Halifax Regional Municipality

Corporate Plan to Reduce Greenhouse Gas Emissions 2012-2020

Sustainable Environment Management Office, HRM
http://www.halifax.ca/environment/semo.html
Prepared by: Lauralee Sim, Environmental Performance Officer
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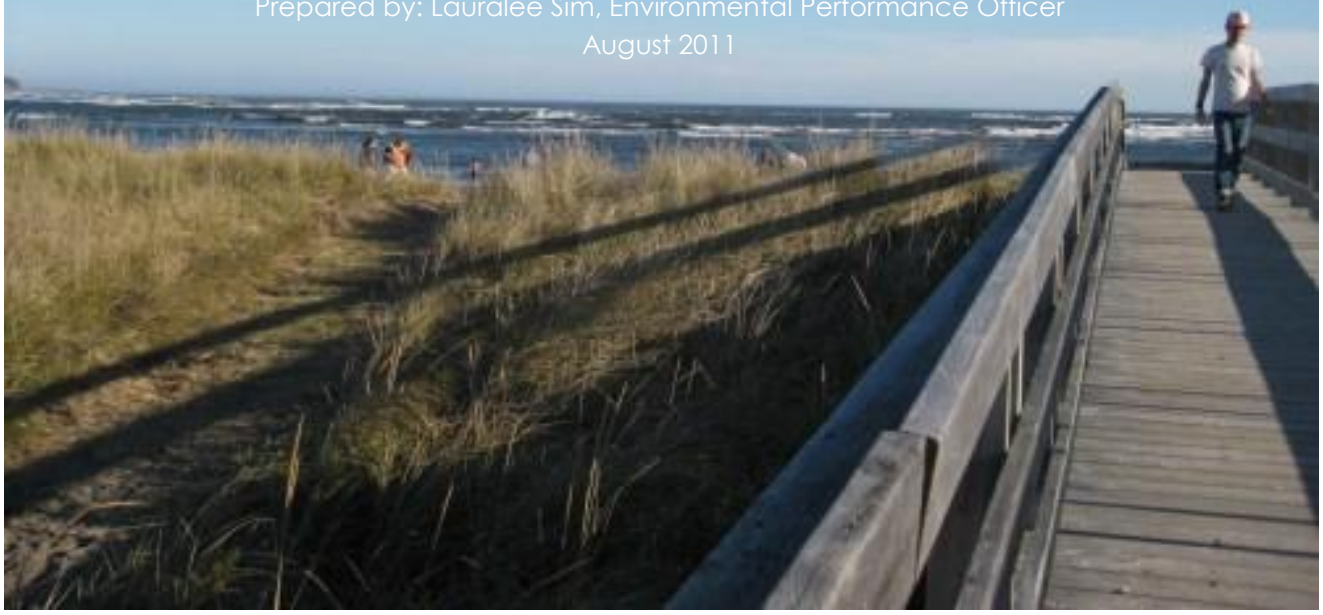

Table of Contents

Appendices

Acronyms

BAU	Business-as-Usual Scenario
CO_2	Carbon Dioxide
eCO_2	Equivalent Carbon Dioxide (GHG emissions are measured in tonnes eCO_2)
GHG	Greenhouse Gas
HRM	Halifax Regional Municipality
LED	Light-Emitting Diode
SEMO	Sustainable Environment Management Office, HRM

Setting the Context

HRM's Commitment

Climate change is one of the world's greatest challenges this century. As a coastal region, the Halifax Regional Municipality (HRM) experiences particularly severe climate risks such as sea level rise and increasingly intense hurricanes, storm surges and coastal erosion. Further inland, HRM communities may experience more frequent forest fires and flooding with a changing climate. Fortunately, municipalities such as HRM are well-positioned to act as leaders in the shift toward reducing the negative impacts of climate change. The Federation of Canadian Municipalities (FCM) estimates that municipal governments directly or indirectly influence about 44% of greenhouse gas (GHG) emissions in Canada. As primary regulators of development and land use, municipalities shape the distribution of the economy, transportation system and energy use patterns. They also manage waste and exert influence over building design. Perhaps most importantly, their high level of interaction with the community allows them to engage households and businesses more easily than higher levels of government[1]. It is for all of these reasons that HRM continues to take a more aggressive approach to reducing its GHGs and mitigating the effects of climate change.

In early 2011, after achieving emission savings in the range of 12,000 tonnes equivalent carbon dioxide (eCO_2) per year, HRM received formal recognition for completion of Milestone 5 in the "Partners for Climate Protection" program for its progress in the corporate sphere[2]. This GHG Reduction Plan is the next step in the process: geared to help the municipality achieve a new corporate 2020 GHG reduction target. With its own house in order, HRM will then embark on developing a plan to reduce community GHGs, which account for 98% of emissions in the region.

Greenhouse Gases and Climate Change

Greenhouse gases such as carbon dioxide (CO_2) have been present in our atmosphere for millennia. Together, they act as a blanket that warms our planet to the point where plants and animals thrive. However, since the onset of the industrial revolution in the mid-nineteenth century, greenhouse gas levels in the Earth's atmosphere have risen at an extremely high rate. The fossil fuels we burn (coal, oil and natural gas) to power electrical equipment, move vehicles, and control the temperature of water and indoor spaces release GHGs into the atmosphere faster than the planet's natural systems can re-absorb them. After almost two centuries of producing so many GHGs, we are now beginning to experience the effects of an intensified "greenhouse effect", which has led to gradual global climatic change. Climate scientists claim that an increase of only 2 degrees in average global temperatures will cause severe social and environmental impacts[3]. As global temperatures rise, HRM will see direct impacts. The sea level in Halifax Harbour is expected to rise an estimated 73cm by 2100 due to a combination of sea level increase and land subsidence[4]. This, coupled with increased storm intensity, could bring even more devastating results than recent Hurricanes Juan and Earl.

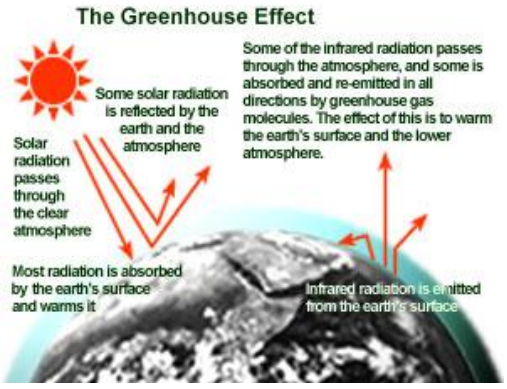

Figure 1: The Greenhouse Effect
Image source: epa.gov

Human activities produce several GHGs including carbon dioxide (CO_2), methane, nitrous oxide and fluorinated gases. Each gas has a different degree of impact on climate change so they are measured in equivalent carbon dioxide (eCO_2) and reported in units of mass such as kilograms or tonnes. For example, methane has 21 times the impact of carbon dioxide on climate change, so one tonne of methane is recorded as 21 tonnes eCO_2.

Currently, Canada's population is responsible for about 22.6 tonnes eCO_2 per capita every year, which ranks our country the second worst polluter among North American and Western European countries[5]. As of 2002, HRM sits at about 19 tonnes eCO_2 per capita[6]. In order to avoid the 2 degree change that climate scientists warn about, we must reduce our emissions to at least 1 tonne eCO_2 per capita by 2050[7].

Greenhouse Gases and Other Impacts

Lowering greenhouse gas emissions has benefits beyond mitigating the effects of climate change. GHG reduction strategies usually go hand in hand with decreased fuel consumption and costs, which will become even more significant to taxpayers in the context of escalating electricity and fuel prices. Additionally, most emission reduction strategies also reduce air pollution and other environmental impacts; for example, fewer greenhouse gas emissions from vehicles also mean fewer particulate matter and nitrogen oxide emissions that negatively affect human health. With cleaner air, HRM will see fewer smog days and a healthier community and environment. Furthermore, much of our coal and oil derives from outside our region – a shift toward reducing our dependence on foreign sources of energy will, in many cases, improve our energy security and strengthen our local economy.

Sources of GHGs from Corporate HRM

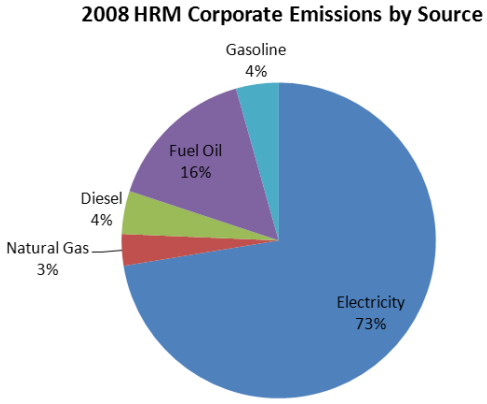

Figure 2: 2008 HRM Corporate Emissions by Source

With such staggering risks and the global nature of the problem, reducing GHGs can seem a daunting task. However, HRM's efforts alongside those of other municipalities, provinces and countries across the world, will contribute to a more sustainable future for generations to come. HRM has taken the approach of getting its own house in order before diving into community GHG reductions. With the experience and lessons learned from the corporate GHG reduction planning process, HRM will be better equipped to strategically help reduce, monitor and report community emissions.

GHG emissions from corporate HRM come from the generation of electricity and the burning fuel to power our fleet and heat our buildings. Nova Scotia's electricity is primarily generated from coal so its impact on climate change is much greater than, for example British Columbia's electricity where power is generated mostly from hydro-power.

Purpose of the GHG Reduction Plan

The ultimate purpose of the GHG reduction plan is to mitigate the impacts of climate change. Climate change will continue to progress for decades to come but now is the time to act to avoid extreme climatic change and severe impacts in the future.

The first objective of the GHG reduction plan is to establish a realistic but ambitious corporate GHG reduction target. Clear quantitative targets direct policy and action and help interpret progress. The plan suggests quantitative measurements to track. Accurate collection of fuel consumption and other data is important to the GHG reduction mission because it enables better analysis and evaluation reduction efforts. While some data is available, to date, it has been very challenging to locate and verify its accuracy.

The second objective of the plan is to offer guidance on how to achieve the target. The actions described in the plan are not exhaustive – they represent only the primary initiatives necessary to keep the municipality on track toward its target. The plan is not designed to be prescriptive but rather, it is a tool for staff and councillors that presents the types of actions necessary to reach reductions in the range of 30% below 2008 levels by 2020. Given the complexity and uncertainty of projecting future emissions, the estimates in the plan are best understood as *orders of magnitude* of reductions and associated costs. As demonstrated in HRM's 2011 Greenhouse Gas Progress Report, unforeseen factors and uncertainties will inevitably affect HRM's ability to achieve and/or surpass its target[8].

Objectives of GHG Reduction Plan

- **To establish a realistic but ambitious corporate GHG reduction target**
- **To provide guidance on achieving the target**

We must remember that while slowing climate change will reduce our environmental impact and bring economic benefits, with a two-century history of excess human-induced emissions, some change in our climate is inevitable. Therefore, as we plan for emissions reductions, we must also plan for climate change adaptation – we must make our communities able to withstand and recover from extreme weather events. HRM's primary climate change adaptation efforts can be found in its Climate SMART Strategy[9].

Method

The plan was initiated after HRM received recognition for completion of Milestone 5 of the Partners for Climate Protection program in Spring 2011. SEMO held three staff consultation sessions to solicit input on priorities for GHG reductions from buildings, fleet, and outdoor lighting. SEMO also consulted outside sources for input through a request for information on park lighting and meetings with Clean Nova Scotia on fleet emission reductions. SEMO continued discussions with relevant staff members throughout the development of the plan.

The plan complements and draws from multiple sources of local, national and international information but it particularly relies on the

- HRM Corporate GHG Emissions Inventory 2008[10];
- Progress Report on Greenhouse Gas Emission Reductions 2005-2011[11]; and
- HRM Corporate Local Action Plan to Reduce GHG Emissions (2005)[12]

While not discussed in this plan, carbon sinks such as trees and other plants affect CO_2 levels by acting as biological "reservoirs"[13]. Forest management and practices that increase the carbon content of soils can help mitigate climate change.

