The HVAC is currently compensating for heat loss in the winter due to minor deficiencies in the building envelope. The objective of the following reduction opportunities is to maintain a properly sealed envelope in order to ensure that heat is not lost in winter months resulting in increased natural gas use.

Opportunity 1: Reduce air leakage by weather stripping

Weather stripping increases the energy efficiency of a building by improving the seal of windows and doors against cold or warm air. Although this has been recently completed and is regularly monitored by facilities staff, it is important to include in the strategy as it will need to be completed again within 10 years. As the building is currently well sealed, this option will consist of maintaining the tightly sealed envelope into future years, meaning the carbon reductions are currently at zero. Based on estimates provided by the facilities staff, weather stripping for doors would cost approximately $100-200 per door every 2-4 years, and the windows would not require weather stripping.

Opportunity 2: Reduce heat loss from side door

In addition to the main front door, there is an alternate door located at the side of the building that is regularly used by staff. Unlike the front door that has a vestibule, this door enters directly in to the building and brings in cold air in the winter and signals the HVAC/BAS to increase internal temperatures. The addition of a vestibule would create a buffer zone to help reduce energy loss. These cost approximately $7,000; however, the estimated carbon reductions associated with the installation of a vestibule are unknown, as there are too many influencing variables (i.e. weather conditions, frequency of door openings, etc.). However, as this is a very expensive and labor intensive option, it is more cost effective to focus on reducing entry from this door altogether by making it an emergency use only door.

Behavioral

Currently, one of the biggest challenges to maintaining an efficient BAS/HVAC is that the temperature is not uniform throughout the entire building, which is heavily influenced by staff behaviour. The actions employees are taking to compensate for the unbalanced air temperature, such as using space heaters and opening windows, increases the load on the BAS/HVAC by altering the space average and therefore overall temperatures of the building.

Fixing this issue falls into two categories. Firstly, ensuring the BAS/HVAC is operating in a manner that minimizes the need for localized individual temperature control such that staff are working in a comfortable environment. By discouraging these behaviours, the BAS and HVAC system will operate more efficiently and conserve more energy. Secondly, ensuring staff are aware of the impact they may be having on the control of the entire building temperature with the goal of changing their behavior. Therefore, the reduction opportunity consists of reducing the load on the temperature control systems by minimizing local temperature control and increasing employee awareness of their behaviours. Table 12 outlines this reduction opportunity and the associated costs and carbon reductions over 10 years. It should be noted that the costs are based on an estimated staff time of two days per year at a salary of $65,000, which would cost $560 per year or $5,600 over 10 years.

Table 12: Behavioral reduction opportunities and their associated costs and carbon reduction targets (% and tCO_2e)

Action	Estimated Cost ($)	Estimated Carbon Reduction* (tCO_2e/yr)	Target Reduction (%)*
Change staff behaviors that affect balance of the HVAC & BAS	$500	0.32	1%

*Compared to 2016 baseline emissions

Carbon Reduction Opportunities Summary

Based on the above analysis of opportunities, Table 13 outlines the recommended opportunities to be included in the overall carbon reduction strategy, including costs and carbon reductions (% and tCO_2e).

Table 13: Recommended reduction opportunities and their associated costs and carbon reductions (% and tCO_2e)

Recommended Opportunity	Estimated Cost ($)	Estimated Carbon Reduction* (tCO_2e/yr)	Estimated Carbon Reduction (%)*
Facilities - building envelope and BAS/HVAC	$1,800 (excluding any future HVAC upgrades)	>2	>6%
Behavioral Change	$500/year	0.3	1%
Total		>2.3	>7%

*Compared to 2016 baseline emissions

Carbon Reduction Target

LSRCA is committed to reduce absolute carbon emissions from the use of natural gas and fuel oil a minimum of **7% by 2026 from 2016 baseline emissions** (Figure 12). The reduction target has been set based on an evaluation of the estimated absolute emissions reductions from the recommended

reduction strategies. This target does not account for potential emission reductions associated with upgrading the HVAC/BAS system as it cannot be determined at this stage whether upgrades to the HVAC/BAS would be a viable option in the future from a cost-benefit perspective.

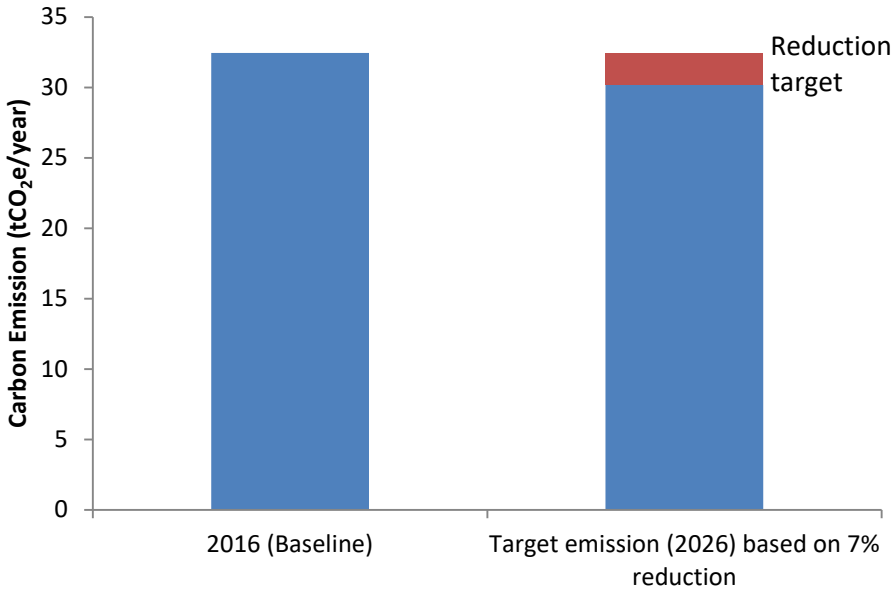

Figure 12: Absolute natural gas carbon emission reduction target based on reducing 2016 consumption by 7%

In addition to an absolute reduction target LSRCA is also establishing an intensity based target of 19% per employee. In 2016 the carbon emission for each employee was 324kgCO_2e. When accounting for a projected 15% increase in the number of staff and the 7% reduction target, a 19% reduction target would reduce emissions to 262kgCO_2e per person (Figure 13).

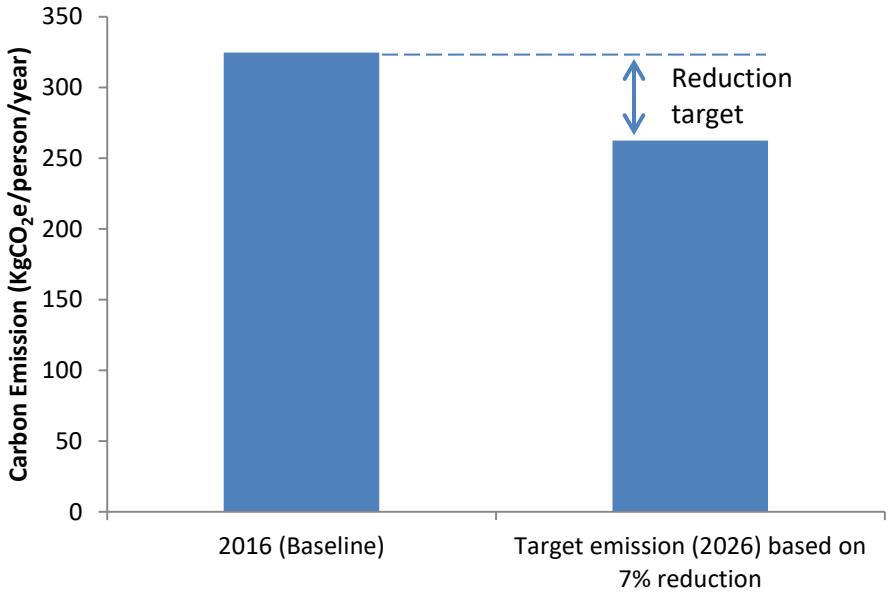

Figure 13: Intensity based natural gas emission reduction target of 19% for each employee by 2026

Financial Implications

The cost associated with implementing the identified emission reductions are low, being a one-off capital $1,800 expense to maintain building envelope (weather stripping) and an annual $500 expense towards staff salary for coordinating behavioral change opportunities.

The greatest potential future expense that is not costed in the strategy relates to updates to all, or parts of, the HVAC/BAS system. As the current system is both relatively new and employs various energy efficiency elements (e.g. heat exchange) it was advised that an assessment be completed in five years' time when the current system is older and new technologies may be available.

Incentives

If in the future it is determined that updates to the HVAC is a viable option then incentives for equipment replacement should investigated. A few current incentive programs are identified below for future reference.

Enbridge Gas Distribution

Enbridge Incentive Programs for Commercial and Industrial Customers

Enbridge offers incentives to help offset the cost of installing energy efficient natural gas equipment in new and existing buildings. As part of this program, customers can receive up to $100,000 towards the purchase and installation of gas-saving, energy efficient equipment. Incentives are available either as fixed rebates for the purchase and installation of certain equipment, or on a custom calculation based on the expected gas savings a project will yield.

