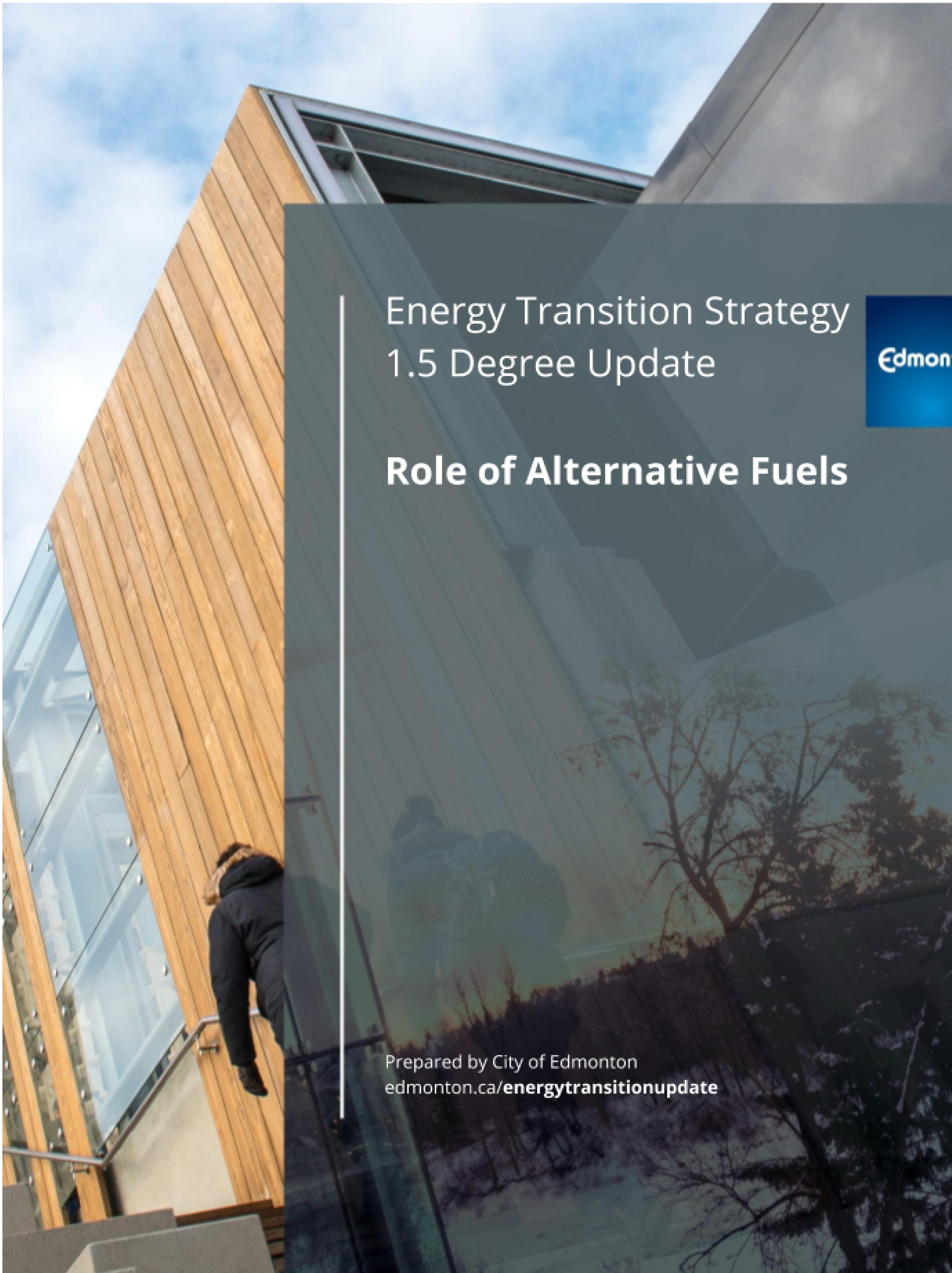


Energy Transition Strategy 1.5 Degree Update

Role of Alternative Fuels

Prepared by City of Edmonton
edmonton.ca/**energytransitionupdate**

TABLE OF CONTENTS

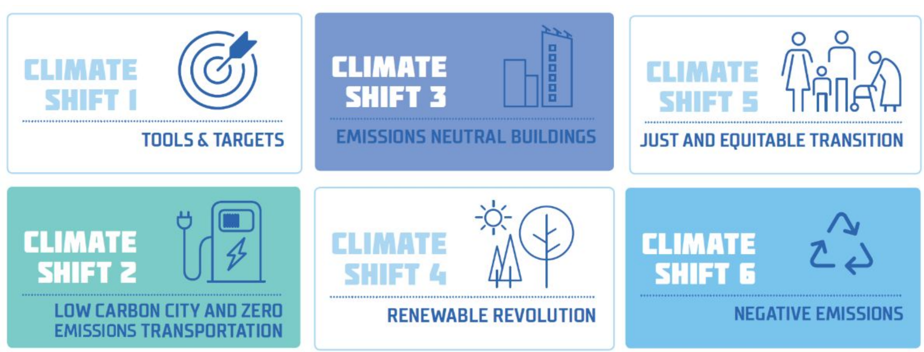
ISSUE IDENTIFICATION

On August 27th, 2019, Edmonton City Council Declared a Climate Emergency and requested that Administration take steps to develop a revised Community Energy Transition Strategy by the end of third Quarter 2020 that aligns the emissions targets and actions with the local carbon budget for City Council's approval.

On August 27th, 2019, Edmonton City Council Declared a Climate Emergency and requested that Administration take steps to develop a revised Community Energy Transition Strategy

Council's motion was informed by Administration's report contextualizing Edmonton's current Community Energy Transition Strategy with a local carbon budget that was developed to assess whether or not the 35% below 2005 levels by 2035 greenhouse gas reduction goal was aligned with a global average temperature increase of 1.5 degrees scenario.

The conclusion was that Edmonton was not on track to limit its contribution to global climate change at a level aligned with 1.5 degrees. The report provided to City Council also provided an illustrative pathway to achieve a level of emissions reductions aligned with the 1.5 scenario. The results were summarized within six climate shifts:



The shifts include 23 modelled actions that would facilitate the emissions reductions required to stay within the local carbon budget and achieve 3 tonnes of emissions per capita by 2030 and carbon neutrality by 2050. One key action within the plan relates to increasing the purchase of renewable natural gas and maximizing renewable natural gas production. This action alone is estimated to be responsible for 23% of the expected reductions necessary by 2050 (Figure 1). Further, while the plan is focused