Emissions and 2020 Targets

Where We've Been

In 2008, corporate operations were responsible for emitting 88,720 tonnes eCO_2. This is equivalent to driving a car to Vancouver and back about 30,000 times. In 2005, HRM approved the Corporate Local Action Plan to Reduce GHGs and as a result of implementing many of the suggested actions, HRM is currently emitting about 10,200 fewer tonnes eCO_2 into our atmosphere than if it had carried on as business as usual over the last few years[14].

HRM's corporate emissions come from burning fossil fuels to power three corporate sectors:

1) buildings (electricity and temperature control);
2) fleet; and
3) outdoor lighting

Waste and water energy uses are accounted for in HRM's community inventory and will be addressed in a forthcoming community GHG reduction plan. Transit emissions, while documented in HRM's 2008 Corporate GHG Inventory, will also be addressed in the community GHG reduction plan because they must be considered alongside the community transportation sector (slight increases in transit emissions may imply decreases in other parts of the transportation sector).

Recent Corporate HRM Emission Reduction Activities

Buildings

- Major energy efficiency projects and retrofits such as Dartmouth Sportsplex, Energy Performance Contract for the Metro Transit facility at 200 Ilsley Ave., Alderney 5, Sackville Sports Stadium, Cole Harbour Place
- Minor retrofits such as lighting replacements
- Oil to natural gas conversions
- Energy efficient new building design

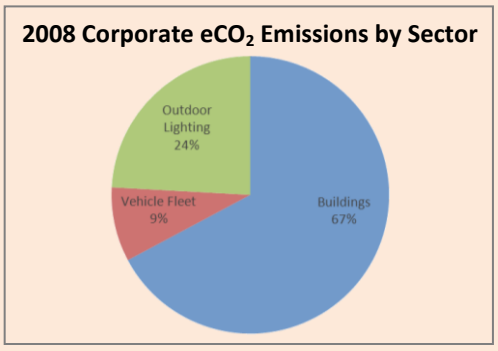

Figure 3: 2008 Corporate eCO_2 Emissions by Sector

Vehicle Fleet

- Replacement of gas with efficient diesel units
- Investigation of alternative fuels
- Smart Cars for employee use
- Initiation of a fleet driver training program
- Utilization of a Vehicle Right Sizing Filter and Life Cycle Analysis for new vehicle purchases

Outdoor Lighting

- Traffic signal conversions to LED lamps (all converted by 2011)
- Street light conversions to LED lamps (~2,500 converted by 2011)

While HRM has actively pursued energy savings over the last 5-10 years, it has done so in the face of several challenges. First, HRM is one of the fastest growing regions in Atlantic Canada. It grew from a population of about 362,700 in 2002 to 398,000 in 2009 (9.7% growth in seven years), leading to an increased demand for municipal services.

Second, wind energy has not developed in Nova Scotia as quickly as anticipated. Without this renewable source of electricity, Nova Scotia continues to rely heavily on coal-generated electricity, which results in high levels of GHG emissions. In 2008, 11% of Nova Scotia's electricity came from renewable sources but by 2015, Nova Scotia aims to reach at least 25% renewable electricity. The Province's new goal is to achieve 40% renewable electricity by 2020[15]. Because almost three quarters of all corporate emissions come from electricity generation, the gradual provincial shift to renewable electricity alone will significantly reduce HRM's corporate emissions. For example, if HRM's corporate electricity demand were to remain constant between 2008 and 2020, a shift to 25% renewable electricity would reduce HRM's overall emissions by about 11%[16].

Third, generous funding from higher levels of government for capital projects has recently spurred the rapid design and construction of new buildings. Over the last three years, HRM has added about 600,000 square feet to its overall building footprint (i.e. HRM building floor area has grown by 19% 2008-2011). While this has been great news for community members who now have access to new facilities, the added floor space has also increased total GHG emissions from HRM buildings. Despite this 19% growth in floor area however, GHGs from buildings have only increased by about 5.9% because of successful energy efficiency projects.

Where We Want to Go

Careful analysis and discussion with HRM staff indicate that HRM should aim for a 30% reduction in eCO_2 below 2008 levels by 2020. The directions described in this plan should take HRM to this target but HRM should continue to seek new opportunities for additional savings.

Corporate Target

30% below 2008 levels by 2020

HRM may see even more savings from measures whose GHG savings cannot be quantified (e.g. continued use of the Vehicle Right Sizing Filter and replacement of old vehicles with new efficient units). Additionally, this plan only includes measures that are foreseeable at the present time. With rapidly growing interest and development in the field of energy efficiency, a range of new possibilities may present themselves before 2020. For this reason, an essential part of this plan includes reviewing the corporate target, taking stock of HRM's progress, and updating the plan's content in 2016.

The GHG Reduction Plan is to be reviewed and updated in 2016

How to Get There

Continued emission reductions will require taking action and utilizing staff experience gained in recent years. Generally, reducing GHGs requires:

1) energy conservation (using less energy);
2) improved energy efficiency (doing more with the same amount of energy); and
3) cleaner sources of energy (replacing oil, gasoline, diesel, etc. with sources of energy that do not emit as many GHGs)

These three approaches to reducing greenhouse gases are applied in GHG reduction plans across the world. In HRM, they can be applied to buildings, fleet and outdoor lighting and indeed, HRM is already engaged in these approaches.

The graph below illustrates the impacts of the actions described in this plan as they relate to a projected Business-As-Usual scenario, 2008 emission levels and the 2020 target.

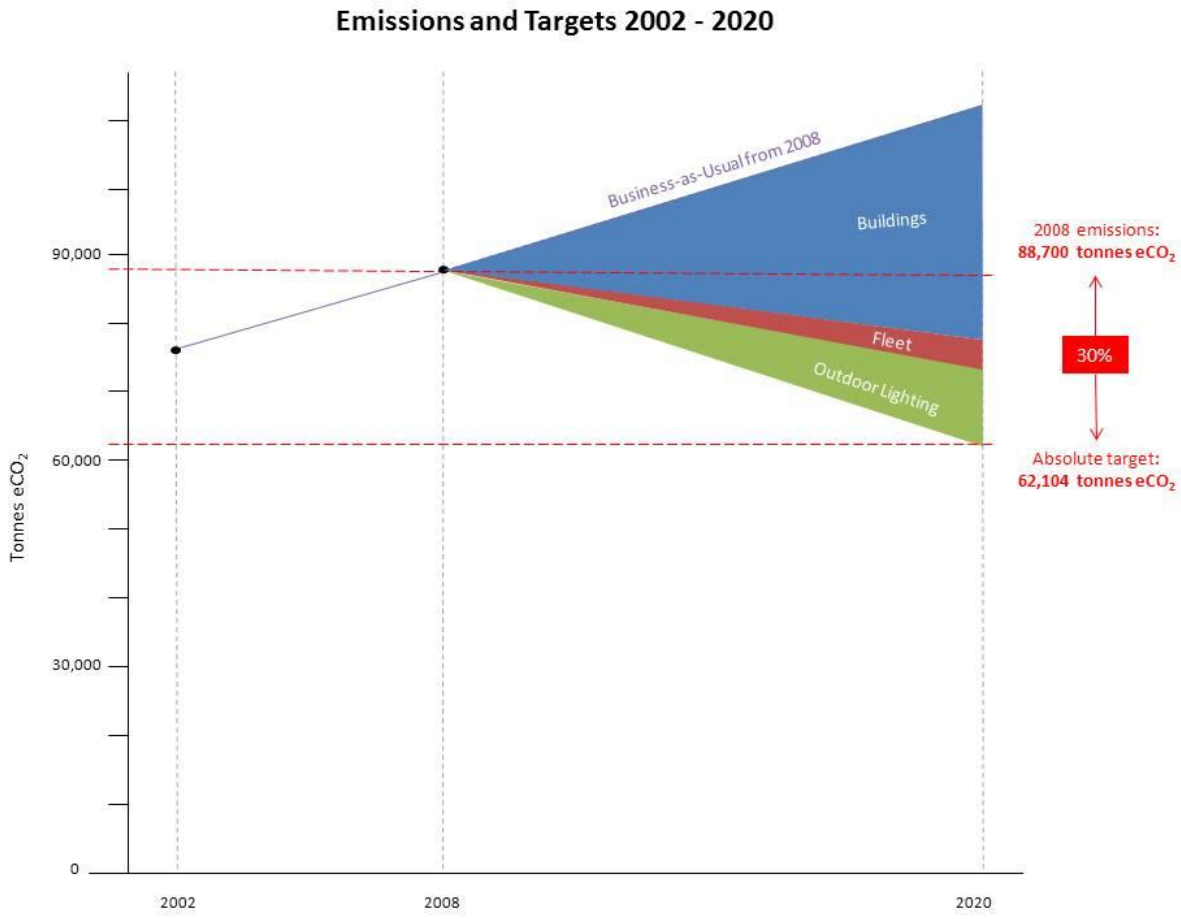

Figure 4: Emissions and Targets 2002-2020

The following table quantifies the predicted emission reductions under buildings, fleet and outdoor lighting. Notes about developing the Business-as-Usual scenario are included in Appendix A.

	2008 absolute emissions	2020 BAU	Savings below BAU (in plan + 2008-11 savings already achieved)	Predicted emissions in 2020	% below 2008 levels	% below BAU
Buildings	59620	78804	29494	49310	17%	37%
Fleet	7693	7693	2514	5179	33%	33%
Outdoor Lighting	21407	23156	15837	7319	66%	68%
TOTAL	**88720**	**109653**	**47845**	**61808**	**30%**	**44%**

Table 1: Reduction Estimates for Buildings, Fleet and Outdoor Lighting

In terms of absolute reductions, the actions in this plan should bring HRM's corporate emissions to about 30% below 2008 levels. However, because HRM is expected to continue to expand its services to meet a growing demand over the next decade, this represents about 44% fewer emissions than if HRM proceeded as business as usual.

Actions in this plan range from those that require no direct investment from HRM to those that require time, money and staff resources. All actions will yield financial, social and environmental benefits in the long term however, some have shorter payback periods than others. Estimated emissions savings and rough costs and benefits are included in the next section of the plan for each sector: buildings, fleet and outdoor lighting.

Below is a summary of the directions HRM should take to reach eCO_2 emissions that are 30% below 2008 levels by 2020.

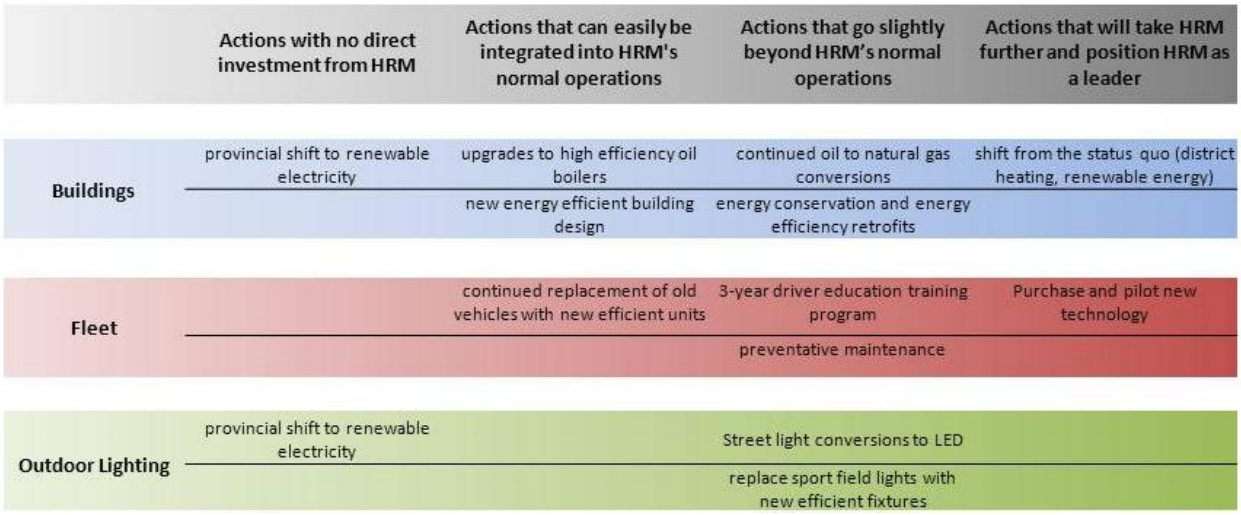

Figure 5: Summary of Actions

Reaching the Target

Buildings

Past and Present

Greenhouse gases from HRM buildings stem from the energy used for electricity, heating and cooling. This is a feature of our general reliance on coal-generated electricity for power and oil for indoor temperature regulation. In 2008, HRM buildings were responsible for emitting 59,620 tonnes eCO_2 (67% of corporate emissions). With such a significant portion of corporate emissions deriving from building operations, buildings represent important opportunities for GHG reductions.