RunItRight Operational Improvement Program

Enbridge offers financial incentives for all three stages of their *RunItRight* program for a total of $5,500.

- Investigation: Enbridge will fund costs up to $1,000 towards a facility investigation if the audit is not completed through Enbridge by a third party organization.
- Implementation: Enbridge will provide an incentive up to $3,500 (for small commercial building) determined based on the Building's normalized gas consumption as provided by Enbridge.
- Monitoring: Enbridge will fund the cost of using the Enbridge Energy Management Information System (EMIS) for a period of 12 months. Participants who opt out are eligible for a $1,000 incentive.

Save on Energy

There are often Save on Energy Deal Days that offer coupons for various energy efficient products such as ENERGY STAR certified LED bulbs, motion sensors, dimmer switches, weather stripping materials, advanced power bars, and baseboard programmable thermostats. Before purchasing any of these products, LSRCA will review the Save on Energy website to see which coupons are available at that time.

Scope 2 Emissions

Electricity

Current Status

By eliminating coal-fired generation, Ontario now has an electricity system that is over 90% free of carbon (Government of Ontario, 2017). This means that, in terms of carbon emissions, electricity is a much cleaner source of energy, and therefore, contributes very little to LSRCA's total carbon emissions compared to other types of energy. As Ontario gets closer to 100% carbon-free electricity, it will mean even further reductions in carbon emissions from electricity for LSRCA. However, according to the Long Term Energy Plan, the price of electricity is expected to rise 43% over the next 10 years, which will mean an increase of approximately $10,000 from 2016 electricity prices.

In 2016, electricity consumption contributed 13% to overall carbon emissions, as shown in Figure 14. LSRCA currently uses electricity in all facilities for a wide variety of applications such as lighting, cooling, ventilation, supplemental heating, and office equipment. The Scanlon Creek Operations Centre and the Nature Centre are run solely on hydroelectric power at present and therefore use electricity for these as well as for heating and domestic hot water supply.

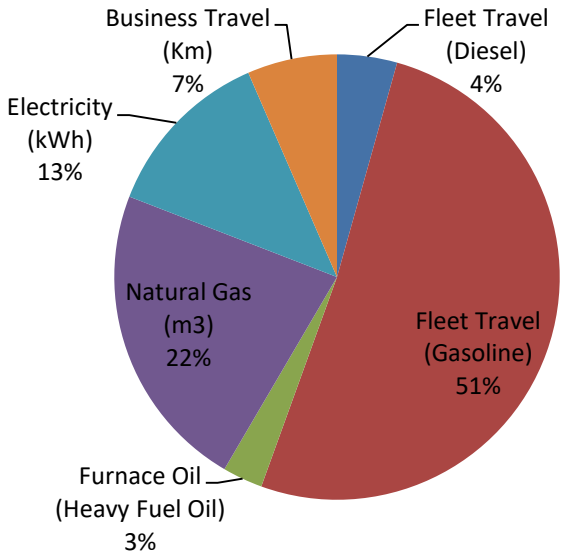

Figure 14: The contribution (%) of each emission category to total CO_2 emissions in 2016

Based on a discussion with the internal facilities staff, the Administrative Office facility is already operating efficiently in terms of its electricity consumption. Occupancy sensors are used in some areas of the building to reduce lighting, power bars (or surge bars) are used in all offices to balance and help reduce electricity of office equipment, and the number of servers was reduced from 25 to 7, which has significantly reduced electricity consumption and associated heat production in the server room. In addition, the Administrative Office facility installed external solar powered lighting in 2016 and rooftop solar panels in early 2018. Although the solar panels are not included as an offset in the carbon

reduction strategy, it is still worth noting as they are a way in which LSRCA is using renewable energy to reduce its carbon footprint.

Furthermore, the Administrative Office facility was designed to the international Leadership in Energy and Environmental Design (LEED) standard at the silver level. These energy efficiencies include:

- Low wattage lighting that allows for enhanced natural light in the building.
- Energy efficient windows that are situated for maximum lighting and minimal heat gain.
- A high efficiency convectional boiler and heat exchange systems that are computer controlled and free of HCFC and Halons.
- Cooling and ventilation that is achieved through a ducting system that has independently controlled vents connected to zone controlling thermostats. The system moves a large amount of air slowly, reducing the energy needed to push air around.

As the renovated Operations Centre and new Nature Centre building at Scanlon Creek will be designed to incorporate energy efficient equipment and materials, the focus of the Scope 2 reduction strategy will be on the Administrative Office building. However, it is still worth noting the energy efficiencies that will be included in the renovated Operations Centre or have already been completed in other Scanlon Creek buildings. They are as follows:

- All baseboard heaters will be replaced with duct work with roof mounted heating/cooling units.
- Roof top units will have a high end heat recovery through forced air.
- Each roof top unit will have a zone that will be controlled by programmable thermostats.
- Glazed glass will be added to external and internal windows to reduce solar heat gain.
- Windows and doors have been recently replaced in the Operations Centre and the workshop and the air leaks have been determined to be minimal.
- The office spaces within the workshop were reinsulated in 2017.

Scanlon Creek Operations Centre Energy

As electricity prices are expected to rise significantly within the next 10 years, an investigation was completed to determine whether bringing natural gas into Scanlon Creek would be more beneficial from a cost and energy perspective. Two scenarios were analyzed: one where natural gas is brought in and used for heating of the office space as well as domestic hot water, and one where only electricity is used (i.e. the current situation). In the analysis it was confirmed that natural gas emits more carbon than electricity does by approximately 1.85kg/L. Therefore, if natural gas was used it would require over 2,300 mature trees to be planted in order to offset this additional carbon or the establishment of close to 4 hectares of mature forest in order to offset this increase compared to continuing with using just electricity (Table 14).

Table 14: Projected carbon emissions and number of trees and hectares of land required to offset various energy scenarios at Scanlon Creek

Energy Type	Carbon emission (tCO_2e/yr)	Number of trees required to offset	Hectares of mature forest required to offset
Natural gas & electricity	32.87	3,221	5.14
Electricity	9.06	888	1.42

It was determined that, due to costs and complexities associated with installing a natural gas line to the property, as well as the costs associated with purchasing and planting trees to offset the increase in emissions, this was not a feasible option. Therefore, the Scanlon Creek Operations Centre will continue to use electricity for all energy requirements. Staff will continue to develop energy reduction strategies for the facility, as well as assess the feasibility of installing solar and/or wind powered energy infrastructure.

Emission Forecasting

As the Administrative Office facility is currently at capacity, all anticipated staff growth is to occur at the Scanlon Creek Operations Centre. Currently, less than half of the Scanlon Creek Operations Centre is being utilized by staff. Upon completion of the renovation, approximately 40 more employees are expected to move in from the Administrative Office, easing space challenges at the Administrative Office. As a result, electricity consumption at Scanlon is expected to increase, especially in terms of heating, lighting and office equipment. In order to determine the 2026 BAU emissions, electricity consumption of lighting (which represents 22% of total energy usage) and office equipment (which represents 17% of total energy usage) for the Scanlon Creek Operations Centre were doubled. This resulted in a 12% increase in carbon emissions within the next 10 years (Table 15). As a new HVAC system is being installed in the Operations Centre, the additional emissions associated with the new system heating the entire building is currently unknown. An evaluation of electricity consumption at the Operations Centre will need to be undertaken a few years after the renovation and updates to this strategy completed accordingly.

Assuming that LSRCA will acquire additional electric vehicles, it should also be anticipated that additional charging stations will be required, which will result an increase in electricity consumption.

Table 15: 2016 Baseline emissions and 2026 Business As Usual (BAU) emissions (tCO_2e) for electricity at both Administrative Office facility and the Scanlon Creek facilities

	Baseline Emissions 2016 (tCO_2e)	BAU Emissions 2026 (tCO_2e)
Total Carbon Emissions from Electricity	16.13	18.07

Carbon Reduction Opportunities

Facilities

The energy audit identified lighting (23%), office equipment (25%), and heating (24%) are the three largest consumers of electricity at the Administrative Office facility and will therefore be given greater focus when assessing reduction opportunities. A large range of reduction opportunities were assessed from a feasibility and cost/kg of carbon perspective and only those considered viable are presented below.

Office Equipment

The objective of the following reduction opportunities is to explore ways in which electricity consumption of office equipment can be reduced. LSRCA will first look at opportunities to improve energy management and conservation of the current office equipment and then look at opportunities upgrading to more efficient models.

Investing in energy efficient devices can help reduce energy consumption and increase savings on electrical bills. According to Energy Star, the newer, more energy efficient laptop models can consume anywhere from 50% – 80% less energy than a desktop (Energy Star, 2012). This is largely due to the fact that laptops are now designed to consume less power so that when disconnected they can last longer on battery. Additionally, laptops have the option of being unplugged, whereas desktops must be connected to power at all times. However, it is important to note that most employees keep laptops

plugged into a docking station in order to use multiple monitors, and therefore it is unknown how this affects the power consumption in comparison to desktops.

LSRCA currently has a total of 146 computers, 85 of which are laptops, and the remaining 61 are desktops. It is estimated that 40 desktop computer can be changed to virtual desktops reducing overall electrical consumption. Virtual desktops cost approximately $700 less than replacement desktop resulting in a cost saving to the organization of approximately $28,000.