on electrification of transportation and transit to reduce emissions from the transportation sector, there are potential reductions that can be achieved by supplementing current fossil-based transportation fuels with renewable options in the current vehicle fleet prior to replacement with electric vehicles.

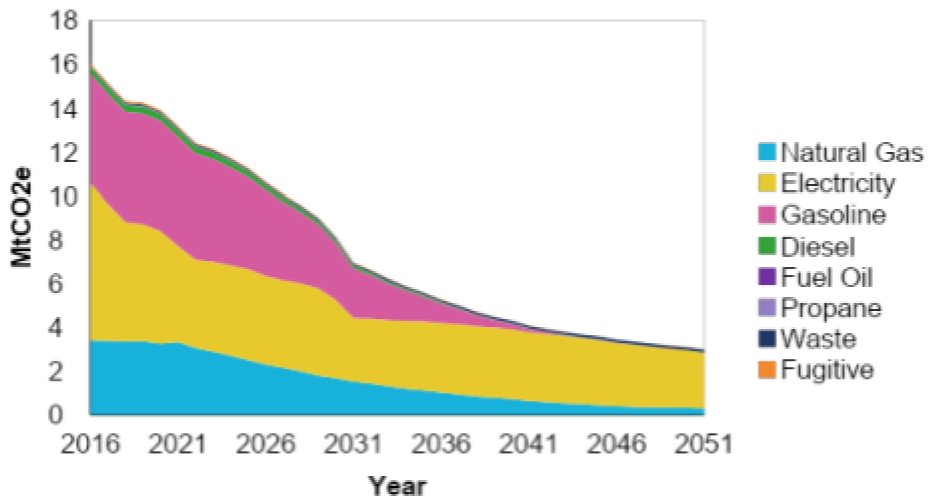


Figure 1: Annual Greenhouse Gas Emissions by fuel to achieve (Source: Sustainability Solutions Group, Community Energy Transition Strategy)

This policy brief explores 5 different renewable fuels that are available to supplement the current use of fossil fuels in transportation and building heating

This policy brief explores 5 different renewable fuels that are available to supplement the current use of fossil fuels in transportation and building heating. These are (1) renewable natural gas, (2) hydrogen, (3) biodiesel, (4) renewable diesel, and (5) ethanol. Each is explored separately to determine the availability of the product in Edmonton, expected supply costs, potential reductions or other benefits from their use, and any technical issues known about their use in the Edmonton climate.

PRODUCT AVAILABILITY AND COSTS

The following section discusses the current production availability for 5 different renewable fuels. Each has unique considerations and end uses that has potential to assist reduce emissions from key sectors in Edmonton.

Renewable Natural Gas

Renewable natural gas is a renewable source of methane gas (the primary component of natural gas) created through the breakdown of organic matter in the absence of oxygen. There are many different processes and waste types that can be used to produce renewable natural gas. The discussion in this brief should not be construed as recommendations in support of any specific technology, rather this is a general evaluation of the potential supply from all sources and current barriers to establishing production facilities.