Savings achieved 2008-11
7,534 tonnes eCO_2

On the Atlantic Canadian scale, HRM is currently a leader in the field of building energy efficiency. The Alderney 5 project introduced the world's first geothermal cold storage system, HRM is home to the largest number of geothermal heating systems in Atlantic Canada, and HRM's Solar City project is already generating an overwhelming amount of community interest[17]. Major retrofits such as the Dartmouth Sportsplex, the Metro Transit Facility at 200 Ilsley Avenue, Cole Harbour Place and Centennial Pool have improved energy efficiency and reduced GHGs by more than 4,600 tonnes eCO_2 per year. Minor retrofits such as boiler upgrades and lighting replacements and have resulted in 2,500 tonnes eCO_2 of savings. Heating system conversions from oil to natural gas are also contributing to GHG reductions because of natural gas' lower carbon content and the fact that it simply burns cleaner. Finally, energy performance and emissions are being incorporated into new buildings from the early design stages. HRM now builds to LEED[18] standards and incorporates technologies such as geothermal heating, solar water heating, heat recapture and high efficiency boilers where possible. Because of these initiatives, HRM has already achieved about 7,534 tonnes eCO_2 per year of savings since 2008. These savings will contribute to meeting the corporate 2020 target[19].

The Energy and Underground Services Reserve has been and will be instrumental to HRM's continued success in reducing corporate energy consumption

One of the key factors to reaching HRM's high regional status has been the establishment of the Energy and Underground Services Reserve that fuels new energy projects with money saved from completed energy projects. As a sustainable source of funding, it ensures the availability of seed money to catalyze new initiatives. In the past, HRM has used these funds to leverage millions of dollars from external sources including the Federation of Canadian Municipalities' Green Municipal Fund, the Eco Nova Scotia Program and Natural Resources Canada's EcoEfficiency grants. This reserve will be instrumental in advancing further energy savings projects.

HRM's energy improvements have brought impressive financial savings to taxpayers because of reduced fuel and electricity requirements. The millions of dollars HRM has invested in energy projects have produced a return on investment of 18.75% and this will only increase as energy costs rise in the future. Some estimates predict electricity rate increases of 20-30% over the next three years, which means that reducing electricity consumption will become even more important to sustainable municipal spending.

Moving Forward

Given that within just the last three years, HRM has added about 600,000 square feet of building floor space to its stock (growth of 19%), achieving reductions significantly below 2008 levels will be challenging. Emissions from buildings have likely already grown to about 63,000 tonnes eCO_2 in 2011 due to this fast-paced growth and the fact that anticipated emissions savings from efficient new designs have not yet presented themselves.

According to HRM's 2010 Citizen Survey, more than 50% of residents are in favour of investments in alternative energy sources for municipal buildings and assets, even if they cost more to purchase or operate.

The prospects, however, of reducing building emissions to about 50,000 tonnes eCO_2 are quite positive for several reasons. First, despite not performing as well as expected to this point, new buildings such as the BMO Centre and the Ragged Lake Transit Facility are still being fine-tuned to reach optimal operation. Therefore, the energy consumption data collected thus far does not reflect the buildings' energy consumption in the years to come. Second, even though HRM's building footprint has grown by 19% in the last three years, total GHGs from corporate buildings have only risen by an estimated 5.9% due to the success of various energy efficiency projects in both new and existing buildings[20]. Third, internal capacity within HRM grows with every new experience. Staff members are learning how to operate and maintain new equipment such as geothermal heating and cooling pumps. Finally, HRM now has a well-established and sustainable financial reserve (Energy and Underground Services Reserve) to kick-start energy efficiency projects.

HRM's building footprint has grown by 19% over the last 3 years but its building emissions have only risen about 5.9%

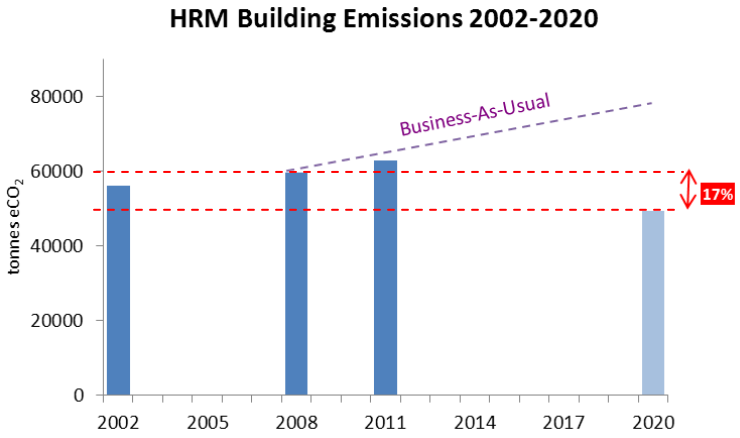

Figure 6: HRM Building Emissions 2002-2020

Because corporate buildings are responsible for more than two thirds of HRM's emissions, HRM must continue to place focus on reducing building energy requirements, using energy more efficiently and finding alternative energy sources. Some of the key actions necessary for continued progress are represented in the following flow chart.

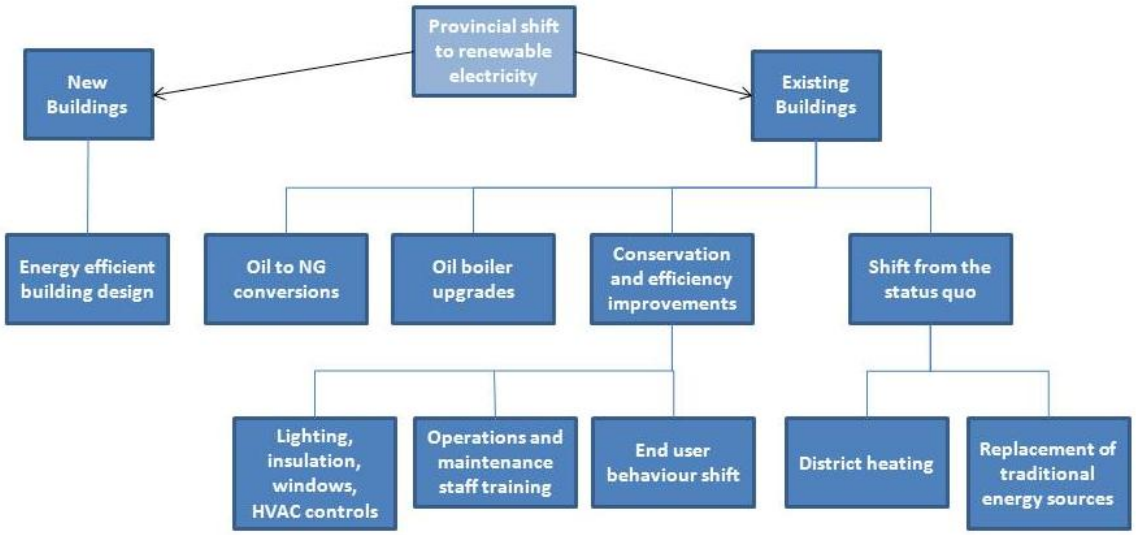

Figure 7: Primary Building Actions

1) New Energy Efficient Building Design

While every new building contributes to an increase in corporate emissions, the construction of new buildings is necessary to meet the needs of a growing municipality. Compared with conventional practices, LEED buildings are generally constructed to be 25% more energy efficient and some are up to 60% more efficient[21]. While HRM has experienced a construction boom in recent years, this is expected to slow in the near future. About 600,000ft^2 were added to HRM's corporate building footprint between 2008 and 2011 but staff project only an additional 450,000ft^2 between 2011 and 2020.

Assuming a total growth of 1,050,000ft^2 of building floor space between 2008 and 2020, conventional building design would likely add about 19,184 tonnes of GHGs to our inventory[22]. However, because new designs tend to be 25% more energy efficient, they will likely only be responsible for about an additional 14,400 tonnes eCO_2.

Opportunity for reductions
4,800 tonnes eCO_2

It is important to note that, as demonstrated with buildings recently constructed in HRM, new buildings may take 1-2 years after completion before reaching optimal operating status. Therefore, the predicted 4,800 tonnes eCO_2 to be saved may not fully present themselves until 2021 or 2022.

Building to LEED Silver standards costs slightly more than conventional construction; the added energy savings features tend to cost 1-5% of the total capital costs of the building[23]. Payback periods vary depending on the particular design but they are estimated to be about 3-5 years[24]. In comparison, LEED Gold buildings (e.g. the new Central Public Library is designed for LEED Gold) typically increase the cost of construction by 6.5-7.5% and have a payback period of 5-10 years. In the long term however, LEED Gold buildings generally yield greater annual energy savings[25]. For example, one estimate states that a LEED Silver building will yield \$1.00/ft^2 in annual utility savings, while a LEED Gold building will bring \$1.25/ft^2 in savings[26].

2) Continued Oil to Natural Gas Conversions

While natural gas is a fossil fuel, it is often considered the "cleanest" of the fossil fuels because it produces less CO_2 than oil or coal when burned. This is a feature of its lower carbon content and the fact that it burns cleaner and more efficiently than other fossil fuels. Across Canada, natural gas is considered a "bridging" fuel that can enable short-term GHG reductions before renewable energy sources and technologies are ready for mainstream implementation[27].

Reductions achieved 2008-2011
2,000 tonnes eCO_2

Opportunity for further reductions
1,000 tonnes eCO_2

Natural gas is still new to the region but HRM has already begun investing in connecting HRM facilities to the natural gas network where possible and converting oil boilers to natural gas boilers. In 2008, about 23% of HRM's heating needs were met with natural gas but within the next few years, this percentage is expected to rise to about 60%. HRM will likely continue to convert heating systems but due to the accessibility of natural gas pipelines, HRM will only be able to meet a maximum of about 70% of heating needs with the gas. If HRM continues to work toward 70% natural gas, HRM's buildings would emit about 3,000 fewer tonnes eCO_2 than in 2008[28]. About two thirds of this was achieved 2008-2011.

While natural gas conversions represent significant opportunities for emission savings in the near future, discussions continue among energy professionals in Canada about the gas' ability to achieve long term emission reductions or reach a carbon-neutral state[29]. Complete reliance on natural gas may hinder reaching long term ambitious reduction goals. However, HRM staff advise that corporate natural gas conversions continue to make sense in our community because the gas usually directly replaces oil or coal. Of course, HRM should continue to explore opportunities to meet its energy demands from non-fossil fuels in the meantime. When many of HRM's natural gas boilers require replacement in 20-25 years, the municipality may have access to new equipment and technology that will allow it to make the next transition to renewable sources of energy for heat in its municipal buildings.

Another aspect of natural gas utilization under discussion in Canada is the environmental impact of its extraction. While Canada has significant natural gas resources, a supply that will last more than a century at current consumption rates, the full implications of new natural gas extraction methods on water resources, landscape and quality of life are still being explored[30]. HRM should continue to carefully monitor and evaluate the benefits of natural gas, particularly as its primary offshore source is depleted over the next two decades.