As the strategy progresses, other opportunities to reduce electrical consumption of office equipment should be further investigated. For example, there may be opportunities to reduce consumption with the photocopiers/printers.

Lighting

The carbon reduction opportunities for lighting focus heavily on optimizing daylight while minimizing energy requirements. The objectives of the following reduction opportunities are to reduce electricity consumption by using more energy efficient lighting fixtures and equipment (Table 16).

Opportunity 1: Upgrade lighting to LED

The lighting fixtures at the Administrative Office facility present one of the greatest opportunities for carbon reduction and long term cost savings. The current lighting at the Administrative Office facility consists of incandescent lighting fixtures which are outdated and inefficient. It is recommended that all light bulbs and lighting fixtures are replaced with LEDs as they are 70% more efficient than incandescent lighting (BC Hydro, 2016). Although the compact fluorescent (T8) light bulbs are approximately 25% more energy efficient than incandescent, they are still less efficient than LEDs by approximately 45%. LEDs also have a life span of 50,000-80,000 hours (or 12 to 20 years), whereas compact fluorescent have 20,000-60,000 (or 5-15 years) and fluorescent have 20,000 (or 5 years) (BY Hydro, 2016). Using LEDs will also provide the advantage of using dimmer switches and other options, which are not available for fluorescent or incandescent bulbs.

Although the cost of LED light bulbs are currently the most expensive option, at approximately $5.00 per light bulb (as per RONA pricing) and $15 per tube (for lighting fixtures, as per Home Depot pricing), it is expected that these costs will decrease within the 10 year span of the strategy. Based on these (2018) prices, it would cost an extra $2,922 to replace all light bulbs with LED compared to replacement costs of the current type of light bulb. However, by switching to LED, it would reduce carbon emissions from lighting by 8%, which is 12 tonnes over 10 years.

It is also recommended that, moving forward, all new buildings are designed to incorporate LED lighting. This includes the renovation at Scanlon Creek Operations Centre, the new Nature Centre building as well as any additional buildings in the future.

Opportunity 2: Automation and control of lighting

Retrofitting standard light switches to either automate lighting and/or provide greater control to the user can reduce both the amount a light is left on and the intensity of the light.

Dimmer switches allow employees to be in full control of the amount of light in the workspace. By dimming the light based on available natural light, this can significantly reduce electricity consumption. The exact amount of carbon reduction from dimmer switches depends on how often the switches are used and to what level the lights are being dimmed. Dimmer switches can, however, extend the lifespan of light bulbs, which can yield additional energy and cost savings. These cost approximately $30 each (as per Home Depot pricing) and the Administrative Office facility would require 25 for a total of $750. It should be noted that dimmer switches can only be used in combination with LED lights (not T8), so this will be completed once areas requiring dimmer switches are retrofitted with LED lighting.

Occupancy sensors will shut off lights after a pre-determined amount of time with no detected movement. There are some hallways and bathrooms that already are equipped with occupancy sensors at the Administrative Office facility. However, there still remain multiple rooms that would benefit from occupancy sensors such as the North Wing printer room, the lunchroom, the boardroom, the storage room/garage, and the remaining hallways and bathrooms. These can also come equipped with built-in light sensors that will ensure that the lights remain off if natural lighting is sufficient and will only allow lights to come on when required (daylight sensors). Occupancy sensors can also be considered as part of the LEED certification. These cost approximately $30 each (as per Canadian Tire pricing) and the Administrative Office facility would require 15 for a total of $450. It should be noted that occupancy sensors can only be used in combination with LED lights, so this will be completed once areas requiring occupancy sensors are retrofitted with LED lighting.

Daylight sensors reduce electricity consumption by dimming or turning off lights based on the available natural daylight entering the space and can deliver 20-60% energy savings from lighting. As the energy from lighting is 14% of total electricity consumption, the energy savings will be approximately 2.8-8.4%. They can help to continuously adjust lights as daylight levels change so that occupants don't have to manually adjust them. Additionally, daylight sensors can contribute up to 19 possible points in the LEED 2009 NC rating system (Lutron, 2014). These cost approximately $100 each (as per Lutron pricing) and the Administrative Office facility would require 10 for a total of $1,000.

Cooling and Ventilation

The objective of the following reduction opportunities is to ensure that the current air conditioning and ventilation (HVAC) equipment is working as efficiently as possible, and if not, to explore ways in which it can be improved.

Opportunity 1: Maintain mechanical efficiency and ensure efficient operation of HVAC and BAS

Maintaining the efficiency of the HVAC and BAS as well as undertaking an equipment audit in 5 years' time also applies to this Scope 2 strategy as these systems use electricity for cooling and ventilation. Therefore, this ties into a similar reduction strategy as Scope 1 (See Section 3.1.2 for more details).

Opportunity 2: Reduce solar heat gain by installing window film

Although the windows are high efficiency, Solar Control Window Film (by Evolution Windows) would help to further minimize heat gain and retain interior temperatures. This has the potential to drastically reduce energy costs and lower carbon emissions from air conditioning and heat sources up to 30%. In the winter months, window film creates a thermal barrier between the indoors and outdoors which retains up to 15% radiant heat, balances internal temperatures, and provides a comfortable place to

work. It also has the added benefit of providing 99-100% UV protection. Niagara College installed Evolution Window Film in their Wine and Visitor Education Centre and saw noticeable decreases in temperatures (Evolution Window Film, n.d.). Window films can also be considered as part of the LEED standard for reducing light pollution. The cost is unknown at this time as it is dependent on the square footage of windows that would be fitted with window film.

Opportunity 3: Replace baseboard heaters and associated thermostats

The furnaces for the upper and lower North wing of the Administrative Office building currently have programmable thermostats, however, the supplemental electric baseboard heaters in this portion of the building do not have programmable thermostats. There are eight electric baseboard heaters with wall mounted non-programmable thermostats (seven on the lower floor and one on the upper floor). As it is easier to implement energy savings measures with a programmable thermostat (as it can be set to shut off or significantly lower when the office is vacant) it is recommended that these be replaced with programmable thermostats. Additionally, these non-programmable thermostats are compensating for a lowered temperature by the programmable thermostats when the office is vacant, and therefore increasing their activity when left operating. The approximate cost of replacing the non-programmable thermostats would be $800 (based on Lowe's and Canadian Tire pricing). Since these are only supplemental heaters, it is estimated that the electricity reduction would be minimal. It should also be noted that at least one room in the North wing has neither a baseboard heater nor a thermostat creating further opportunity to help balance temperature.

The remaining electric baseboard heaters have been noted by staff to either not work properly or not produce enough heat to warm the room to a comfortable temperature. As these baseboard heaters are old and outdated, they could be replaced with a newer, more efficient and appropriately sized type which could help to increase temperatures in the lower level and avoid use of space heaters. This was completed at the Scanlon Creek Operations Centre and there was a noticeable improvement observed from staff in terms of heat and overall comfort levels. Smart electric baseboard heaters cost approximately $120 each and the Administrative Office facility would require 4 for a total of $480 (as per Home Depot pricing).

An additional issue that impacts the heat production in these lower level rooms is the placement of the baseboard heaters, most of which are located behind desks. This inhibits the movement of warm air to the room and causes only localized heating. It is recommended that the desks or baseboard heaters are relocated in order to help facilitate the movement of heat around the room.

Opportunity 4: Install live energy monitoring system for optimized energy management

The Building Automation System (BAS) does not track electricity consumption or demand, so a live energy monitoring system will help to better monitor specifically where and when electricity is being consumed. The Sense home energy monitor provides the user the ability to track energy over time through a mobile or desktop app and identify sources of energy waste and how much extra it is costing. This system costs approximately $1000. However, the carbon reductions associated with this system are unknown and would be realized through improved operation and use of electrical equipment.

Table 16: Electricity reduction opportunities (office, lighting and cooling/ventilation) and their costs and carbon reductions

Reduction Opportunity	Estimated Cost ($)	Estimated Carbon Reduction (tCO_2e/yr)	Estimated Annual Carbon Reduction (%)*
Office Equipment			
Upgrade desktop computers to laptops / or virtual desktops	-$28,000 (savings)	0.5	3%
Lighting			
Upgrade light bulbs to T8 or LED	$2,922	2.1	13%
Automation and control of lighting (daylight sensors, dimmer switches & occupancy sensors)	$2,500	0.8	5%
Cooling and Ventilation			
Maintain mechanical efficiency and ensure efficient operation of HVAC and BAS	Unknown at this time. Will reassess in 5 years.		
Window film	TBC	0.3	2%
Replace electric baseboards and thermostats	$1,200	0.4	2.3%
Live energy monitoring system	$1,000	0.0	0%
Total	-$20,000	4.0	25%

*Compared to 2016 baseline emissions

Behavioral

The following section outlines various opportunities for reducing carbon emissions from office equipment, lighting, and ventilation and cooling through behavioral changes. It should be noted that actual carbon reduction potential is highly dependent on how successful the behavioral strategy is and therefore the reductions are considered an aspirational target. Actual reductions will be monitored and reported on in future years. A summary of the reduction opportunities and their associated costs and carbon reductions can be found in Table 17. It should also be noted that the costs are based on an estimated staff time of 5 days per year to support at a salary of $65,000, which would cost $1,250 per year or $12,500 over 10 years.