In 2017 Edmonton produced around 310 kilograms of waste per resident[1], which represents a potential feedstock to produce renewable natural gas. Assuming a yield of 3 GJ of renewable natural gas produced per tonne of waste, this would generate around 0.9 GJ per resident (around 1% of a residents average use).

Beyond Edmonton, a study completed by Alberta Agriculture and Forestry[2] indicated that there is up to 3.38 million tonnes per year of dry organic wastes that are produced across Alberta (including wastes produced in Edmonton) that could be used as a feedstock to produce renewable natural gas. Table 1 presents the breakdown of the source of these wastes by subsector (exclusive of municipal solid waste). Combining the Edmonton waste volumes with other available waste feedstocks in Alberta can increase the renewable natural gas generation potential while also allowing for blending of feedstocks to optimize biogas production.

Table 1: Organic Waste Identified by Subsector

Subsector	Tonnes per Year (dry)
Livestock Operation (manure)	2,560,000
Livestock Operation (on-farm dead)	70,000
Food-processing Waste	500,000
Grocery Store Waste	50,000
Yard Waste	200,000
Total	**3,380,000**

[1] Edmonton Open Data, Waste Produced per Person, February 13, 2019. https://dashboard.edmonton.ca/Environmental-Services/Waste-Produced-per-Person/wj9w-kkrb
[2] Bell, Jeff; *An Organic Waste Inventory for Alberta's Agrifood Sector*; Alberta Agriculture and Forestry; August 2015.

The Future of Waste: Edmonton 25-year Comprehensive Waste Management Strategy sets the City of Edmonton on a path of transformational change to achieve a zero waste target, adopting the internationally accepted solid waste management hierarchy (Figure 2). As shown in the solid waste management hierarchy, waste management reduction initiatives are focused on reducing, reusing, and recycling the waste generated, but there remains a role for the production and use of renewable natural gas with any residual organic wastes that can't be managed through other ways. There are also ample opportunities for legacy organic wastes in landfills to become an initial source for renewable natural gas production.