The price of oil to natural gas conversions ranges depending on building size. Small buildings could cost $50,000 to convert, while larger buildings may cost up to $500,000. The estimated total costs of natural gas conversions between 2012 and 2020 will be in the range of $1 million.

3) Upgrade Old Oil Boilers to New High Efficiency Units

Opportunity for reductions
270 tonnes eCO_2

Given that boilers generally last 20-25 years and that HRM has a significant number of old boilers in its stock, it is feasible to expect that about half of the municipality's boilers will need to be replaced between 2011 and 2020. While this may initially appear burdensome and costly, every new boiler is an opportunity for emissions reductions and long term cost savings because new units are at least 10% more efficient than older units. If HRM were to replace half of its oil boilers with high efficiency units, HRM would save in the range of 270 tonnes eCO_2 per year[31].

Depending on building size and boiler requirements, boilers range from about $10,000 to $15,000 per unit. Staff estimate spending approximately $200,000 on boiler replacements between 2012 and 2020. Because new boiler purchases will have to be made regardless of energy efficiency considerations, the primary challenge is to ensure that fuel and emissions savings are key criteria in purchase decisions. Fuel savings will ultimately lead to significant cost savings, particularly in the context of rising energy costs.

4) Energy Conservation and Energy Efficiency Projects

Opportunity for reductions
7,600 tonnes eCO_2

HRM is currently saving about 2,530 tonnes eCO_2 from minor building retrofits including lighting changes, insulation upgrades, HVAC control improvements, and vending miser installations. HRM should be able to at least triple these savings from minor retrofits by 2020, especially in the context of HRM's upcoming focus away from new buildings and toward recapitalization. This would result in savings in the range of 7,600 tonnes eCO_2. To further support this direction, HRM's corporate plan directs staff to complete energy efficiency projects on 278 of its buildings over the next five years[32].

In addition to upgrading electric and heating technology, the equipment and building must be properly maintained, managed and operated. This requires that first, HRM's operations staff have sufficient training to manage new equipment. Industry-specific training may be required to ensure that the installed new technology and retrofits reach maximum efficiency. Second, end users such as HRM staff and community members can do their part to conserve energy by turning off lights and computers, and permitting higher indoor temperatures in the summer and lower temperatures in the winter. Operations staff estimate fuel savings of up to 15% with a shift in behaviour. Education campaigns can raise levels of awareness but alone, tend to produce limited results[33]. Feedback systems, such as those with real-time displays, have proven more effective in changing behaviour but studies that have monitored the impact of such systems have focused on the residential sector[34]. In terms of corporate buildings, offering interesting and engaging ways to participate in energy conservation in concert with other energy initiatives are worth investigating[35]. A shift such as this goes hand in hand with the larger cultural shift toward greater energy awareness that is currently underway in our community.

By the end of 2009, HRM had spent $6.8 million on energy efficiency projects that yielded 10,000 tonnes of emissions savings[36]. At this rate, HRM should expect to spend about $5 million to achieve 7,600 tonnes of savings. If HRM continues to produce a return on investment of 18.75%, the municipality will save close to $1 million.

5) Shift from the Status Quo

Opportunity for reductions
2,000 tonnes eCO_2

Fortunately, there is no shortage of creative and innovative ideas in HRM that can help achieve further savings. Some of the projects and directions on the horizon represent distinct shifts from the status quo in HRM:

District Heating

District heating can be used to heat a group of buildings. Rather than relying on individual furnaces and boilers, buildings connected to a district heating system make use of a single centralized heating facility. Systems can be scaled to meet the needs of particular groups of buildings or neighbourhoods; they can range from small systems for 2-3 homes to larger systems that provide heat for hundreds of buildings. District heating is a much more efficient way of using energy to heat buildings.

District heating technology is more than a century old but to date, its use in Canada has been limited to a handful of hospitals and universities[37]. Recently, however, district energy has generated a surge of interest because of its potential to reduce fuel consumption and limit emissions. It is commonly used in countries such as Denmark, Sweden and Iceland.

HRM recently retrofitted Centennial Pool and the Halifax Police Department to take advantage of district heating. One of HRM's most well-known energy projects, Alderney 5, uses a district heating system to provide heat to a complex of five buildings in downtown Dartmouth. HRM's Corporate Plan also directs the municipality toward district energy by calling for the adoption of strategies that would accommodate district energy uptake with the future redevelopment of Cogswell Interchange[38].

Combined heat and power (CHP) is often discussed alongside district energy. In a CHP system, when a fuel such as natural gas is burned to generate electricity, the leftover heat that would otherwise be discarded is used to provide heat to buildings. Therefore, CHP uses energy much more efficiently: it can yield 80% efficiency compared to 40-60% efficiency for conventional heat and power[39]. The University of Calgary is currently converting a central heating and cooling plant to a CHP facility that is expected to reduce emissions to 50% of the current levels. The $48 million investment is expected to yield $3.5 million in operating cost savings[40].

Replacement of traditional energy sources with renewable sources
Widespread replacement of fossil fuels for energy is ultimately what will bring the municipality to near "carbon-neutral" state. Every unit of energy that is harnessed from renewable sources such as the sun or the earth is less energy that must be derived from coal, oil or natural gas and fewer GHGs that are released to the atmosphere. However, replacing fuel sources often requires a more significant initial financial investment.

Geothermal heating
HRM is already taking advantage of geothermal energy at several of its facilities such as the Alderney 5 complex, Gordon R. Snow Community Centre and Prospect Road Community Centre. In these cases, heat from the ground is harnessed to warm indoor temperatures and as a result, less oil is required to meet the heating demands of the building.

Solar for domestic hot water
HRM is already using solar energy to heat water in some of its buildings such as the Findlay Community Centre and several fire stations. HRM is promoting the use of solar hot water heating to the community through its innovative Solar City project and must therefore continue to demonstrate its commitment to this energy source. Solar water heaters can save 50-65% of the costs on a water bill.

Solar photovoltaics
Solar photovoltaic technology enables the conversion of solar energy to electricity for use. This technology is currently quite costly and has long payback periods. However, in the coming years, as new technologies develop further, costs for this technology will likely decline and it will become more feasible to consider solar energy as a viable replacement for traditional electricity. The predicted rise in electricity costs will also improve the practicality of using solar energy to generate electricity.

6) Provincial Shift to Renewable Electricity
In 2008, about 11% of Nova Scotia's electricity was generated using renewable resources such as wind and hydro power and by 2015, Nova Scotia's electricity producers are legislated to use a minimum of 25% renewable

electricity sources[41]. By 2020, the province is aiming to increase the share of renewable electricity sources to 40% however, this new goal has not yet been legislated[42]. For the purposes of this plan, HRM should assume that by 2020, Nova Scotian electricity will be generated from 25% renewable sources. Any further success in the local renewable electricity field will bring even greater GHG reductions.

Opportunity for reductions
6,300 tonnes eCO_2

As illustrated in the first five actions, HRM can reduce its emissions by at least 15,660 tonnes eCO_2 below business-as-usual by 2020. Together with the savings achieved 2008-2011, HRM's building emissions will likely sit at around 55,600 tonnes eCO_2. However, a shift from 11-25% renewables should bring this total down to about 49,300 tonnes[43]. Therefore, the provincial shift will save HRM 6,300 tonnes of emissions with no direct investment from the municipality.

Order of Magnitude of Costs and Savings

Action	Order of Magnitude of Costs	Order of Magnitude of Cost Savings
1) New Building Design	An additional 1-7.5% of building costs are usually required to achieve LEED Silver or Gold.	Will vary but may fall close to $1.00/ft^2 per year
2) Continued Oil to Natural Gas Conversions	$1,000,000	$500,000 per year Based on savings reported in the HRM Corporate GHG Inventory 2008.
3) Upgrade Old Oil Boilers to High Efficiency Boilers	$200,000 Purchases will have to be made regardless of energy efficiency considerations because many boilers will reach the end of their lifespan in the coming years.	$40,000 per year
4) Energy Conservation and Efficiency Projects	$5,000,000	$1,000,000 per year
5) Shift from the Status Quo	Will vary.	Will vary.
6) Provincial Shift to Renewable Electricity	$0 No direct costs involved but the price of electricity per KWh will likely rise in the coming years.	$0

Table 2: Order of Magnitude of Costs and Savings for Buildings

Keeping Track: Data to Collect and Monitor Annually

- Fuel consumption (electricity, fuel oil, natural gas, diesel)
- Fuel consumption/ft^2
- GJ/ft^2
- Average building eCO_2/ft^2
- Total floor area growth

Vehicle Fleet

Past and Present

About 9% of HRM's corporate emissions come from its municipal, police and fire fleet. In 2008, this accounted for 7,693 tonnes eCO_2. Several factors determine the fuel efficiency of the fleet including the vehicles themselves and how they are operated and maintained. Action in all of these areas will lower HRM's GHG emissions from its fleet. Fuel consumption has already begun to decline in recent years because of concentrated efforts.

HRM is transforming its fleet with a view to better fuel efficiency and GHG reductions. It uses a Vehicle Right Sizing Filter and Life Cycle Analysis to ensure that new vehicles are appropriately sized and purchased with long-term fuel efficiency and costs in mind. As HRM continues to replace old units, its fleet will become increasingly more efficient overall.

In terms of vehicle operation, HRM has enacted an internal anti-idling policy and staff have begun working with Clean Nova Scotia to administer *Fleetwiser* and *Drivewiser* programs, which can reduce emissions by 30%.

Moving Forward

Emission reductions from HRM's fleet will be integral to achieving HRM's overall reduction target. The actions presented below demonstrate that HRM could feasibly reduce emissions from its fleet by about 33%.

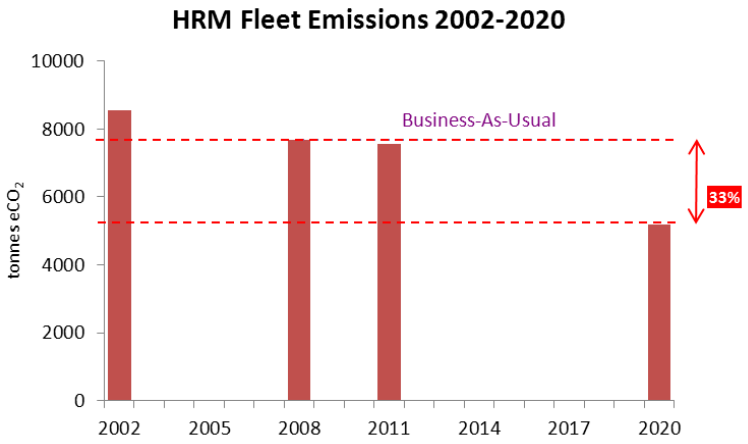

Figure 8: HRM Fleet Emissions 2002-2020

HRM has several options for reducing fuel consumption, emissions and costs including targeting driver behaviour (idle reduction, speed reduction, etc.), ensuring vehicles are maintained to operate efficiently, and ensuring that new vehicles are always procured with efficiency and emissions in mind. At an initial consultation session, HRM fleet services and SEMO agreed that HRM should focus on driver training in order to realize the highest return on investment.

Representatives from Clean Nova Scotia (CNS), a local not-for-profit organization with a mandate to work with individuals, government, business and communities to improve the environment, collaborated with SEMO to develop the following fleet actions. CNS' input is incredibly valuable because they administer Nova Scotia's *Drivewiser* and *Fleetwiser* programs. *Drivewiser* has delivered education programs to over 20,000 Nova Scotians since 2006 on how to drive, maintain, and buy for fuel efficiency; meanwhile *Fleetwiser* has followed in its

footsteps assisting municipal and utility fleets toward reductions in fuel consumption, emissions and business costs. *Fleetwiser* targets vehicle efficiency on a management-systems level by addressing policy, tracking vehicle and fuel consumption, practicing preventive maintenance, and optimizing assets. *Drivewiser* complements fleet management with practical and proven driver awareness initiatives such as idle-free campaigns, *Drivewiser 101* presentations, in-vehicle training, and follow-up surveys. Clean Nova Scotia's report titled *Options for Developing an HRM Greenhouse Gas Reduction Plan for Non-transit Vehicles up to 2020* is in Appendix B.