Lighting

Reduce lighting

Staff will be encouraged to turn off the lights or use dimmer switches in their individual offices when unoccupied or when adequate daylight is available. Staff will also be encouraged to turn off lights when leaving a room that is not equipped with an occupancy sensor.

Office Equipment

Reduce energy consumption of office equipment

Energy consumption of office equipment is highly influenced by employee behavior. Fortunately, there are many different ways in which staff can be involved in reducing energy consumption of their own office equipment. These include:

- Switching off computers at the end of the day or when not in use
- Reduce phantom power consumption by unplugging laptop adapters, cell phone chargers or other electrical devices from the wall outlet when they're fully charged or at the end of the day

- Turn off main power bars at the end of the day or when not in use
- Changing power management settings on computers to remove screensavers and enable sleep mode or turn off when not in use

Ventilation and Cooling (HVAC)

Reduce load on HVAC and BAS by limiting opening of windows

Much like the natural gas issues discussed in the previous section, the HVAC and BAS system, particularly ventilation and cooling, are heavily impacted by employee behaviour. When employees open the windows during the warmer months, warm outdoor air is brought into the building, which signals the air conditioning to increase and cools the entire building. This impacts the comfort level for staff as some parts of the building (not near the open window) become much colder. This in turn, forces staff to use other means of heat such as space heaters. By encouraging staff to keep the windows closed, the temperature control systems won't be impacted and the air temperature will be more uniform throughout the entire building.

Table 17: Behavioral reduction opportunities and their associated costs and carbon reductions (% and tCO_2e) at the Administrative Office facility.

Reduction Opportunity	Estimated Cost ($)	Estimated Carbon Reduction (tCO_2e/yr)	Estimated Carbon Reduction (%)*
Reduce lighting	$1,250/yr (staff salary)	0.81	5.0%
Reduce load on HVAC by limiting opening of windows			
Reduce energy consumption of office equipment			

*Compared to 2016 baseline emissions

Carbon Reduction Opportunities Summary

Table 18 summarizes total estimated costs and carbon reduction from both facilities and behavioral changes over 10 year implementation period to achieve the reduction target.

Table 18: Recommended reduction opportunities for both facilities and behaviour, and their associated costs and carbon reductions (% and tCO_2e).

Recommended Opportunity	Estimated Cost ($)	Estimated Carbon Reduction (tCO_2e/year)	Estimated Carbon Reduction (%)*
Facilities	(-$20,000) (one time saving)	4	25%
Behavioral	$1,500/year	0.8	5%
TOTAL		4.8	30%

*Compared to 2016 baseline emissions

Carbon Reduction Target

LSRCA is committed to reduce 2016 baseline carbon emissions from electrical consumption by 4.8 tonnes by 2026; this represents a 30% reduction from the 2016 baseline (Figure 15). However, as the BAU electrical consumption is projected to increase due to additional staff and the renovation of the Scanlon Creek Operation Centre, LSRCA's actual 2026 estimated carbon reduction will be 3.12 tonnes, representing a 19% reduction from 2016 baseline.

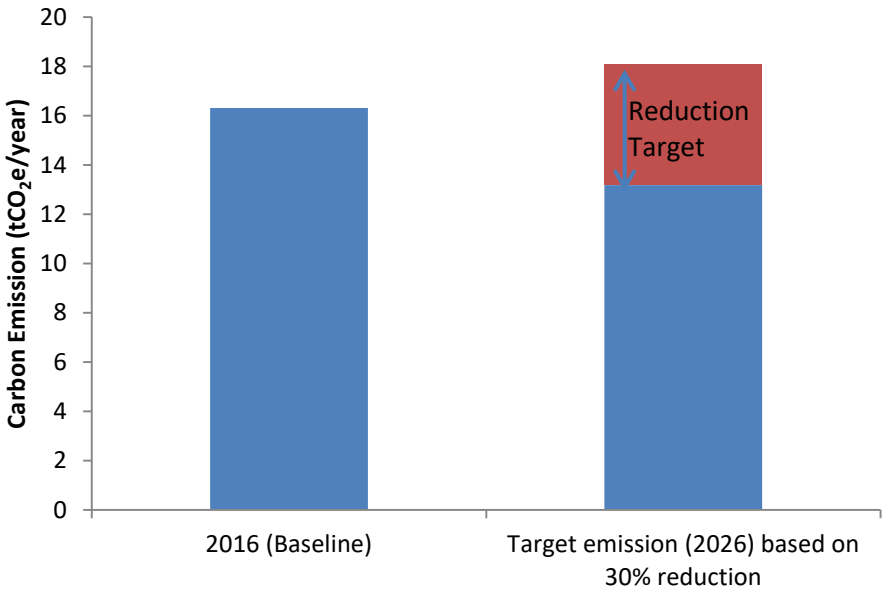

Figure 15: Absolute electrical consumption emission reduction target based on reducing 2016 consumption by 30%

In addition to an absolute reduction target, LSRCA is also establishing an intensity based target of 30% per employee. In 2016 the carbon emission for each employee was 163kg CO_2e. When accounting for a projected 15% increase in the number of staff and the 30% reduction target, the intensity target is 114 kgCO_2e per person (Figure 16).

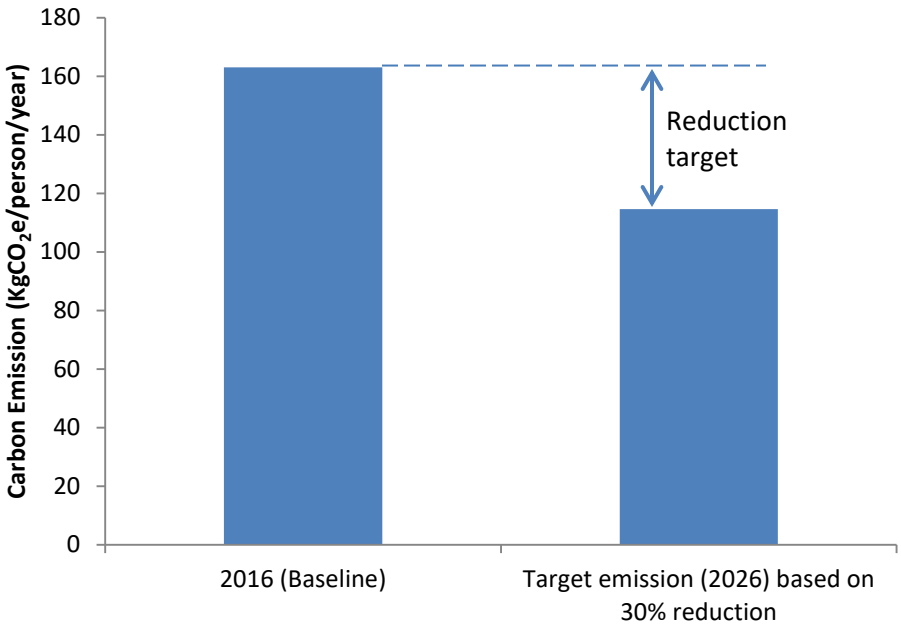

Figure 16: Intensity based natural gas emission reduction target of 30% for each employee by 2026

Financial Implications

Based on 2016 baseline electricity consumption and price, a 30% reduction in electricity use could save LSRCA an estimated $23,000 per year. This saving may be considerably higher by 2026 if the projected increase electricity price transpires. Savings associated with the reduced cost to LSRCA would be sufficient to offset annual expenses associated with implementing the known projects. While the ClimateWise framework prohibits LSRCA from accounting for the carbon associated with installation of the solar panel (to avoid double counting), it should be noted that the panels will generate approximately $9,000/year which can also be used to support emission reduction opportunities.

Upgrading desktop computers to virtual desktops is estimated to save the organization approximately $700 per unit equating to a total saving of $28,000 if 40 units are replaced. An estimated cost to upgrading lighting and baseboard heaters is $7,622. Overall savings to the organization through implementing the recommended opportunities is therefore approximately $20,000. However it should be noted this does not include the unknown cost of upgrades to the HVAC system or installation of window film. Whether these particular opportunities proceed will be assessed at that time based on the cost and associated emission reduction estimates.

Scope 3 Emissions

Business Travel

Current Status

Business travel contributes the least amount to overall carbon emissions, at 2%, as shown in Figure 17. This emission category includes the emissions associated with travel by staff during work hours using their personal vehicles. Due to the rare and irregular use of other modes of transport for business such as commercial flights, they have not been incorporated into the strategy.