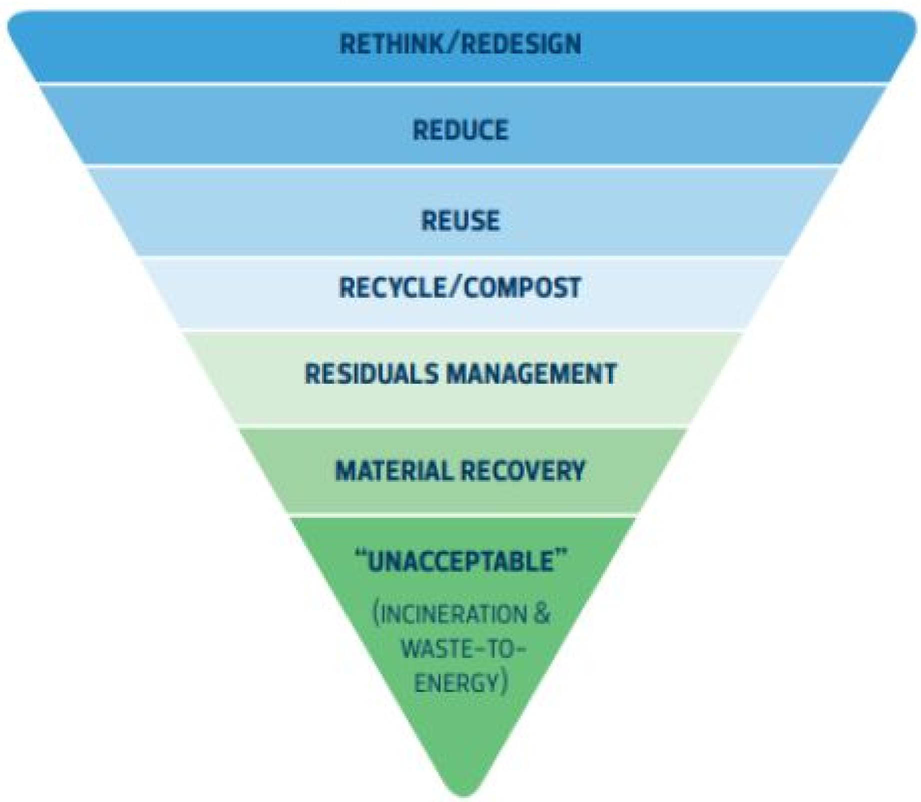


Figure 2: Solid Waste Management Hierarchy

Current purchases of renewable natural gas have predominantly been motivated by low-carbon fuel standards (such as those in California or British Columbia) where $5 to $50 per GJ can be added to the sales price to meet the low-carbon portfolio requirements. In these markets, gas utilities have been purchasing renewable natural gas and offer 20-year contracts to secure the product at lower cost. For example, FortisBC recently signed a 20-year contract with the City of Vancouver to purchase landfill renewable natural gas at an estimated cost of $22 per GJ[3]. At this price level replacing all natural gas used in Edmonton with renewable natural gas would increase the fuel cost by approximately 10 times (assuming November 2019 natural gas price levels). There also isn't currently adequate supply of renewable natural gas to supplement all natural gas consumption in the City. However, the purchase of increasing proportions of renewable natural gas could be phased in to achieve some interim reductions prior to electrification of these heating systems and provide a secure, long-term supply contract to help build the renewable natural gas industry in Alberta.

Supply of renewable natural gas in Alberta is restricted from the availability of low cost fossil-based natural gas making the project economics very challenging. Dedicated long-term supply contracts at higher than current market prices for natural gas would be necessary to provide economic certainty for projects to making investments. Renewable portfolio requirements for natural gas suppliers have also been successful at motivating projects, but these policies require provincial legislation.

Hydrogen

Hydrogen is a gaseous fuel that when combusted only produces water. Hydrogen has various potential uses that would assist in reducing emissions. Currently most hydrogen produced in Alberta is used in industrial operations; namely refining and fertilizer manufacturing. Alberta's industrial heartland in particular represents an established hydrogen production hub, however those production facilities are dedicated to individual industrial customers with no common market for wider use of hydrogen beyond the industrial sector.

The hydrogen that is produced in Alberta is created through steam methane reforming. In this process, fossil-based natural gas is converted into hydrogen and carbon dioxide. Hydrogen produced in this manner is called "blue hydrogen" since the carbon dioxide that is generated is sourced from a fossil fuel and therefore has less of a climate benefit. The climate benefit of blue

[3] Information provided by Innotech

hydrogen can be improved through capturing the carbon dioxide and sequestering or utilizing it in other industrial processes. There is also research underway to commercialize technology to generate hydrogen from oil, gas, and oilsands reservoirs while leaving the carbon dioxide in the reservoir. If proven commercially this could provide another potential supply of blue hydrogen and provide market diversification opportunities for Albertan oil and gas production.

Hydrogen can also be produced through electrolysis. Electrolysis produces hydrogen from water using an electrical current and does not produce any greenhouse gas emissions directly. The hydrogen produced through electrolysis is referred to as “green hydrogen” reflecting the better environmental performance. There may still be greenhouse gas emissions generated from the electricity used to produce green hydrogen, and to maximize the emissions reductions this electricity should be generated from renewable sources. The objective of a hydrogen economy in Alberta should maximize green hydrogen production to maximize the environmental benefit.

Currently, blue hydrogen has lower production costs mostly associated with the current low natural gas feedstock prices. If natural gas prices increase, the economics of blue hydrogen may become less advantageous. Alberta is also well suited to be a producer of green hydrogen due to low electricity costs, however production costs are generally higher for green hydrogen. Blue hydrogen remains the currently economic production method, but as demand for low carbon fuels increase and electrolysis technologies mature green hydrogen may become increasingly competitive.

Biodiesel

Biodiesel is derived from either vegetable or animal sourced oils and fats, and is converted into biodiesel through a process called transesterification. This results in an oxygenated fuel that is chemically distinct from fossil-based diesel. This chemical difference results in biodiesel generally having poor low temperature properties compared to fossil-based diesel. This makes using biodiesel alone impossible while maintaining operability throughout all seasons. For this reason, biodiesel is generally blended with fossil-based diesel (ranging from 2-5% by volume) to maintain operability throughout all seasons. This blending process is not a significant challenge however, as the composition of conventional fossil-based diesel must be adjusted to suit the season and geography in standard practices already. However, the proportion of biodiesel is effectively limited to a maximum of 5% due to the cold weather operability limitation (and typically lower to minimize operability challenges).

Biodiesel is currently blended with fossil-based diesel in Alberta to meet the Renewable Fuel Standard regulation. This regulation requires that diesel fuel sold in Alberta contants 2% renewable content. The renewable fuel blended with the diesel must demonstrate at least 25% fewer GHG emissions than the petroleum equivalent. Under the Alberta Renewable Fuel Standard regulations, Alberta diesel fuels have consistently achieved the 2% renewable content required (see Table 2) through a combination of blending fossil-based diesel with biodiesel and renewable diesel (discussed in the next section).