The following flow chart maps the primary strategies that will reduce HRM's fleet emissions over the next several years.

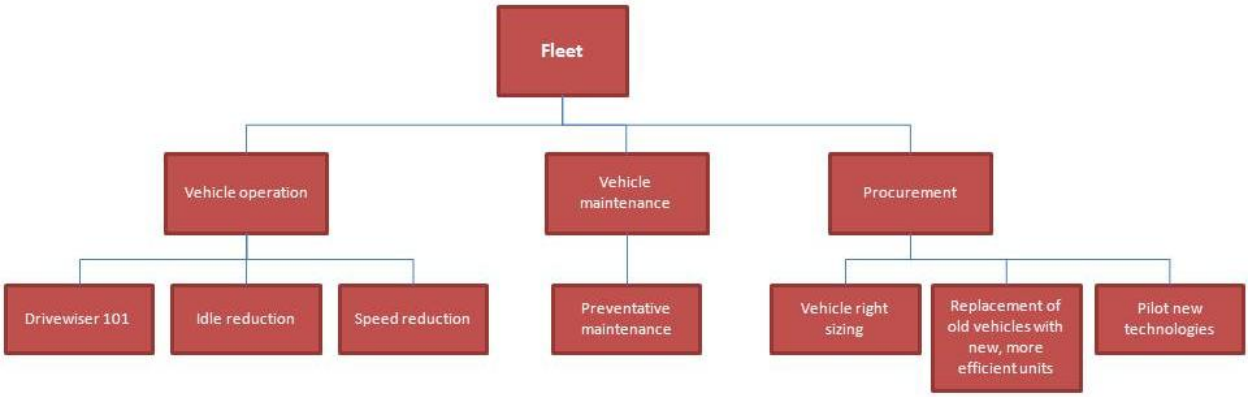

Figure 9: Primary Fleet Actions

1) Vehicle Operation: 3-year Driver Education Program

The 3-year program would include three key components: *Drivewiser 101* driver training, fostering idle-free habits, and limiting vehicle speeds. All of these components would be carried out with a view to fuel efficient vehicle operation.

a. Driving for Efficiency: *Drivewiser* 101

Opportunity for reductions
1,133 t eCO_2

Drivewiser 101 driver training delivers instruction to fleet operators on fuel efficient driving techniques. CNS has delivered the training to numerous fleet operators in the province and has consistently seen 10-15% fuel and emissions savings. Depending on existing individual driver habits, the training could bring up to 45% savings. Combining effective trip/route planning choices with eco-driving techniques can boost fuel efficiency to 25-30%. The training would be tailored to the needs of the particular group and type of fleet but it usually consists of educational and promotional materials, presentations, in-vehicle and one-on-one training, dashboard technology solutions, learning events, etc.

b. Idle Reduction

Unnecessary idling wastes fuel, produces needless GHG emissions and costs the municipality money. Given that municipal vehicles typically idle 35-45% of their operating time and police vehicles often idle 65-85% of their operating time, idle reduction presents a significant opportunity to lower fleet emissions[44]. HRM is beginning to track various features of vehicle operation more carefully with specialized GPS units that record data such as idle time. When this data becomes available, HRM will be able to better track progress on reducing idling within its fleet.

Fostering idle-free habits can be performed with two approaches simultaneously: encouraging a shift in driving habits and installing idle-reduction technology.

Shifting driver habits: CNS proposes to deliver idle free training to fleet personnel and to help review and update HRM's anti-idling policy if necessary. This would complement HRM's discussions on implementing a public engagement program to reduce idling[45].

Opportunity for reductions
136 t eCO_2

(Assumes 600 vehicles, 250 days, 2.5L/hr of idling)

Idle-reduction technology: Some municipal drivers must currently idle in order to operate in-vehicle equipment or to maintain a comfortable in-vehicle temperature. To address the need to idle, HRM can explore the option of purchasing specialized equipment such as block heaters that warm engine coolant and lubricants, cab heaters that maintain driver comfort in trucks, and auxiliary power units that permit the operation of safety lights, equipment and electronics without the use of the engine.

Opportunity for reductions
414-729 tonnes eCO_2

Payback period: 9 months – 1.5 yrs
(Savings depend on vehicle type – e.g. much more potential for savings in police cars than municipal vehicles)

After an initial evaluation and purchase of effective idle-reduction technology for various types of fleet vehicles, operators and maintenance personnel must be trained on how to use and service the equipment.

c. Speed Reduction

Vehicles tend to operate most efficiently at 55-88km/hr. Fuel consumption increases by 10% for every 10km/hr increase in speed over 90km/hr. Therefore, keeping speeds under 90km/hr is ideal for reducing fuel costs and emissions. To limit fleet speeds of greater than 90km/hr, HRM could explore the possibility of creating an internal speed reduction policy, integrate speed reduction into driver education, and/or invest in electronic programming of select vehicle engines that cap vehicle speeds.

Opportunity for reductions
76 t eCO_2

(assumed 10% on hwy)

The following table summarizes the predicted savings, financial investment, scope, and payback period of a 3-year driver education program aiming to shift behaviour toward more fuel efficient practices. It includes a summary of the costs and benefits of a strict "driver-training-only" program alongside a summary of additional costs and benefits with the purchase of equipment to aid in training. Overall, a 3-year driver training program is expected to yield very positive results: significant cost savings and GHG emission savings that would present themselves no more than a year after the completion of the program.

Annual Savings & Costs	Driver Training Only	With Add-Ons (Assume 100 Vehicles)
Emission savings	1,345 tonnes eCO_2	1,760 tonnes eCO_2
Fuel savings	521,000 L	682,000 L
Financial cost to implement program (total over three years)	$150,000 - $300,000*	$150,000* + (25,000-200,000)**
Annual financial savings resulting from program	$456,000	$597,000
Payback period	*<0.5 years	0.5 – 1.0 years

Table 3: Costs and Savings for a 3-Year Driver Training Program

*Depending on level of engagement

**Includes cost of purchasing and installing 100 add-ons - simply used to demonstrate sample costs and savings. HRM may wish to purchase more or fewer units depending on its needs.

Sample costs of add-ons & installation

GPS/AVL systems	$1,100/year
Idle-reduction tech.	$500-$2,000
Dashboard plug-in tools	$250-$700
Total estimated cost range:	$25,000-$200,000

2) Vehicle Maintenance: Preventative Maintenance

Proper and proactive maintenance of every fleet vehicle is one of the most cost-effective ways to maximize fuel efficiency. This can begin with a review of current maintenance practices, and then lead to delivering maintenance tips to fleet operators in every fleet segment. Preventative maintenance may require specialized training that would cost in the range of $26,000 but it could yield cost savings of $256,300-$512,600 annually[46].

Opportunity for reductions
755-1,520 tonnes eCO_2

3) Procurement Planning: Purchase and Pilot New Technology

As HRM purchases new vehicles to replace old units, it is shifting toward better all-round fuel efficiency. HRM is also implementing its Vehicle Right Sizing Filter to ensure that appropriately sized vehicles are purchased based on their required use, rather than perceived need. Additionally, fleet services have begun exploring more fuel efficient options such as electric and hybrid vehicles. As more information becomes available and financial capacity grows, HRM should continue to explore and take advantage of these options. It should also seek opportunities for funding, such as the Green Municipal Fund that distributes grants and low-interest loans, to pilot new technologies.

While it is difficult to quantify anticipated costs and savings from new vehicle purchases and upgrades, there is no doubt that HRM's fleet will continue to shift toward greater fuel efficiency.

Order of Magnitude of Costs and Savings

Action	Order of Magnitude of Costs	Order of Magnitude of Cost Savings
1) 3-Year Driver Education Program	$150,000-$500,000 The program is scalable depending on the desired level of engagement. Costs above represent total costs over three years.	$500,000-$700,000 per year Payback period is likely less than a year, beginning after completion of the program.
2) Preventative Maintenance	$26,000 Costs for training	$250,000-500,000 per year
3) Procurement Planning	Will vary	Will vary

Table 4: Order of Magnitude of Costs and Savings for Fleet

Keeping Track: Data to Collect and Monitor Annually

- Fuel consumption, type of fuel and type of vehicle
- Cost of fuel
- Kilometres travelled
- Km travelled/L fuel
- Kg eCO_2 emitted/Km travelled
- Idle time (with specialized technology)

Outdoor Lighting

Past and Present

In 2008, outdoor lighting accounted for about 24% of HRM's corporate emissions: 21,417 tonnes eCO_2. The majority of outdoor lighting emissions are from street lights but they also result from traffic signals, park lights and sport field lights; all of which consume electricity.

Primary GHG savings from outdoor lighting thus far have come from traffic signal and street light conversions to LED (Light Emitting Diode) technology, which is significantly more energy efficient than conventional technology. Beginning in 2008, HRM began replacing its traffic signals with LED bulbs that are about 85% more energy efficient than conventional signals. The last of HRM's approximately 260 traffic signals were converted in 2011. LED street lights also result in energy savings; to date, HRM has converted about 2,400 fixtures (about 16% of all of its street lights) which each require 62% less electricity than traditional street lights[47]. Sport field lights, which account for only a small percentage of emissions, have received upgrades to their management system in recent years. Most sport field lights are controlled by a timer and key system. The timer ensures that the lights are only on during appropriate hours (after dark but not overnight) and the manual key system ensures that lights are not turned on if a field is not used because of poor weather or game cancellation. Overall, this is designed to make sure that electricity is not wasted by lighting an empty field.

All of HRM's traffic signals now use LED technology, which is saving the municipality more than 2,300 tonnes eCO_2 every year. **1,377 tonnes eCO_2** of this has been achieved since 2008.

Moving Forward

New Nova Scotia legislation that requires street light conversions to LED technology will significantly drive down HRM's emissions. While the legislated completion date has not yet been set, it will likely be before 2020. Combined with emission savings from traffic signals and park and sport field lights, HRM's outdoor lighting could reach about 7,300 tonnes eCO_2, or a reduction of 66%, from outdoor lighting within the target timeline[48].

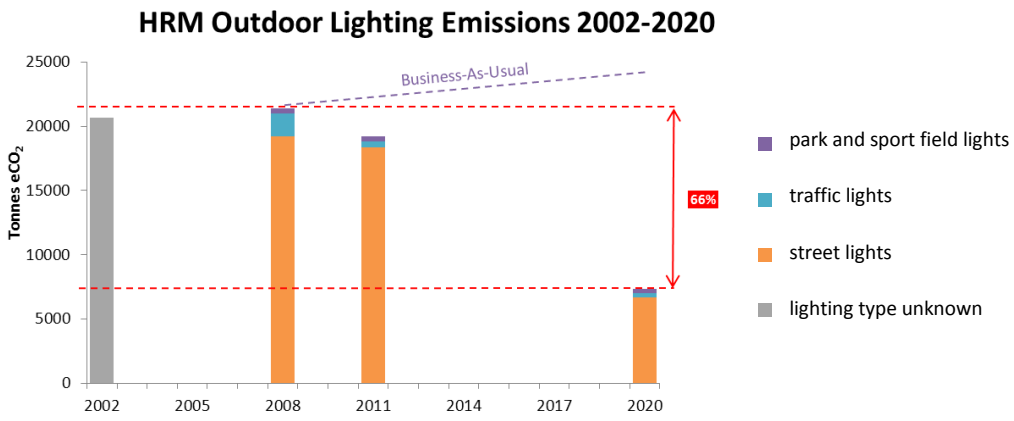

Figure 10: HRM Outdoor Lighting Emissions 2002-2020

Primary actions to achieve these savings from outdoor lighting are illustrated in the following chart.