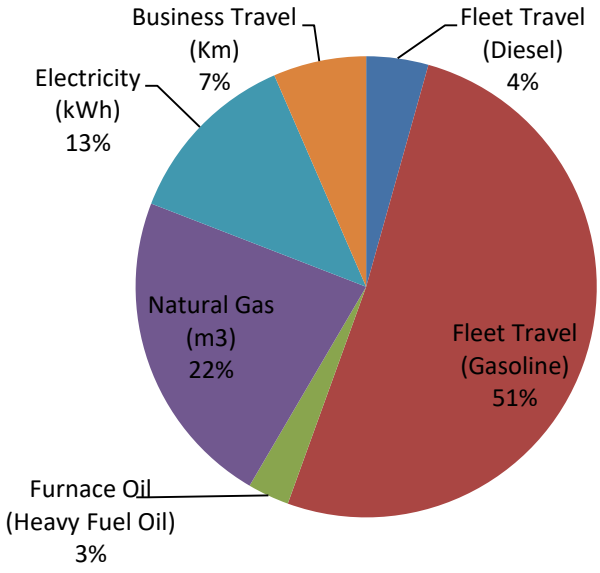

Figure 17: The contribution (%) of each emission category to total CO_2 emissions in 2016

Emission Forecasting

As identified in Scope 1 fleet vehicle emissions, there is a projected increase of 15% in business travel over the next 10 years due to increased staff. This growth rate was then applied to the 2016 baseline to determine the Business As Usual (BAU) emissions for 2026 (Table 19).

Table 19: 2016 Baseline emissions and projected 2026 Business As Usual (BAU) emissions for business travel

	Baseline Emissions 2016 (tCO_2e)	**BAU Emissions 2026 (tCO_2e)**
Total Carbon Emissions from Business Travel	8.35	9.6

Carbon Reduction Opportunities

Facilities

As business travel represents the travel undertaken by staff using their own vehicle for business purposes there are no facility related reduction opportunities.

Behavioral

The behavioral carbon reduction opportunities for business travel are the same as those employed for fleet vehicle reduction and include strategies to reduce the total number of trips, reduce single occupancy trips and ensure the right vehicle for the trip. In alignment with the Scope 1 fleet vehicle carbon reduction strategy, the business travel carbon reduction goal is 5% (Table 20) by 2026.

Table 20: Recommended behavioral reduction opportunities for business travel and their associated costs and carbon reductions (% and tCO_2e).

Recommended Opportunity	Estimated Cost ($)	Estimated Carbon Reduction* (tCO_2e/yr)	Estimated Carbon Reduction (%)*
Behavioral Change (Reduce number of trips & single occupancy, right vehicle, efficient use)	Accounted for under fleet vehicle strategy	0.42	5%
TOTAL		**0.42**	**5%**

Carbon Reduction Target – Business Travel

LSRCA is committed to a 5% reduction of 2016 carbon emissions resulting from business travel. However, due to a projected 15% increase in staff by 2026, the absolute amount of carbon emission from business travel would increase by 10% unless reductions above the 5% can be achieved (Figure 18).

In addition to an absolute reduction target, LSRCA is also establishing an intensity based target of 5% per employee. In 2016, the carbon emission for each employee was 83.5 $kgCO_2e$. When accounting for a projected 15% increase in the number of staff and the 5% reduction target, the intensity target is 79.87 $kgCO_2e$ per person (Figure 19).

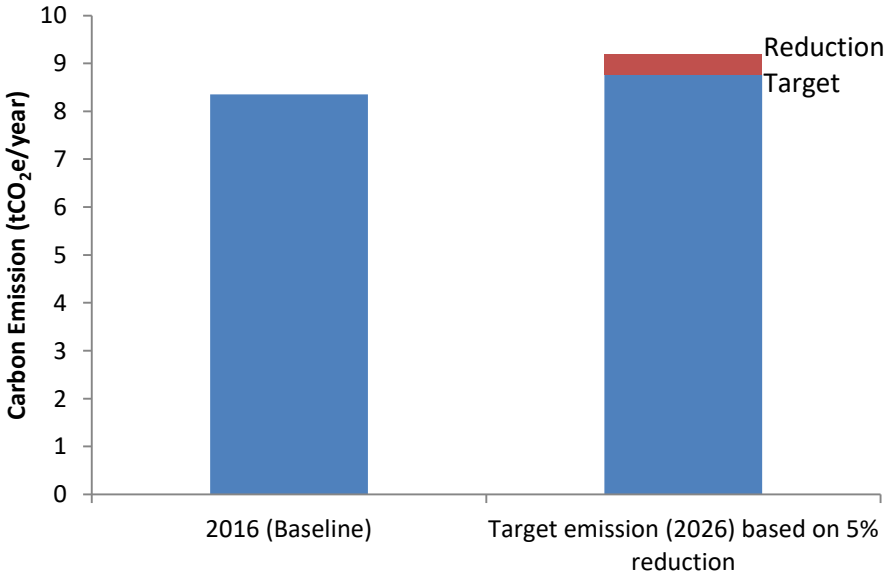

Figure 18: Absolute business travel emission reduction target based on reducing 2016 consumption by 5%

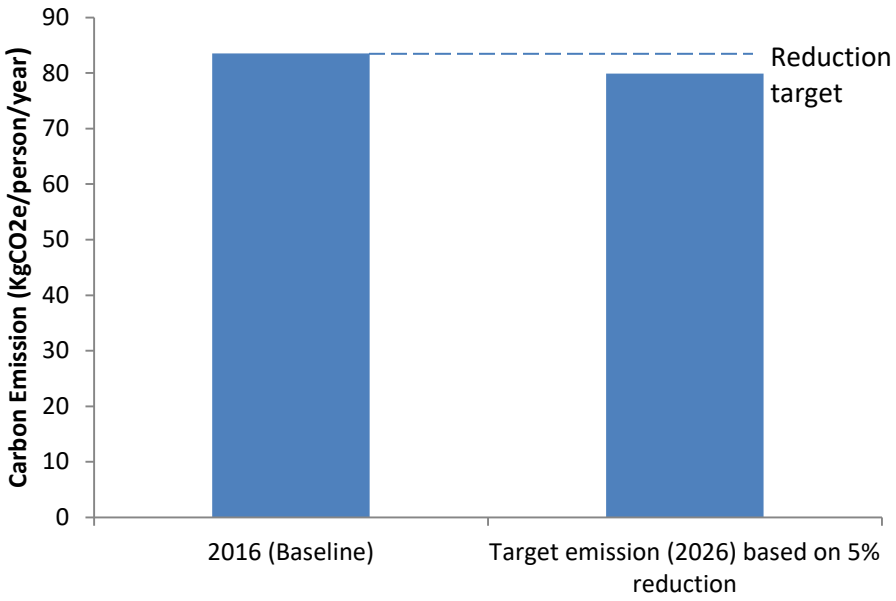

Figure 19: Intensity based business travel emission reduction target of 30% for each employee by 2026

Financial Implications

As the behavior change strategy for business travel is the same as the strategy employed for fleet vehicles, there are no additional expenses and all expenses are identified in the Scope 1 (fleet vehicle) chapter.

Employee Commute

Employee commute is being considered as a Scope 3 emission since it is a very large part of LSRCA's total carbon footprint. However, as emission reduction strategies such as compressed work week and telecommute have significant business and human resource implications, a thorough evaluation is required before a full commitment to this Scope 3 emission category is confirmed and an associated target is set. Therefore, the carbon reduction opportunities put forward in the following chapter will be reviewed further and, if determined to be feasible, an associated strategy and target will be created by 2021. That being said, LSRCA will continue to support emission reduction strategies such as Smart Commute that encompasses the promotion of biking, carpooling and use of public transport.

Current Status

Employee commute was determined to be the largest contributor to total carbon emissions, at 65%, as shown in Figure 20. The baseline was determined from the results of a companywide commute survey that was completed by approximately 72% of all staff. The survey gathered information regarding commuting habits of employees for 2016, including commute distance, number of carpool/public transit/biking/walking days, and type of vehicle used to commute.

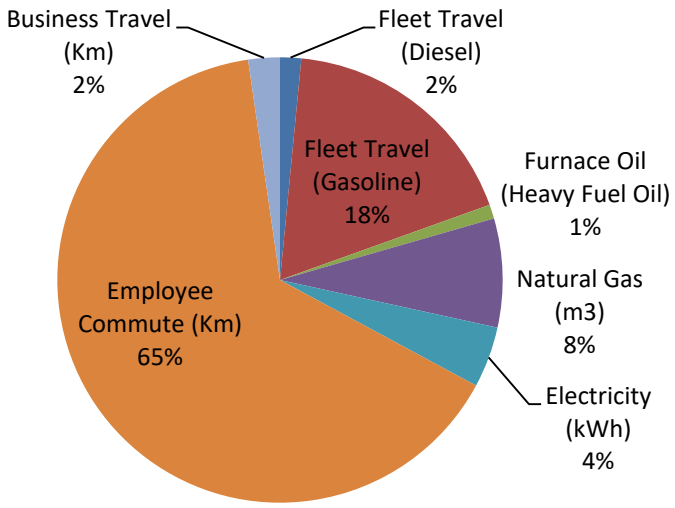

Figure 20: The contribution (%) of each emission category to total CO_2 emissions in 2016

LSRCA has been a member of Smart Commute since 2010 and since then has been recognized for outstanding achievement in the areas of commitment, leadership, innovation and results in the Smart Commute program. Some of these achievements are listed below.