Table 2: Total diesel and bio-based diesel blended in Alberta for compliance with the Alberta Renewable Fuel Standard[4]

Fuel (million litres)	2011	2012	2013	2014	2015	2016	2017
Total Diesel	4,812	6,702	7,244	7,573	6,367	5,698	6,541
Biodiesel	106	143	161	176	151	126	134
Renewable Diesel							15
Renewable Content (%)	2.2	2.1	2.2	2.3	2.4	2.2	2.3

Research completed by Navius Research found that annual Canadian consumption of biodiesel has grown from roughly 123 million litres in 2010 to 376 million litres in 2017[5]. The increase in production is primarily attributable to federal and provincial renewable fuel requirements. This research also

[4] Government of Alberta, *Renewable Fuels Standard (RFS): Fuel volumes for the Alberta market.* Retrieved November 20, 2019. https://open.alberta.ca/dataset/8ca7bd59-d7e6-4822-99ef-e1d76ba2dfcc/resource/6d3fd36f-4cf2-47ed-b51a-eaac64073866/download/rfs-fuelvolumes-jan07-2019.pdf

[5] Wollnetz, Michael; Heln, Mikela; Moawad, Barbar, *Biofuels in Canada 2019: Tracking biofuel consumption, feedstocks and avoided greenhouse gas emissions*. Navius Research. May 2019.

identified that diesel fuel costs to consumers increased by 0.65% due to biodiesel and renewable diesel blending required by standards (Figure 3).

Biodiesel in general is estimated to cost approximately 60% more than standard fossil-based diesel, but further market research would be necessary to define the expected price for Edmonton.

Renewable Diesel

Renewable diesel is derived from the same types of feedstocks as biodiesel, but is produced using a process called hydroprocessing. This process uses technology typically used in petroleum refining to produce a product that is chemically similar to fossil-based diesel. This allows renewable diesel to be used interchangeably with diesel or blended in any proportion and maintain the cold climate properties necessary.

Although renewable diesel can be produced using similar feedstocks, the processes employed to produce either are very different. Whereas biodiesel properties are strongly dependent on the feedstock from which it was derived, renewable diesel properties are more dependent on the production process parameters such as temperatures, pressures, and the catalysts used. Renewable diesel also requires the addition of hydrogen as part of the process, and therefore production facilities benefit from a local source of hydrogen production.

The difference in production processes results in renewable diesel generally being more expensive than biodiesel due to the higher capital cost of the equipment needed. However, renewable diesel is considered to be a ‘drop-in’ fuel, in that it is fully compatible with existing fuel infrastructure, distribution systems, and diesel engines at any blended proportion. It is important to note that while it is possible to produce winter grade renewable diesel that can be used at temperatures below -20 degrees, this product is produced at a premium relative to a summer grade product.

Fuel standards are established by the Candian General Standards Board, which provides the specifications for fuels. The Canadian General Standards Board recognizes that renewable diesel is chemically equivalent to fossil-based diesel, and they are in the process of considering updating their standards to add specific definitions and specifications for renewable diesel to provide assurances for end-users.

Both renewable diesel and biodiesel are blended to meet renewable fuel content requirements. Table 2 in the biofuels section identify the combined volumes of both biodiesel and renewable diesel, as well as the split between these two products for 2017. This showed that biodiesel is predominantly used to meet the Alberta renewable fuel standard over renewable diesel. This might be due to biodiesel generally cheaper than renewable diesel, and therefore being preferentially selected to minimize costs. While biodiesel generally costs 60% more than standard fossil-based diesel, renewable diesel generally costs around 150% more than fossil-based diesel.

Assisted through the British Columbia clean fuel standard and selected through a competitive request for proposal process, the City of Vancouver starting purchasing 100% renewable diesel for their fleet operations in 2019 and has not yet reported any operational issues with its use.[6]

Ethanol

Ethanol is an alcohol which is suitable for use within standard gasoline engines. Ethanol is produced through the fermentation of starches and sugars from crops such as corn, sugar cane, or wheat. To be used as a transportation fuel ethanol is blended with gasoline at various proportions. Alberta's Renewable Fuels Standard requires 5% ethanol by volume is blended with gasoline. This has lead to around 400 million litres of ethanol blended into gasoline annually since 2011, exceeding the Renewable Fuel Standard requirements of 5% renewable content (see Table 3).