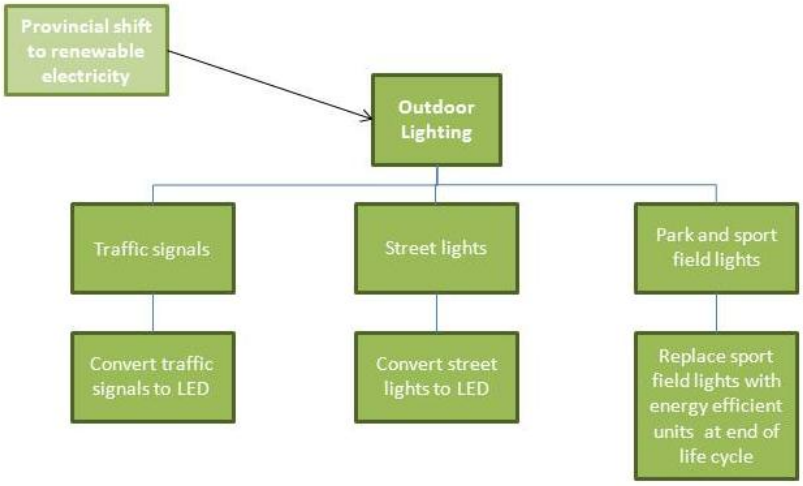

Figure 11: Primary Outdoor Lighting Actions

1) Convert Remaining Street Lights to LED and Ensure that all New Installations are LED

With new legislation requiring all street lights in the province to be converted to LED within about five years (precise deadline to be confirmed in fall, 2011), HRM will see significant reductions in electricity consumption in the coming years. The conversion of all of HRM's 40,000 street lights to LED, which consume 62% less electricity, will bring emissions from street lights from about 19,189 in 2008 to 7,319 tonnes eCO_2 in 2020. After accounting for the projected addition of new street lights, this equates to 13,000 tonnes of eCO_2 savings per year.

Capital costs for street light LED technology will be in the range of $8-35 million, depending on how HRM approaches the conversions[49]. Annual cost savings due to reduced electricity requirements are estimated to be about $500,000-$600,000, with a payback period of 10-15 years.

Opportunity for reductions
13,000 tonnes eCO_2

2) Replace Sport Field Lighting Fixtures with Energy Efficient Units as Needed

When sport field lights reach the end of their lifecycle, HRM should consider long term energy and cost savings in replacement purchase decisions. Improvements in photometrics and other specialized lighting technology result in more efficient lighting control and reduced electricity needs primarily because fewer fixtures are required to meet the same lighting standards as traditional technology[50]. In HRM, two Harbour East fields are each expected to save 9-12 tonnes eCO_2 per year with their new energy efficient fixtures. While these two fields have slightly larger electricity demands than the average HRM field, this can be used as a general indication of potential emissions savings. If HRM were to replace fixtures with new efficient units at one field per year over the next eight years, it could save 40-80 tonnes eCO_2.

Opportunity for reductions
40-80 tonnes eCO_2

HRM's Harbour East fields are seeing cost savings that correspond with reduced electricity demand in the range of $2,000-$3,000 per year but projected savings in the future are expected to be slightly lower, $1,500-$2,000, due to fewer anticipated annual operating hours[51].

3) Provincial Shift to Renewable Electricity

Opportunity for reductions
1,400 tonnes eCO_2

With street light conversions, sport field lighting fixture replacements, and the traffic signal savings already achieved between 2008 and 2011, corporate emissions from lighting will sit close to 8,719 tonnes eCO_2[52]. This will be further reduced with the provincial shift to renewable sources of electricity. This shift from 11% renewables in 2008 to 25% renewables by 2020 will bring outdoor lighting emissions to about 7,347 tonnes (bringing savings of about 1,400 tonnes eCO_2).

Order of Magnitude of Costs and Savings

Action	Order of Magnitude of Costs	Order of Magnitude of Cost Savings
1) Street Light Conversions	$8,000,000-35,000,000 Costs depend on how HRM approaches the conversions[53].	$500,000-$600,000 per year Payback period is expected to be 10-15 years.
2) Sport Field Light Replacements	$480,000-$1,600,000 $60,000-$200,000 for infrastructure to light each sport field with energy efficient lights (the above total was calculated for 8 fields). A majority of these costs would be incurred regardless as lighting infrastructure requires replacement at the end of its lifecycle.	$12,000 per year Based on savings estimated in Musco's submission to HRM's Request for Information 11-050.
3) Provincial Shift to Renewable Electricity	$0 No direct costs involved but the cost of electricity per KWh will likely rise in the coming years.	$0

Table 5: Order of Magnitude of Costs and Savings for Outdoor Lighting

Keeping Track: Data to Collect and Monitor Annually

- Street light, traffic light, park light, sport field light electricity consumption
- Electricity consumption reductions due to LED installations

Final Notes

A comprehensive climate change strategy must involve measures that help our municipality both adapt to climate change and mitigate GHG emissions. Targeted efforts in both fields will strengthen our community's ability to withstand the impacts of climate change in the years to come. This plan is therefore just part of HRM's overall climate change strategy – other parts include HRM's Regional Plan, Climate SMART, the Community Action Guide to Climate Change and Emergency Preparedness, the Community Local Action Plan to Reduce Greenhouse Gas Emissions, etc.

This plan demonstrates the feasibility of a 30% reduction in emissions below 2008 levels by 2020. In absolute terms, a 30% reduction will mean bringing HRM's emissions from 88,720 tonnes eCO_2 in 2008 to 62,104 tonnes eCO_2 by 2020. Given the growing nature of our municipality, this may imply a 44% reduction below where HRM would be if it continued as business-as-usual. Many of the actions and initiatives in this plan can be integrated into normal operations (e.g. continued upgrades to high efficiency boilers) while some go above and beyond the status quo (e.g. installing district heating systems). Others cannot be quantified (e.g. use of Vehicle Right Sizing Filter; forest management to preserve and expand carbon sinks) but will also contribute to overall emission reductions and may even help HRM exceed its target.

HRM is well on its way to reducing corporate emissions - it has already achieved savings of about 10,200 tonnes eCO_2 since 2008. Energy efficiency projects such as traffic signal conversions to LED and building retrofits have set the stage for emission reductions and their associated cost savings. At a quarter of the way into the 2008-2020 timeline, HRM has achieved about a fifth of the required reductions[54]. Reaching the 2020 target will therefore be challenging but realistic, based on the savings predicted from initiatives in the plan. HRM must achieve, on average, 4,706 tonnes eCO_2 of savings per year (below business-as-usual) between 2012 and 2020.

The plan should be reviewed in 2016, which will involve taking stock of HRM's progress, reviewing the target, realigning it if necessary, and updating the plan's content to reflect evolving technologies and new directions. An essential part of the plan, the review will act as a checkpoint from which to gain a new perspective on corporate emission reductions and how some of the uncertainties play out between the writing of the plan and 2016.

Over the last few years, climate change has risen to the top of the Canadian public's mind and increasingly, Canadians are taking action to reduce social and environmental impacts by reducing fossil fuel consumption. As a coastal community, HRM will see dramatic effects from climate change but if we act now, we may succeed in preventing the worst of the impacts. Together with other municipalities around the world, HRM has the opportunity to take action and see tangible results in the future.

Endnotes

[1] EnviroEconomics. (2009). Act Locally: The Municipal Role in Fighting Climate Change. Prepared for FCM.

[2] Partners for Climate Protection Program is a joint initiative of the FCM and the International Council for Local Environmental Initiatives (ICLEI) that commits members to achieving five established milestones to monitor and reduce their GHG emissions.

[3] UNSW Climate Change Research Centre. (2009). The Copenhagen Diagnosis: Updating the World on the Latest Climate Science. Retrieved Aug 15, 2011 from: http://www.ccrc.unsw.edu.au/Copenhagen/Copenhagen_Diagnosis_LOW.pdf

[4] Forbes et al. (2009). Halifax Harbour extreme water levels in the context of climate change: Scenarios for a 100-year planning horizon. Prepared by Natural Resources Canada. Retrieved Aug 16, 2011 from: http://www.halifax.ca/regionalplanning/documents/OF6346final.pdf

[5] The Conference Board of Canada (2011). Environment: GHG Emissions per Capita. Retrieved Aug 15, 2011 from: http://www.conferenceboard.ca/hcp/details/environment/greenhouse-gas-emissions.aspx

[6] Calculated with 2001 census data and 2002 Corporate and Community GHG inventory data

[7] UNSW Climate Change Research Centre. (2009). The Copenhagen Diagnosis: Updating the World on the Latest Climate Science. Retrieved Aug 15, 2011 from: http://www.ccrc.unsw.edu.au/Copenhagen/Copenhagen_Diagnosis_LOW.pdf

[8] Uncertainties include the cost of fuel over next nine years, utilization of renewable sources for electricity, and growth in HRM buildings, fleet and outdoor lighting, etc.

[9] HRM Climate SMART. Retrieved Aug 15, 2011 from: http://www.halifax.ca/climate/index.html

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[13] The Pembina Institute. (2008). Choosing Greenhouse Gas Emission Reduction Policies in Canada. Retrieved Aug 15, 2011 from: http://pubs.pembina.org/reports/pembina-td-final.pdf

[14] Note that the 10,200 tonnes recorded here does not include transit emissions and therefore differs from the total recorded in the 2008 Corporate GHG Inventory.

[15] Renewable Electricity Plan. (April 2010). Nova Scotia Department of Energy. Retrieved Aug 2, 2011 from http://www.gov.ns.ca/energy/resources/EM/renewable/renewable-electricity-plan.pdf

[16] In 2008, when 11% of Nova Scotia's electricity came from renewable sources, 64,256 tonnes eCO_2 (73%) of HRM's corporate emissions came from electricity. A shift from 11% renewable electricity to 25% renewable electricity would reduce HRM's electricity GHGs by 10,108 tonnes eCO_2, which is about 11% of its total emissions.

[17] For a map of "Energy Successes" in HRM, see: http://www.halifax.ca/environment/documents/EnergySuccessMap_RevisedList_Feb142011.pdf

[18] Leadership in Energy and Environmental Design is a certification program that rates buildings based on performance in key areas of human and environmental health. HRM recently celebrated the formal recognition of its first LEED certified building: East Dartmouth Community Centre.

[19] SEMO, HRM. (2011). Progress Report. Retrieved August 5, 2011 from: http://www.halifax.ca/environment/documents/3-Progress_Report_final_15Feb2011.pdf Only savings achieved from buildings 2008-11 were counted in this total. Savings achieved 2002-08 were not included.

[20] 2008 buildings emissions + added emissions from 594,580 ft^2 of new floor space based on current energy performance for 5 new buildings of 18.6kg/ft^2 – energy savings achieved 2008-2011 = estimated emissions from buildings in 2011. This is 5.9% higher than emissions from buildings in 2008.

[21] The Pembina Institute. (2011). Options for Reducing GHG Emissions in Calgary. Retrieved Aug 4, 2011 from: http://www.pembina.org/pub/2175; Turner, C. and Frankel M. (2008). Energy Performance of LEED for New Construction Buildings. Retrieved Aug 4, 2011 from: http://www.usgbc.org/ShowFile.aspx?DocumentID=3930

[22] Calculated at 18.27kg eCO_2/ft^2 (HRM's average emissions/ft^2 in 2008)

[23] (a) Haxton, B. and Beckstead, G. (2008). Crunching the Numbers: A Conceptual Cost Estimating System for LEED Facilities. Retrieved Aug 4, 2011 from: http://www.rdmag.com/Featured-Articles/2008/02/Policy-And-Industry-Crunching-The-Numbers-A-Conceptual-Cost-Estimating-System-For-LEED-Facilities/; (b) Princeton Engineering Services. LEED GreenBuilding Rating System. Retrieved Aug 4, 2011 from: http://www.ehvacdesign.com/sustainable.html

[24] Ibid.

[25] Ibid.