2009	Started a Carpooling info Board
2010	Joined Smart Commute as a Member
2011	Won Smart Commute Employer of the Year
2015	Honorable mention for Smart Commute Employer of the Year
2016	Won Smart Commute Employer of the Year for York Region

In addition to Smart Commute, LSRCA also supports carpooling through the SWITCH Committee through hosting ride matching events to help connect staff members who live in the same area. In addition, as of 2016, there are nine designated carpool spaces at the Administrative Office facility which act as an incentive for carpoolers.

Furthermore, LSRCA has made efforts to reduce carbon emissions through promoting active commuting such as biking or walking to work. In 2016, a bike shed was constructed at the Administrative Office facility to allow employees to store their personal bikes in a secure place and to encourage biking to work. LSRCA also purchased two bikes for staff to use for recreational purposes (before or after work and during lunch), errands, meetings, and for borrowing to test out commuting to and from work. To further support active commuting, the Administrative Office facility has showers available for employees to use and once renovated, the Scanlon Creek Operations Centre will also have these. From the data collected from the 80 individuals who completed the employee commute survey, it was determined that, by carpooling or using other modes of commuting (including walking, biking, or using public transport), LSRCA reduced carbon emissions by 30 tonnes, or 15%, in 2016 compared to emissions from single occupancy vehicle commute.

The involvement in Smart Commute, the bike to work program, as well as other carbon reducing activities are implemented and managed on an ongoing basis by the SWITCH Committee.

Emission Forecasting

It is anticipated that LSRCA will experience a growth within the organization of 15% over the next 10 years in terms of the number of employees. Therefore, as shown in Table 21, the Business as Usual emissions are expected to increase as a result of this growth. Another factor that should be considered is the changes that will arise from the relocation of staff to the Scanlon Creek facility as a permanent work space, which may increase or decrease commute distance for staff.

Table 21: 2016 Baseline emissions and 2026 Business As Usual (BAU) emissions for employee commute

	Baseline Emissions 2016 (tCO_2e)	**BAU Emissions 2026 (tCO_2e)**
Total Carbon Emissions from Employee Commute	236.13	271.55

Carbon Reduction Opportunities

The carbon reduction opportunities focus on various approaches to reduce number of commuter trips and encourage low carbon emission commuting such as active transport (e.g. walk and bike) or use of electric/hybrid vehicles. These opportunities may relate to LSRCA facilities, such as installation of EV charging stations, or behavioral change, such as increase carpooling or telecommuting.

Facilities

Opportunity 1: Increase designated carpool spaces as required

The Administrative Office facility currently has nine designated carpool parking spaces, and additional spaces are added on an as needed basis in order to further support and provide incentives for staff to carpool. The parking lot at the Scanlon Creek Operations Center, however, does not currently have any designated carpool spaces. Once the Scanlon Creek Operation Center has been renovated and staff from the Administrative Office facility are relocated, it will be necessary to ensure adequate designated carpool parking spaces are provided. Space should be located in more premium location (i.e. closer to the building) as an added incentive.

Opportunity 2: Increase number of electric/hybrid vehicle charging stations

The results from the commute survey showed that the majority of staff commuted to work with a small to mid-size car/hybrid SUV (65%), an SUV (22%), or a pickup truck (6%), all of which consume either gasoline or diesel fuel. There was a very small percentage of staff who commuted to work with a plug-in fully electric (4%) or hybrid vehicle (3%). However, it has become evident that the staff who have electric/hybrid vehicles are using LSRCA's charging stations to charge their personal electric vehicles. This presents a need to ensure a strategy is in place to meet staff demand for charging stations without impacting electric/hybrid fleet vehicle needs. The EV40R EV charger costs approximately $3,000-5,000 each (including installation) and LSRCA will likely need at least two within the next 10 years, which totals approximately $6,000-10,000.

Opportunity 3: Implement an Employee Shuttle Program at Scanlon

The York Region transit system is in walking distance to the Administrative Office facility in Newmarket, which is advantageous for staff who use the train for their commute. However, the train station in Bradford is not in walking distance from the Scanlon Creek facilities. If there was a carpool or shuttle service that provided transportation for commuting employees to and from the train station, it may remove a barrier and allow staff to commute by train more often. This could be accomplished by implementing an Employee Shuttle Program. By using an LSRCA owned fleet vehicle, this program would not cost the organization any additional fees. This may become more feasible upon completion of the renovation and staff are relocated to Scanlon Creek, and therefore, will be explored further at that time.

Alectra (formerly PowerStream) has nine vans that they use to shuttle employees to and from work with as part of their Employee Vanpool Program. The program eliminated 300 tonnes of greenhouse gases each year by taking 56 employee personal vehicles off the roads. The costs associated with the vans are in part covered by Alectra and in part by the employees participating in the program (Power Stream).

Behavioral

Opportunity 1: Ongoing organizational support for carpooling and active commuting through SWITCH and Smart Commute

LSRCA has already reduced current emissions 15% in 2016 and would like to maintain this level of reduction into future years and see even further reductions. This will be accomplished by continued efforts from the SWITCH Committee and LSRCA's involvement in Smart Commute. It will also be beneficial to host another ride-matching event once staff transition from the Administrative Office facility to Scanlon Creek, as there may be new opportunities for carpooling among staff. This relocation may also create more opportunities for staff to carpool to and from the GO station in Bradford and make way for a carpool program that is especially designed for these purposes. Opportunities for carpooling to transit hubs such as the Barrie Go station should also be explored.

Opportunity 2: Increase use of public transit

The results of the commute survey showed that each employee commuted by public transit an average of 10 days in 2016. This number is lower than desired, especially given the fact that there is public transit (i.e. bus and train) available in the direct vicinity of the Administrative Office facility. Therefore, LSRCA would like to encourage employees to take advantage of the public transit system and help reduce the number of cars on the road.

One way this could be accomplished is by providing employees a discounted public transit pass (e.g. Metrolinx, YRT). York Region Transit (YRT) has a YRT@Work Program which provides monthly passes at a discounted rate for employees. This pass is purchased by the employee through their employer and then loaded onto a PRESTO card, valid for unlimited travel on all YRT services for the month. As LSRCA is located within the YRT service area, they are eligible to apply for the program. The discount is based on the number of employees enrolled in the program, and ranges from 10 to 15 percent off the regular cost of $145, which would amount to approximately $125/per employee. The minimum number of participants required to qualify for this program is 10 employees per month.

Opportunity 3: Telecommuting

Telecommuting (work from home) is becoming increasingly common with an estimate 115% increase in a decade within US workplaces. The increased uptake is due to the many advantages such as increased productivity, staff job satisfaction and carbon emission reduction. Despite the many benefits there are drawbacks and limitations that also need to be considered. While LSRCA policies enable telecommuting, it is not widely or consistently implemented across the organization due to a variety of reasons that may include; (1) positions that are not compatible telecommuting (e.g. field technicians, customer service positions); (2) processes to ensure staff have appropriate resources (e.g. computers, phone, internet) to work from home; and (3) required work planning (e.g. to minimize need for face to face meeting on telecommute days). Before LSRCA commits to a broader telecommute strategy a detailed study needs to be undertaken that evaluates the various advantages and disadvantages as well as the most feasible implementation options. LSRCA is committing to undertake this strategy by 2021.

In addition to the traditional concept of telecommuting by working from home, there are other alternate workplace scenarios that should also be considered. These include working at other LSRCA offices (e.g. Scanlon vs Administrative Office) or other partner offices (e.g. TRCA, municipal office).

In support of investigating telecommuting as a viable choice for Scope 3 emission reduction, LSRCA conceived a few hypothetical telecommute scenarios and calculated the associated carbon emission reductions for each. If staff are given one day a month to work from home, that would total 12 days a year, which amounts to a reduction of 24 vehicle trips a year per employee. Alternatively, if staff are given one day a week to work from home, that would total 52 days a year, which amounts to a reduction of 104 vehicle trips a year per employee. Annual carbon reductions from these options were explored based on 5%, 10% or 30% of employees and resulted in a reduction of 1-7% from 2016 baseline average emissions.

Opportunity 4: Compressed work weeks

Implementation of compressed works weeks at LSRCA has similar opportunities and challenges as telecommuting. LSRCA does have policies to enable compressed work weeks, but like telecommute it is not widely used across the organization for similar reasons as telecommuting, e.g. compatible positions and work planning. Before LSRCA commits to a broader use of compressed work weeks a detailed study needs to be undertaken that evaluates the various advantages and disadvantages as well as the most feasible implementation options. LSRCA is committing to undertake this strategy by 2021.

In support of investigating compressed work weeks as a viable choice for Scope 3 emission reduction, LSRCA conceived a few hypothetical compressed work week scenarios and calculated the associated carbon emission reductions. If work weeks were reduced to 4 days a week every other week (with increased daily work hours) it would reduce number of commuting days by 24 and vehicle trips by 48 a year per employee. Annual carbon reductions from this option were explored based on 5%, 10% or 30% of employees and resulted in a reduction of 0.5-3% from 2016 baseline average emissions.

Based on the above analysis of opportunities, Table 22 outlines the recommended opportunities that could be included in a carbon reduction strategy for employee commute. This includes costs and carbon reductions (% and tCO_2e) per year.