Table 3: Total gasoline and ethanol blended in Alberta for compliance with the Alberta Renewable Fuel Standard[7]

Fuel (million	2011	2012	2013	2014	2015	2016	2017

[6] City of Vancouver, *City's own diesel fleet transitioning to 100 percent renewable fuel*. Retrieved November 28, 2019.
[7] Government of Alberta, *Renewable Fuels Standard (RFS): Fuel volumes for the Alberta market.* Retrieved November 20, 2019. https://open.alberta.ca/dataset/8ca7bd59-d7e6-4822-99ef-e1d76ba2dfcc/resource/6d3fd36f-4cf2-47ed-b51a-eaac64073866/download/rfs-fuelvolumes-jan07-2019.pdf

litres)							
Total Gasoline	4,298	5,901	6,014	6,198	6,278	6,132	6,144
Ethanol	285	416	417	416	408	377	369
Renewable Content (%)	6.6	7.1	6.9	6.7	6.5	6.1	6.0

Navius Research found that under the renewable fuel requirements across Canada the average consumer of gasoline paid 1.15% less ($23/yr) in annual fuel costs due to ethanol blending in Canada (Figure 3)[8]. This is predominantly because blending ethanol with gasoline can boost the octane value of the final product.

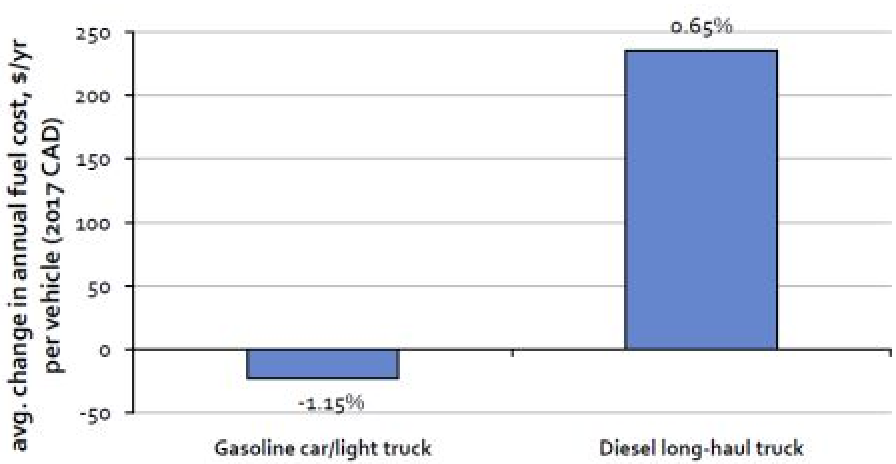


Figure 3: Estimated fuel consumer cost impact, annual average 2010-2017

POTENTIAL REDUCTIONS AND CO-BENEFITS

This section explores the potential reductions generated from each of the fuels investigated as well as identifies co-benefits that can arise from their use.

[8] Wollnetz, Michael; Heln, Mikela; Moawad, Barbar, *Biofuels in Canada 2019: Tracking biofuel consumption, feedstocks and avoided greenhouse gas emissions*. Navius Research. May 2019.

Renewable Natural Gas

Renewable natural gas provides a climate benefit in multiple ways. First, the methane that is captured would have been released to the atmosphere if the wastes were landfilled, and it's capture and use results in the conversion of methane into carbon dioxide which has a lower global warming potential. Further, renewable natural gas replaces the fossil-fuel based natural gas that would be used in its absence.

When produced, raw renewable natural gas is usually around 50-60% methane and 40-50% carbon dioxide with some residual trace gases in small proportions. This raw gas can be combusted to produce electricity or upgraded to renewable natural gas through the removal of carbon dioxide and trace gases to meet pipeline specifications. Further reductions could be achieved if the removed carbon dioxide is captured and sequestered or utilized, but this step reflects an additional cost for a production facility that may not be justified under current carbon prices.

The combustion of renewable natural gas produces similar emissions and air pollution as fossil-based natural gas - the primary distinction is that the carbon dioxide released is biogenic, sourced from the decomposition of organic material, and therefore is considered to be carbon neutral when used. This was confirmed and certified by Offsetters for FortisBC's renewable natural gas product[9]. Due to this carbon neutral status, any volumes of renewable natural gas used by the City or its residents would be considered non-emitting and assist in reducing emissions.

Natural gas use in the City of Edmonton represented 23% of the total community emissions in 2018. Using renewable natural gas can eliminate the greenhouse gas contribution from the use of natural gas, but it is important to note that the amount of renewable natural gas used in the City would have to be tracked to account for any reductions made from its use. These reductions would not occur within the City of Edmonton boundary directly,

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[9] Offsetters, *Report Update: Biomethane Greenhouse Gas Emissions Review*, Prepared for FortisBC, March 31, 2017. https://www.cdn.fortisbc.com/libraries/docs/default-source/services-documents/offsetters-biomethane_greenhouse_gas_emissions_reviewe6fecb594de843768ae02951f4b8d3eb.pdf?sfvrsn=821688c4_2, retrieved November 18, 2019.

but would be generated off site through the City's procurement of renewable natural gas outside of Edmonton (i.e. the reduction occurs at the renewable natural gas production facility). Further, there are no direct air quality benefits from increasing use of renewable natural gas since both fossil-based and renewable natural gas release similar air pollutants when combusted - although there are potential air quality benefits in proximity to the renewable natural gas production site.