[26] Ibid. See http://www.apollosolutionsgroup.com/ourprojects.html for several examples of costs and savings of American buildings designed with energy efficiency in mind.

[27] The Pembina Institute and David Suzuki Foundation. (2011). Is Natural Gas a Climate Chance Solution for Canada? Retrieved Aug 4, 2011 from: http://www.pembina.org/pub/2240

[28] 2008 heating fuel consumption: 4,874,644L oil (186,768GJ) + 1,513,155cum NG (54,474GJ). This is a 77%oil/23%NG split. Assume equal heating needs for existing building in 2020 and recalculate emissions with a 30%oil/70%NG split including a 10% efficiency improvement for energy previously derived from oil.

[29] The Pembina Institute and David Suzuki Foundation. (2011). Is Natural Gas a Climate Chance Solution for Canada? Retrieved Aug 4, 2011 from: http://www.pembina.org/pub/2240

[30] Ibid.

[31] Calculated assuming that 30% of HRM's heating will come from oil in 2020.

[32] 2011-2012 HRM Corporate Plan. Retrieved Aug 4, 2011 from: http://www.halifax.ca/budget/CorporatePlan/

[33] The Pembina Institute. (2011). Options for Reducing GHG Emissions in Calgary. Retrieved Aug 4, 2011 from: http://www.pembina.org/pub/2175

[34] Ibid.

[35] See the WWF's National Sweater Day for an example of a successful campaign to reduce energy consumption among end users. http://wwf.ca/takeaction/sweater_day/

[36] MacLellan, R. (2009). Update on HRM Renewable Energy and Energy Efficiency Projects and Initiatives. Retrieved Aug 10, 2011 from: http://www.halifax.ca/environment/documents/EUGSPortionofCouncilSwedenPresentation120809.pdf

[37] Enmax. Calgary Downtown District Energy Centre. Retrieved Aug 4, 2011 from: http://www.cocnmp.com/idb/img/EV-DE-GeneralFAQ.pdf

[38] 2011-2012 HRM Corporate Plan. Retrieved Aug 4, 2011 from: http://www.halifax.ca/budget/CorporatePlan/

[39] The Pembina Institute. (2011). Options for Reducing GHG Emissions in Calgary. Retrieved Aug 4, 2011 from: http://www.pembina.org/pub/2175

[40] Hoskins, V. (2008). New U of C power plant will slash emissions. Retrieved Aug 12, 2011 from: http://www.ucalgary.ca/news/uofcpublications/oncampus/november2008/power

[41] Nova Scotia Environment. (2010). Environmental Goals and Sustainable Prosperity Act Progress Report 2010. Retrieved Aug 5, 2011 from: http://gov.ns.ca/nse/egspa/

[42] Nova Scotia Department of Energy (2010). *Renewable Electricity Plan*

[43] Calculated by assuming that similar to the 2008 emissions data, 72% of emissions will come from electricity generation (28% would come from heating). This ratio is actually likely to change slightly by 2020 but it can provide a rough order of magnitude.

[44] See Appendix B.

[45] Discussed at Environment and Sustainability Standing Committee meeting, May 5, 2011.

[46] See Appendix B.

[47] Staff Report to HRM's Environment and Sustainability Standing Committee of Council. (April 26, 2011). Amendments to the Energy-Efficient Appliance Act.

[48] Assumptions: 1) 300 street lights will be added per year, beginning with 40,000 in 2008. 2) no growth in traffic light emissions or park/sport field emissions. 3) shift from 11% renewables in 2008 to 25% renewables in 2020. 4) street light LED conversions save 62% electricity 5) traffic signal LED conversions save 85% electricity

[49] Staff Report to HRM's Environment and Sustainability Standing Committee of Council. (April 26, 2011). Amendments to the Energy-Efficient Appliance Act.

[50] Musco submission to HRM's Request for Information No. 11-050

[51] Ibid.

[52] Savings from traffic signal conversions to LED technology 2008-2011 are about 1377 tonnes eCO_2. See SEMO, HRM. (2011). Progress Report. Retrieved August 5, 2011 from: http://www.halifax.ca/environment/documents/3-Progress_Report_final_15Feb2011.pdf

[53] Staff Report to HRM's Environment and Sustainability Standing Committee of Council. (April 26, 2011). Amendments to the Energy-Efficient Appliance Act.

[54] According to the 2020 BAU, HRM must reach 47,845 tonnes eCO_2 savings. The Progress Report indicates that HRM is currently saving 10,200 tonnes eCO_2 without transit emissions and savings.

Appendix A

Business-As-Usual Forecasting

	BAU from 2008		
	2008*	**2020****	**notes**
Buildings	59620	78804	2020 BAU calculated by adding anticipated growth 2008-2020 (1,050,000ft^2 at 0.01827 tonnes eCO_2/ft^2) to 2008 baseline.
Vehicle Fleet	7693	7693	Assumes negligible growth in fleet
Outdoor Lighting	21407	23156	Assumes 300 streetlights added per year at 0.48 tonnes/SL/yr. Assumes negligible growth in traffic, park and sport field lights. 2020 BAU calculated by adding 12 years of growth to 2008 baseline.
TOTAL	**88720**	**109653**	

*2008 values obtained from 2008 Corporate GHG Inventory
**2020 BAU scenarios are estimated and forecasted from 2008 baseline data and projected growth rates in each sector

Appendix B

Options for Developing an HRM Greenhouse Gas Reduction Plan for Non-Transit Vehicles up to 2020

By Clean Nova Scotia

Clean Nova Scotia
inspiring environmental change

DRIVEWISER.ca Drive, Maintain and Buy for Fuel Efficiency

FLEETWISER.ca Fostering Long-term Energy Efficient Transport

Options for Developing an HRM Greenhouse Gas Reduction Plan for Non-Transit Vehicles up to 2020

Introduction

Clean Nova Scotia's *Drivewiser/Fleetwiser* program recognizes custom scalable opportunities for fleet-holding organizations to improve their vehicle fleet efficiency. This document provides a list of options that may be suitable for Halifax Regional Municipality to adopt in their Corporate GHG Reduction Plan for Non-Transit Vehicles up to 2020. The goal is to reduce corporate fleet emissions by 30% below 2008 levels.

A summary of each recommended action is provided, including the estimated cost, timeline, and long-term reduction potential of fuel consumption, costs, and GHG emissions.

Background

Clean Nova Scotia is a not-for-profit organization that encourages a cleaner, healthier environment through informing, enabling and inspiring Nova Scotians to consider the environment in all their choices.

Clean Nova Scotia has worked with Halifax Regional Municipality (HRM) toward improvements in vehicle fleet efficiency through programs such as *Drivewiser*, Idle-free campaigns, and most recently the *Fleetwiser Pilot Project*. HRM Fleet Services, Sustainability and Environmental Management Office (SEMO), and Transportation Public Works Strategic Transportation Planning Office continue to develop effective working partnerships.

Clean Nova Scotia is proud to include programs such as *Drivewiser* and *Fleetwiser* whose main goals are to educate fleet personnel and members of the public about fuel management and provide practical solutions through buying, maintaining and driving with fuel efficiency in mind. As such, *Drivewiser* and *Fleetwiser* have concrete baseline knowledge and resources in place surrounding vehicle fleet efficiency initiatives.

Qualifications

Drivewiser has delivered education programs to over 20,000 Nova Scotians since 2006 on how to drive, maintain, and buy for fuel efficiency; meanwhile *Fleetwiser* has followed in its footsteps assisting municipal and utility fleets toward reductions in fuel consumption, emissions and business costs.

Fleetwiser targets vehicle efficiency on a management-systems level, addressing policy, vehicle and fuel tracking, preventive maintenance, and asset optimization. *Drivewiser* compliments fleet management with practical and proven driver awareness initiatives such as idle-free campaigns, *Drivewiser 101* presentations, in-vehicle training, and follow-up surveys.

- *Drivewiser 101* in-vehicle driver training consistently demonstrates an average of 10-15% fuel & emissions savings - and up to 45% savings, depending on individual driver habits. Combining effective trip/route planning choices with eco-driving techniques can boost fuel efficiency by 25-30%.

- Idle-reduction alone can easily achieve significant fuel and emissions savings, especially when fleets implement and enforce idling policies and take advantage of available GPS and other idle-reduction technologies (vehicle heaters, auxiliary power units, LEDs, battery packs for emergency vehicles, etc.). Municipal vehicles typically idle 35-45% of operating time, meanwhile police vehicles idle 65-85% of operating time (Federation of Canadian Municipalities, 2010).

- Clean Nova Scotia has worked with the Union of Nova Scotia Municipalities (UNSM) Municipal Sustainability Office to create an *Idle-free Toolkit for Municipalities*

- *Fleetwiser* has the experience and know-how to train and support HRM personnel on how to use the *NRCan online Fleet Tool*.

- *Fleetwiser* is developing a ***Fleet Efficiency Tool Kit***

- *Fleetwiser* demonstrates that vehicle/fleet right-sizing & green procurement are effective short & long-term strategies.

- It has been demonstrated that the *Fleetwiser* program can achieve, on average, at least $500 savings/vehicle and 1 ton of GHGs saved per vehicle annually.

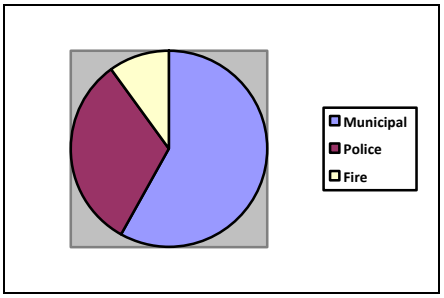
HRM Fleet Emissions 2008

Stats from the 2008 HRM Corporate GHG Inventory Report, prepared by SEMO:

HRM's Fleet contributes about 30% of corporate emissions (27% diesel, 3% gasoline); of this 30%, 22% come from police, fire and municipal vehicles. The remainder comes from transit vehicles.

Non-transit fleet GHG emissions breakdown:

Fleet Segment	eCO_2
Municipal vehicles	58%
Police	32%
Fire	10%



Fuel Consumption & Corresponding Emissions 2008:

Source	Diesel (L)	Gasoline (L)
Non-transit vehicles	1,245,067	1,435,364
Fuel cards:	55,341	138,699
GE Capital Cards:	91,964	73,168
Total Liters	**1,392,372**	**1,647,231**
eCO_2 per fuel type	3,843 tonnes	4,003 tonnes
Total eCO_2	**7846 tonnes**	

**Assumptions: Estimates are based on generalized data from 2008 (above) using the following assumptions:

**GHG Emission Factors (NRCan, 2010)

Fuel Type	GHGs (CO_2 + CH_4 + N_2O)
Diesel	2.76 kg/L
Gasoline	2.43 kg/L

**Costs/savings are based on fuel consumed/saved at $0.86/L diesel; $0.89/L gasoline

Non-transit fleet emissions, 2010-2011: 7550 tonnes (t) eCO_2 (SEMO); assuming a similar percentage of diesel (49%) vs. gasoline (51%) fuel consumption from 2008 to 2011, diesel cost HRM approx. $1,152,900 and generated 3700t eCO_2; Gasoline cost HRM approx. $1,410,100 and generated about 3850t eCO_2.