Table 22: Recommended behavioral reduction opportunities for employee commute, and their associated costs and carbon reductions (% and tCO_2e).

Strategy	Recommended Reduction Opportunity	Estimated Cost ($)	Estimated Carbon Reduction (tCO_2e)	Estimated Carbon Reduction (%)
Improved facilities	Add designated carpool spaces to Scanlon parking lot	0	Accounted for in behavior change strategy	
	Increase number of electric/hybrid vehicle charging stations	$10,000	4.72	2%
	Implement an Employee Shuttle Program at Scanlon	$1,500/yr.	TBD	
Behavioral change	Ongoing organizational support for carpooling and active commuting through SWITCH and Smart Commute	$1,500/yr.	11.81	5.0%
	Increase use of public transit			
Policy update	Compressed work week	TBD		
	Telecommuting			
TOTAL		$9,000	16.53	7%

Financial Implications

The costs associated with reducing employee commute carbon emissions are relatively minor. As with the other scopes there will be a $1,500/year cost associated with a staff position to support behavior change programs. If an employee shuttle program is determined to be a cost effective opportunity then this would also cost a minimum of $1,500/year assuming an existing fleet vehicle is used. Installation of EV charging stations represents a one off capital expense of approximately $3-5,000 each. While LSRCA has costed two charging stations, it is quite likely that more may be needed considering how common and more affordable EVs are becoming.

Carbon Reduction Target – Employee Commute

Since staff commute is not being incorporated into the strategy at this stage, LSRCA is not establishing a reduction target.

Overall Carbon Reduction Target

Through the opportunities set out in the strategy, LSRCA is proposing to reduce 2016 baseline emissions from 128 to 91 tCO_2e/year by 2026, representing a 28% reduction target (Figure 21). This target accounts for projected growth of the organization and successful implementation of the various opportunities identified. A review of similar organization's 10 year reduction targets shows a range between 30% (e.g. TRCA) to 10% (e.g. Rankin College), highlighting the aggressive nature of the LSRCA target. This target may be adjusted in the future once additional information and decisions related to staff commute and upgrades to the Administrative Office HVAC/BAS are considered.

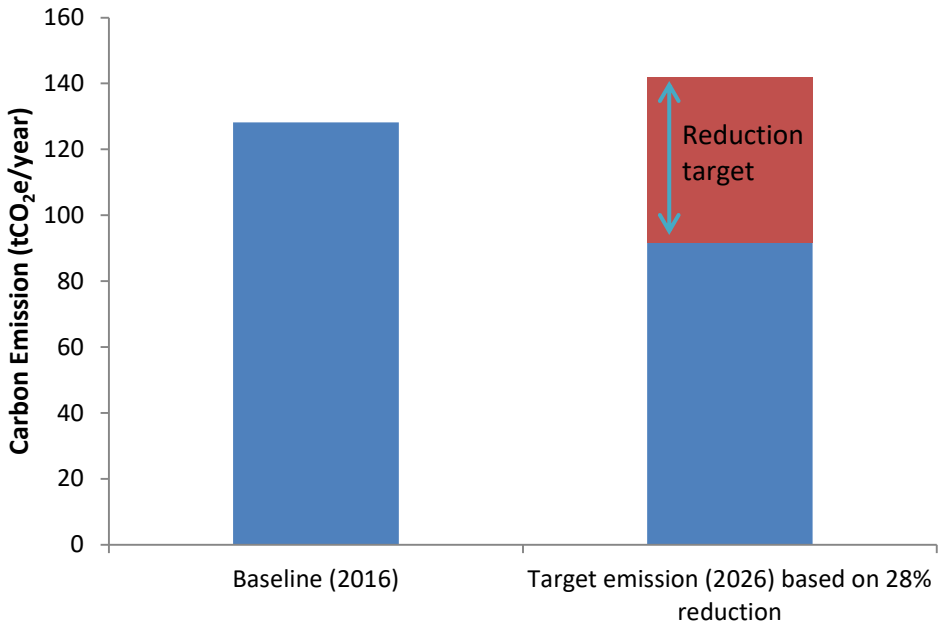

Figure 21: The overall absolute reduction target from 2016 baseline emissions to be achieved in 2026

In addition to an absolute reduction target LSRCA, is setting an intensity based target of 37% per capita. The per capita target accounts for both the absolute reduction target (28%) while also accounting for the estimated organizational increase in number of staff of 15% by 2026. In 2016 the carbon emission for each employee was an estimated 1,282 $kgCO_2e$. When accounting for a projected 15% increase in staff and the 26% absolute reduction target, the emission per person would be 796 $kgCO_2e$ (Figure 22).

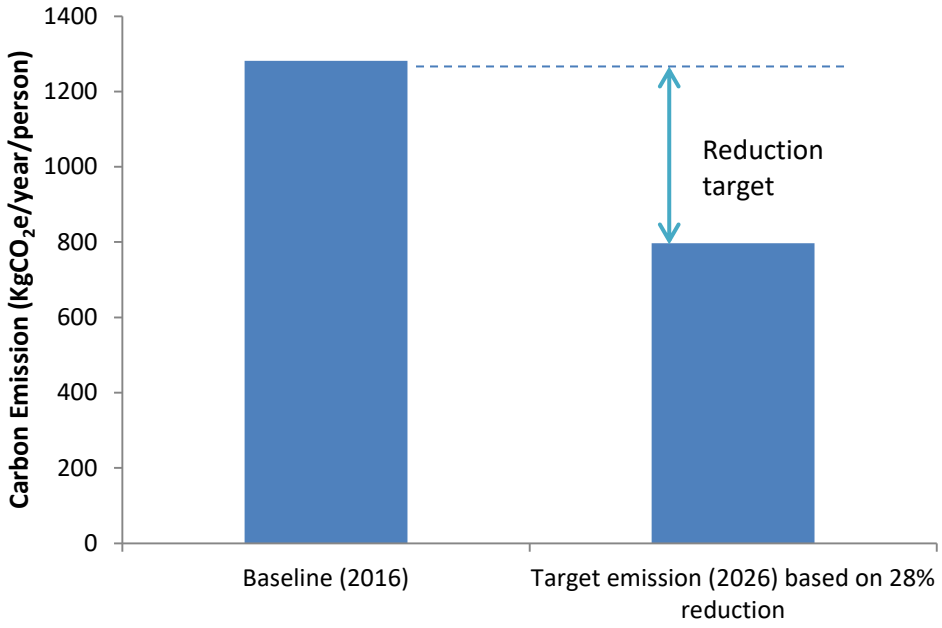

Figure 22: Intensity based target of 37% per employee by 2026

Overall Monitoring and Reporting

The strategy will continue to be refined into the future to align with LSRCA's 2016-2020 Strategic Plan and to assess the performance of the carbon reductions against the 2016 baseline year. As per ClimateWise requirements, LSRCA will report on its emissions and update the ClimateWise carbon accounting database (Verisae) annually. Additionally, an annual implementation plan that outlines specific ways in which LSRCA will achieve the carbon reduction targets will be circulated in support of and working in conjunction with this strategy.