Hydrogen

Hydrogen fuel cell technology has been developed that allows for vehicles to be powered by hydrogen and reduce emissions from the combustion of transportation fuels such as gasoline and diesel. The Alberta Zero Emissions Truck Electrification Collaboration (AZETEC) received funding from Emissions Reduction Alberta to test two long range hydrogen fuel cell trucks for operation between Edmonton and Calgary. Compared to electric vehicles, hydrogen fuel cell vehicles are better suited to achieve reductions in the long haul freight sector due to the long distances travelled and better energy density and storage provided by hydrogen. This allows for these vehicles to travel up to 700 km before refueling. While there are few commercial personal vehicles that use hydrogen fuel cell technology, as the technology is demonstrated and fueling infrastructure expands such products may increase in demand. The primary drawback of hydrogen use in the transportation sector is that it requires replacement of the current gasoline/diesel vehicles and therefore requires a significant investment into new equipment to realize any reductions. Fuel prices for hydrogen are also expected to be higher than current gasoline or diesel. In 2015, the California Energy Commission found that hydrogen fuel prices were around $14 per kg, equivalent on an energy basis to $1.48 per litre of gasoline[10]. Therefore to see uptake of hydrogen fuel vehicles beyond select industries requires an improved value proposition both regarding the vehicle cost and the fueling costs.

A simpler approach to use hydrogen to reduce emissions is through blending it with natural gas and reduce emissions generated from home and building heating systems. As the transition to electrification occurs, interim reductions

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[10] California Energy Commission, *Joint Agency Staff Report on Assembly Bill 8: Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California*, December 2015. https://ww2.energy.ca.gov/2015publications/CEC-600-2015-016/CEC-600-2015-016.pdf

can be attained through supplementing a proportion of current natural gas use with hydrogen in building heating systems. This can serve to extend the available carbon budget of Edmonton by reducing these building emissions to meet emissions neutral building targets. The amount of hydrogen that can be blended with natural gas will be limited by the end use equipment of the fuel. Studies have identified that up to around 25% hydrogen can be blended with natural gas and not cause any end-user equipment issues. To avoid major challenges with blended natural gas and hydrogen, it is likely that hydrogen blending would begin at low proportions and increase gradually over time as equipment is shown to successfully operate with the fuel.

While the objective of using hydrogen as a transportation fuel or a heating fuel is to reduce carbon dioxide emissions, there is also a reduction in other common air pollutants from its use. When hydrogen is burned only water is produced, whereas the combustion of natural gas releases nitrogen oxides and particulate matter which are troublesome urban air pollutants. Increased use of hydrogen over natural gas, gasoline, or diesel will help reduce local air pollution and improve air quality. Reducing these air pollutants is an arising issue across Alberta. In response to health research, new Canadian Ambient Air Quality Standards for nitrogen dioxide are to be implemented in 2020 and it is expected that this will highlight the need for actions to reduce nitrogen dioxide and prevent exceedance of the standard. Blending natural gas used within the City of Edmonton with hydrogen is likely to assist in reducing these pollutants.

Further, Alberta is well suited to become a hub of hydrogen technology development and the establishment of supporting technical services. Trials for long range hydrogen fuel cell electric trucks for operation between Edmonton and Calgary have already been initiated with funding provided by Emissions Reduction Alberta.[11] Novel ways to store hydrogen so that it can be more easily used are being developed, employing Alberta trained professionals.[12][13] Innovations are under development related to the

[11] Alberta Zero Emissions Truck Electrification Collaboration (AZETEC), retrieved on November 28, 2019. https://www.eralberta.ca/projects/details/alberta-zero-emissions-truck-electrification-collaboration-azetec/
[12] Kubagen: Hydrogen Storage Materials and Power Systems. https://www.kubagen.co.uk/
[13] Hydrogen in Motion. https://www.hydrogeninmotion.com/

production, storage, transportation and final use of hydrogen around the world - and Alberta has the skilled technical workforce and expertise to become a hub for a hydrogen production and supply industry.

Biodiesel, Renewable Diesel, and Ethanol

Biodiesel, renewable diesel and ethanol all have lower life cycle carbon intensities than either gasoline or diesel. Figure 4 presents the lifecycle carbon intensity of each fuel consumed in Canada since 2010 estimated by Navius Research[14]. This highlights that biofuels consumed in Canada offer significant reductions of emissions, even when considering land use changes associated with biofuel production. Ethanol is shown to be 52% less carbon intensity than gasoline and biodiesel and renewable diesel are around 87% less carbon intensive than diesel.