Project Proposal

Objective:	Develop and implement Eco/efficient driver training and procedures for HRM non-transit fleet personnel. Refer to potential actions below.	
Goal:	Improve fleet-wide driving efficiency by at least 10%	
Timeline:	3-years	
*Expected cost:	$50,000-100,000 annually *Depending on level of engagement*	
*Expected annual savings:	(10-30%)	$256,300 - $768,900 in fuel savings 293,000 – 878,000 L of fuel 755 – 2265 tonnes of eCO_2

***Resources to be dedicated to the project(s):**

Nature of Tasks	Staff Time (Assume $150/day)	Anticipated Annual Cost/Value
Admin Meetings & planning Coordination/communication Fundraising Reporting	**350 hrs** (1 day/week)	**$52,500**
Fleet Review/Audit Data collection & analysis	**350 hrs** (50 days)	**$52,500**
Marketing Design & implementation Professional services	**175 hrs** (3.5hrs/week) (Sub-contract)	**$26,250**
Driver Training (*Drivewiser 101*) Presentations x30 In-vehicle training (1-on-1) 12/wk Train-the-trainer sessions IDLE-FREE exclusive (?) Speed reduction exclusive (?)	**450 hrs** 100 hrs 350 hrs To be determined To be determined To be determined	**$67,500** $15,000 $52,500 To be determined To be determined To be determined
Technology Solutions Research & evaluation (field studies) ***Unit*** *cost & installation** *'Dashboard plug-in' tools* *GPS/AVL systems* *Idle-reduction tech* User training	**350 hrs** 175 hrs - - - - 175 hrs	**$52,500** $26,250 **$250* **$500 + data services* **$500-$2000* $26,250
Procurement Planning	**70 hrs** (10 days)	$10,500
Preventive Maintenance Program	**175 hrs**	$26,250
TOTAL:	**1920 hrs**	***$288,000+**

Deliverable Summary:

Scope 1:

- **Fleet inventory**
- **Baseline data**
- **Policy**
- **Practice**
- **Needs assessment**
- **Benchmarking**

- **Education**
- **Promotion**
- **In-vehicle training**
- **Technology solutions**
- **Event coordination**
- **Evaluation**

- **Policy review**
- **Education**
- **Signage & promo**
- **Technology solutions**
- **Evaluation**
- **Potential by-law**

- **Policy review**
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Scope 2:

- **Fleet tracking and monitoring solutions**
- **Procurement Planning**
- **Preventive Maintenance Program**

Timeline:	June 2011:	Develop Fleet GHG Reduction Plan and present to CAO and Council
	2011-2012:	Engage fleet managers and operators across departments Implement Scope 1, develop Scope 2
	2012-2014:	Evaluate, adjust and continue Scope 1, Implement Scope 2

Potential Actions (expanded)

Fleet Audit/Review — Timeline: 1-2 years

- Assist HRM and SEMO with ongoing GHG inventory projects.
- Conduct a comprehensive review of current fleet management practices, policies and equipment inventories.
- Compile an extensive fleet baseline account of annual fuel consumption, costs, and emissions per vehicle.
- Demonstrate the utility and relevance of the NRCan online Fleet Tool for fleet managers, supervisors, and HRM/SEMO initiatives.
- Identify gaps in fleet utilization data and prescribe effective solutions to achieve complete and accurate baseline accounts for all fleet segments.

Monitoring and Tracking Solutions — Timeline: 1-3 years

- Demonstrate the effectiveness of automated vehicle tracking systems with HRM administrative bodies, fleet managers, maintenance personnel, and operators.
- Develop effective fleet tracking solutions to optimize the quality and accuracy of baseline and monitoring data up to 2020 (ie. AVL/GPS).
- Evaluate and maintain effective tracking solutions to assist with driver training, idle-reduction, preventive maintenance initiatives, and more...
- Assist fleet managers and supervisors with aids and resources when required, such as the *NRCan online Fleet Tool* (fleettool.ca)
- Identify personnel within HRM, Clean Nova Scotia, and other stakeholders, to effectively monitor and manage the data with each fleet segment/department.

> "A well configured fleet data management system is an important asset to a green fleet, as it provides a tool to evaluate and identify areas for improving efficiencies (and can save as much as 20% of annual operating budget, if not more)."
>
> -Fleet Challenge Ontario, 2008

Driving for efficiency (Drivewiser 101) **Timeline: 1-3 years**

Expected savings (15%)

Emissions:	**1133 tCO_2e**
Fuel:	**438,700 L**
Fuel cost:	**$384,000**

Fact:

Drivewiser 101 in-vehicle driver training consistently demonstrates an average of 10-15% fuel & emissions savings - and up to 45% savings, depending on individual driver habits. Combining effective trip/route planning choices with eco-driving techniques can boost fuel efficiency by 25-30%.

- Develop and distribute effective education and promotional materials
- Deliver presentations to fleet operators
- Deliver practical, in-vehicle, one-on-one training[1]
- Provide drivers with and train them in dashboard technology solutions such as plug-in trip computers to engage driver/operators and complement interactive driver training activities
- Hold celebratory/learning events to promote internal policies, such as eco-driving habits (i.e. eco-Rally. More information available.)
- Collaborate with and promote HRM initiatives such as vehicle and idling policies, SmartTrips and Guaranteed Ride Home programs
- Adapt and deliver effective education components to complement existing programs such as Snow School and safety training

The City of Edmonton has launched a new driver training program to encourage employees in several departments to improve their driving habits in order to reduce fuel consumption and emissions that affect the environment. In the first year alone, the driver training program has saved city taxpayers an estimated $205,000. Even more savings are anticipated down the road when the program is implemented in Edmonton's transit system.

The Fuel $ense on-road training program has produced outstanding results, with the average driver recording an 11% reduction in fuel consumption on the second lap of the course. Some drivers improved their fuel economy by as much as 40%.

-NRCan 2010

[1] We see the benefits of in-car training go far beyond the learnings of the individual driver: once they have seen the results, they tend to share the information with others. This type of information, from a trusted peer who has witnessed the changes is much more potent than traditional methods of teaching. The savings drivers have seen is about 25%-30%.

Idle-reduction **Timeline: 1-2 years**

1. **Change habits** (Reduce idling by 8min/day) (Assumptions)
   Expected savings **Emissions: 136 tCO_2e** **600 vehicles**
   Fuel: 50,000L **250 days**
   Fuel cost: $43,750 **2.5L/hr of idling**

Fact:
Municipal vehicles typically idle *35-45% of operating time, meanwhile police vehicles idle **65-85% of operating time (Federation of Canadian Municipalities, 2010).

The average Canadian driver idles for 6-8 minutes per day.

Gasoline engines consume between 2.5 – 4L of fuel per hour while idling, and diesel engines use from 1-4L per hour, depending on the size of the engine, the idle speed, accessory loads and power take-offs (NRCan, 2010).

2. **Idle-reduction technology:** Minimize the 'need' to idle on the job

Examples of idle-reduction technologies

- Block heaters warm the engine coolant, block and lubricants prior to job departure
- Cab heaters maintain comfort in pick-ups to transport trucks
- Auxiliary Power Units (APUs) dramatically reduce idling to run safety lights, equipment, and electronics (police vehicles)
- Hybrid vehicles improve fuel efficiency and reduce idling even in traffic

Assumptions:

- 100 vehicles; 250 days @8hrs/day; 2.5L/hr of idling
- *Municipal (Diesel) 35% idle time = 2.8hrs/day
- **Police (Gas) 65% idle time = 5.2hrs/day
- $2000 per unit including installation

Goal: Maximum idle 5% of operating time

		(Mun.* -Vehicle Heaters)	(Police** - APU/Batteries)
Expected savings (annual)	**Emissions:**	**414 tCO_2e**	**729 tCO_2e**
	Fuel:	**150,000L**	**300,000L**
	Fuel cost:	**$129,000**	**$267,000**
Payback Period:		1.5 years	9 months

Idle-reduction (cont'd)

Action items:

- Assist with and support internal idle-free policies
- Deliver idle-free training to fleet personnel.
- Review and update idling policy, practice and protocol to minimize unnecessary engine idling and to ensure policy reflects why idle-reduction is a priority.
- Evaluate effective idle-reduction technology solutions for all HRM fleet segments; this includes current solutions already installed and potential additions.
- Coordinate training for operators and maintenance personnel on how to use and service idle-reduction technologies properly.
- Support and develop HRM's public idle-free initiatives such as "Ladies and Gentlemen Stop your Engines!" (2005) and a potential idling by-law for the future.

Reduced idling (without consideration of reduced engine wear-and-tear and lower maintenance and repair costs) can provide impressive savings. For example:

- Molson saves over $225,000 annually by enforcing its idling policy of restricting idling to 5% of operating time.
- The City of Hamilton is realizing savings of $300,000 annually through reduced idling and estimates it can save $2-3 million annually through full compliance with its idling policy of limiting idling to 3 minutes per hour of operating time.

-Fleet Challenge Ontario, 2008

Speed Reduction **Timeline: 1-2 years**

Expected savings (10% on hwy)

Emissions:	**76 tCO_2e**
Fuel:	**29,300 L**
Fuel cost:	**$25,630**

Highway driving for the HRM fleet is estimated at **10-20%** of operating time (SEMO).

Fact:
Fuel consumption increases by **10%** for every 10km/h increase over 90km/h; thus driving 120km/h consumes 30% more fuel than 90km/h. Studies show that the amount of time saved by speeding-up is insignificant, especially when compared to the relative increase in fuel costs. For example, a 100km trip takes 60min at 100km/h and 50min at 120km/h, costing you 20% more in fuel to save only 10min.

Vehicles tend to operate most efficiently (L/100km) between 55-88km/h.

Speed Reduction - Action items:

- Explore and assist with development of a strategy on the adoption of an internal speed reduction policy (90km/hr. speed cap).
- Deliver education and materials to promote speed reduction habits among fleet operators and the public.
- Coordinate the electronic programming of select vehicle engines to not exceed desired speed caps, such as 90km/hr.
- Promote the effective use of tracking technologies to reinforce eco-driving habits and provide timely feedback to fleet managers and operators.
- Evaluate and monitor the success of speed reduction initiatives.

Procurement Planning **Timeline: 2-3 years**

- Discuss and advise on long-term procurement planning strategies.
- Seek rebates, incentives, and funding opportunities for green procurement. *****FCM Green Municipal Fund*** (more info available)**
- Demonstrate potential savings in terms of vehicle/equipment replacement and investment in technology solutions.
- Promote uptake of HRM's Vehicle Right-sizing Filter among fleet managers and supervisors.
- Assist HRM with life-cycle analysis of vehicles and equipment.
- Liaise with industry providers to discover and develop future solutions.

Potential savings with vehicle and fleet right-sizing and/or green procurement can be done using the NRCan online Fleet Tool or at the following link:

http://oee.nrcan.gc.ca/transportation/tools/compare/compare-search-one.cfm?attr=8

Preventive Maintenance **Timeline: 2-3 years**

Potential savings (10-20%)

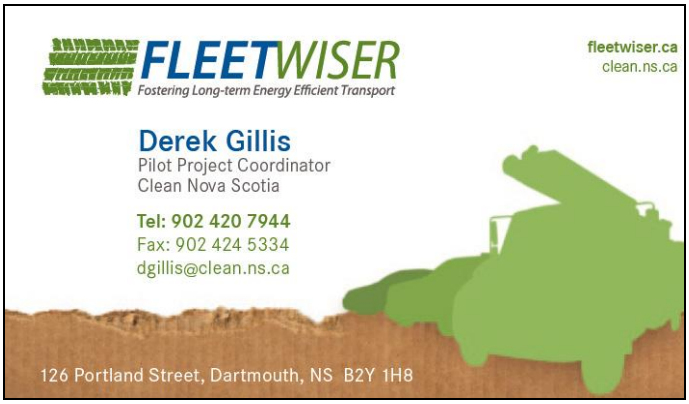
Action items:

- Review current maintenance practices and schedules per fleet segment.
- Deliver essential preventive maintenance tips to fleet operators.
- Evaluate effective maintenance solutions per fleet segment.
- Assist with the development and implementation of vehicle-specific preventive maintenance strategies.
- Coordinate effective training for maintenance personnel, including proper maintenance of auxiliary systems and technology solutions.
- Evaluate the success of a preventive maintenance program.

According to the US/EPA Federal Energy Management Program (FEMP), preventive maintenance is one of the most cost effective ways to reduce fuel use. FEMP notes that preventive maintenance programs:

- Increase cost effectiveness in many capital intensive processes and equipment
- Increase component life cycle
- Generate energy savings
- Reduce equipment and/or process failures
- Result in an estimated 12–18 percent cost savings over that found in a reactive maintenance program

Draft document prepared by:



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