Appendix A

Current vehicle								Replacement options														
Vehicle	Vehicle primary use	Current annual mileage	L/100km	fuel (L)	Current Carbon emission (t)	Current carbon emisson (t/10 years)	Option	Replacement type	Estimated Cost	Estimated Cost (Adjusted for growth)	Annual fuel running cost (@$115/litre)	Lifespan fuel cost (lifespan = 5 years)	Total life cost	Total Life Cost (Adjusted for growth)	projected annual mileage	L/100km	fuel (L)	projected Carbon emission (t/y)	projected Carbon emission (t/10 years)	Estimated Annual Carbon reduction (t/y)	Estimated Carbon Reduction (t/10 years)	Estimated cost/kg - capital cost only	Estimated cost (cost/kg) - incl. fuel
Silverado	Monitoring	20000	15.7	3140	7.222	72.22	1	2017 Silverado 1500	$35,000	$37,100	$3,197	$15,985	$50,985	$54,044	20,000	13.9	2780	6.394	63.94	0.828	8.28	$42.27	$61.58
							2	2017 Ford F150 (4X4)	$36,000	$38,160	$2,507	$12,535	$48,535	$51,447	20,000	10.9	2180	5.014	50.14	2.208	22.08	$16.30	$21.98
							3	2017 RAM 1500 EcoDiesel	$42,000	$44,520	$2,231	$11,155	$53,155	$56,344	20,000	9.7	1940	5.2574	52.574	1.9646	19.646	$21.38	$27.06
Ram	Monitoring	28000	15.9	4452	10.2396	102.396	1	2017 Ram 1500	$29,000	$30,740	$4,508	$22,540	$51,540	$54,632	28,000	14	3920	9.016	90.16	1.2236	12.236	$23.70	$42.12
							2	2017 Ford F150 (4X4)	$36,000	$38,160	$3,510	$17,549	$53,549	$56,762	28,000	10.9	3052	7.0196	70.196	3.22	32.2	$11.18	$16.63
							3	2017 Nissan NV200 Cargo Van	$25,000	$26,500	$3,027	$15,134	$40,134	$42,542	28,000	9.4	2632	6.0536	60.536	4.186	41.86	$5.97	$9.59
truck	Bio Crew	20000	15.8	3160	7.268	72.68	1	2017 Silverado 1500	$35,000	$37,100	$3,220	$16,100	$51,100	$54,166	20,000	14	2800	6.44	64.4	0.828	8.28	$42.27	$61.71
							2	2017 Ford F150	$36,000	$38,160	$2,507	$12,535	$48,535	$51,447	20,000	10.9	2180	5.014	50.14	2.254	22.54	$15.97	$21.53
							3	Toyota RAV4 Hybrid AWD	$35,000	$37,100	$1,679	$8,395	$43,395	$45,999	20,000	7.3	1460	3.358	33.58	3.91	39.1	$8.95	$11.10
2003 Ford van	Lands	5000	16.9	845	1.9435	19.435	1	2017 Ford Van	$35,000	$37,100	$840	$4,198	$39,198	$41,549	5,000	14.6	730	1.679	16.79	0.2645	2.645	$132.33	$148.19
							2	Ford Transit Connect	$35,000	$37,100	$598	$2,990	$37,990	$40,269	5,000	10.4	520	1.196	11.96	0.7475	7.475	$46.82	$50.82
							3	2017 Nissan NV200 Cargo Van	$25,000	$26,500	$541	$2,703	$27,703	$29,365	5,000	9.4	470	1.081	10.81	0.8625	8.625	$28.99	$32.12
2005 GMC Sierrra 2500	Lands	10000	16.1	1610	3.703	37.03	1	2017 GMC Sierra 2500 (4X4)	$38,000	$40,280	$1,507	$7,533	$45,533	$48,264	10,000	13.1	1310	3.013	30.13	0.69	6.9	$55.07	$65.99
							2	2017 Ford F150 (4X4)	$36,000	$38,160	$1,254	$6,268	$42,268	$44,804	10,000	10.9	1090	2.507	25.07	1.196	11.96	$30.10	$35.34
							3	2017 RAM 1500 EcoDiesel	$42,000	$44,520	$1,116	$5,578	$47,578	$50,432	10,000	9.7	970	2.6287	26.287	1.0743	10.743	$39.10	$44.29
2006 Dodge Ram 3500 diesel	Lands	10000	21	2100	5.691	56.91	1	2017 Ram 3500 Diesel	$42,000	$44,520	$2,415	$12,075	$54,075	$57,320	10,000	21	2100	5.691	56.91	0	0	$0.00	$0.00
							2	2017 Ford F150 (4X4)	$36,000	$38,160	$1,254	$6,268	$42,268	$44,804	10,000	10.9	1090	2.507	25.07	3.184	31.84	$11.31	$0.00
							3	2017 RAM 1500 EcoDiesel	$42,000	$44,520	$1,116	$5,578	$47,578	$50,432	10,000	9.7	970	2.6287	26.287	3.0623	30.623	$13.72	$15.54
2011 kia rondo	Fleet	12000	8.9	1068	2.4564	24.564	1	2017 Kia Rondo	$25,000	$26,500	$1,228	$6,141	$31,141	$33,009	12,000	8.9	1068	2.4564	24.564	0	0	$0.00	$0.00
							2	Toyota Prius	$27,000	$28,620	$621	$3,105	$30,105	$31,911	12,000	4.5	540	1.242	12.42	1.2144	12.144	$22.23	$24.79
							3	2018 Nissan Leaf	$36,000	$38,160	$0	$0	$36,000	$38,160	12,000	2.1	252	0.5796	5.796	1.8768	18.768	$19.18	$19.18
2013 GMC Sierra 1500	Stew. / Forestry	10000	15.6	1560	3.588	35.88	1	2017 GMC Sierra	$30,000	$31,800	$1,507	$7,533	$37,533	$39,784	10,000	13.1	1310	3.013	30.13	0.575	5.75	$52.17	$65.27
							2	2017 Ford F150 (4X4)	$36,000	$38,160	$1,254	$6,268	$42,268	$44,804	10,000	10.9	1090	2.507	25.07	1.081	10.81	$33.30	$39.10
							3	2017 RAM 1500 EcoDiesel	$42,000	$44,520	$1,116	$5,578	$47,578	$50,432	10,000	9.7	970	2.6287	26.287	0.9593	9.593	$43.78	$49.60
2015 Nissan Leaf	Fleet	5000	2.1	105	0.2415	2.415	1	2018 Toyota Yaris	$20,000	$21,200	$403	$2,013	$22,013	$23,333	5,000	7	350	0.805	8.05	-0.805	-8.05	-$24.84	-$27.34
							2	Toyota Prius	$27,000	$28,620	$259	$1,294	$28,294	$29,991	5,000	4.5	225	0.5175	5.175	-0.5175	-5.175	-$52.17	-$54.67
							3	2018 Nissan Leaf	$36,000	$38,160	$0	$0	$36,000	$38,160	5,000	2.1	105	0.2415	2.415	0	0	$0.00	$0.00
2015 GMC Sierra 1500	Lands	12000	17.5	2100	4.83	48.3	1	2017 GMC Sierra	$30,000	$31,800	$1,808	$9,039	$39,039	$41,381	12,000	13.1	1572	3.6156	36.156	1.2144	12.144	$24.70	$32.15
							2	2017 Ford F150 (4X4)	$36,000	$38,160	$1,504	$7,521	$43,521	$46,132	12,000	10.9	1308	3.0084	30.084	1.8216	18.216	$19.76	$23.89
							3	2017 RAM 1500 EcoDiesel	$42,000	$44,520	$1,339	$6,693	$48,693	$51,615	12,000	9.7	1164	3.15444	31.5444	1.67556	16.7556	$25.07	$29.06
2015 GMC Sierra 1500	Stewardship	10000	17.5	1750	4.025	40.25	1	2017 Mitsubishi Outlander	$29,000	$30,740	$1,035	$5,175	$34,175	$36,226	10,000	9	900	2.07	20.7	1.955	19.55	$14.83	$17.48
							2	Toyota Prius v	$29,000	$30,740	$667	$3,335	$32,335	$34,275	10,000	5.8	580	1.334	13.34	2.691	26.91	$10.78	$12.02
							3	2018 Nissan Leaf	$36,000	$38,160	$0	$0	$36,000	$38,160	10,000	2.1	210	0.483	4.83	3.542	35.42	$10.16	$10.16
2015 GMC Sierra 1500	Enforcment	18000	17.5	3150	7.245	72.45	1	2017 Mitsubishi Outlander	$29,000	$30,740	$1,863	$9,315	$38,315	$40,614	18,000	9	1620	3.726	37.26	3.519	35.19	$8.24	$10.89
							2	Toyota Prius v	$29,000	$30,740	$1,201	$6,003	$35,003	$37,103	18,000	5.8	1044	2.4012	24.012	4.8438	48.438	$5.99	$7.23
							3	2018 Nissan Leaf	$36,000	$38,160	$0	$0	$36,000	$38,160	18,000	2.1	378	0.8694	8.694	6.3756	63.756	$5.65	$5.65
2016 Dodge journey 1	Fleet	16000	11.1	1776	4.0848	40.848	1	2017 Mitsubishi Outlander	$29,000	$30,740	$1,656	$8,280	$37,280	$39,517	16,000	9	1440	3.312	33.12	0.7728	7.728	$37.53	$48.24
							2	2018 Nissan Leaf	$36,000	$38,160	$0	$0	$36,000	$38,160	16,000	2.1	336	0.7728	7.728	3.312	33.12	$10.87	$10.87
							3	2018 Nissan Leaf	$36,000	$38,160	$0	$0	$36,000	$38,160	16,000	2.1	336	0.7728	7.728	3.312	33.12	$10.87	$10.87
2016 Dodge journey 2	Fleet	22000	11.1	2442	5.6166	56.166	1	2017 Mitsubishi Outlander	$29,000	$30,740	$2,277	$11,385	$40,385	$42,808	22,000	9	1980	4.554	45.54	1.0626	10.626	$27.29	$38.01
							2	2018 Nissan Leaf	$36,000	$38,160	$0	$0	$36,000	$38,160	22,000	2.1	462	1.0626	10.626	4.554	45.54	$7.91	$7.91
							3	2018 Nissan Leaf	$36,000	$38,160	$0	$0	$36,000	$38,160	22,000	2.1	462	1.0626	10.626	4.554	45.54	$7.91	$7.91

																							% Reduction
								replace with like	$426,000	$451,560			$573,091	$607,476		25581	60.28	602.84	8.45	84.53	$440.61	$560.06	12.30
TOTAL		198000	N/A	29,258	68.1544	681.544	1	most suitable vehicle type and minimal replacement efficiency	$435,000	$461,100			$572,310	$606,649		23,880	55.785	557.85	12.1279	121.279	$435.56	$564.29	18.15
							2	most suitable vehicle type and moderate replacement efficiency	$447,000	$473,820			$552,047	$585,170		15,697	36.1031	361.031	31.8098	318.098	$190.35	$217.43	47.03
							3	most suitable vehicle type and aggressive replacement efficiency	$514,000	$544,840			$580,275	$615,091		12,319	30.79944	307.9944	37.35496	373.5496	$240.71	$272.11	54.81