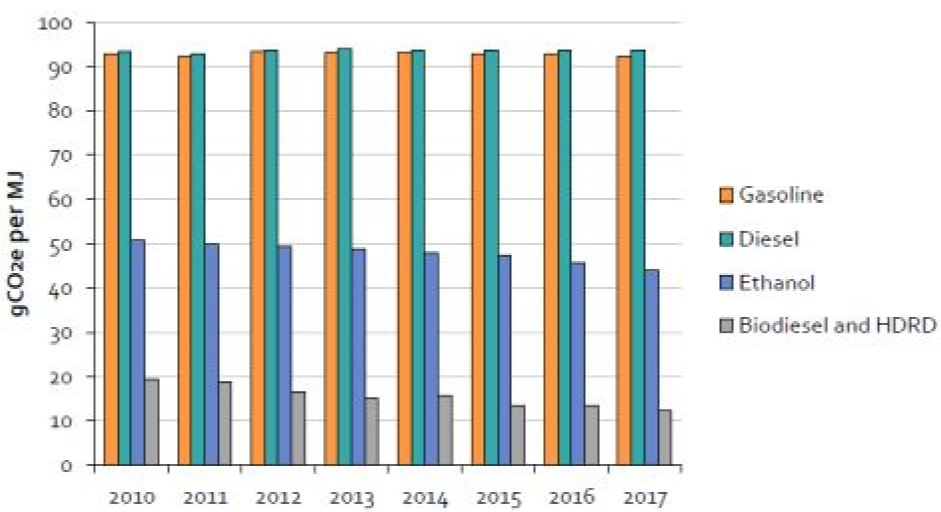

Figure 4: Lifecycle carbon intensities of fuels consumed in Canada.

The use of gasoline and diesel in the City of Edmonton was responsible for 2.9 million tonnes and 2.5 million tonnes of greenhouse gas emissions in 2018. This represents around 29% of the City of Edmonton's total community greenhouse gas releases in that year - a significant local contributor to climate change. Increasing the proportions of biofuels with lower carbon intensities

[14] Wollnetz, Michael; Heln, Mikela; Moawad, Barbar, *Biofuels in Canada 2019: Tracking biofuel consumption, feedstocks and avoided greenhouse gas emissions*. Navius Research. May 2019.

while maintaining operability throughout all seasons can help reduce emissions from this sector.

Based on modelling completed by SSG, by 2030 the emissions from gasoline and diesel use need to be reduced by 49% to remain on track to minimize global temperature increases to 1.5 degrees. This does include a significant increase in the use of electric vehicles, but additional reductions can be achieved by increasing the volumes of biofuels used within Edmonton.

Beyond the emission reduction potential from the use of these fuels, there is also potential to diversity the market for canola producers by increasing use of alternative fuels. According to the Canadian Canola Growers Association, over 90% of canola produced in Canada is exported[15]. This reliance on exports has become an increasing problem as international tension between China and Canada continues over canola. Growing the local demand of canola through increasing use of biofuels produced from canola can assist diversify this market and provide better stability. Canada currently produces around 20 million tonnes of canola each year with plans to grow production to 26 million tonnes by 2025. Canada also has 14 crushing and refining facilities that have a combined capacity to crush around 10 million tonnes of canola seed into oil that can be used to produce biofuels.

MUNICIPAL CONTROLS AND LEVERS

For all of the fuels explored in this briefing, the municipal controls and levers to motivate their use are generally the same. Alternative fuel use has been motivated in other jurisdictions through clean or renewable fuel standards. These require fuel distributors to meet specified levels of clean or renewable product within their portfolio of fuel sales. This allows fuel distributors to seek out the products that are best able to meet these standards, and facilitates competition between alternative fuel providers separate from fossil-based fuels. Although this has been shown to be effective at increasing production of alternative fuels, there is no current authority for Edmonton to pursue such a requirement for all fuel supply in the City.

[15] Canadian Canola Growers Association, *Candian Canola: Growing low-carbon transportation solutions*. 2018. https://www.ccga.ca/policy/Documents/CCGA_Canola%20Biofuels%20White%20Paper_September19_2018.pdf

Alberta currently has a Renewable Fuel Standard for transportation fuels, and Edmonton could advocate to the province to increase the renewable fuel content required to motivate greater volumes of alternative fuels to be used to meet energy demands. Similarly, Edmonton could advocate for the establishment of a renewable/low carbon standard for heating fuels, and motivate the blending of renewable natural gas and/or hydrogen to reduce emissions.

The most direct control available to the City is to purchase alternative fuels directly for use within City operations. Figure 5 shows that in 2018 gasoline and diesel consumption represented 21% of GHG emissions from City operations (around 0.5% of total community emissions). In the same year natural gas use from City operations represented 19% of total City emissions (around 0.5% of total community emissions).

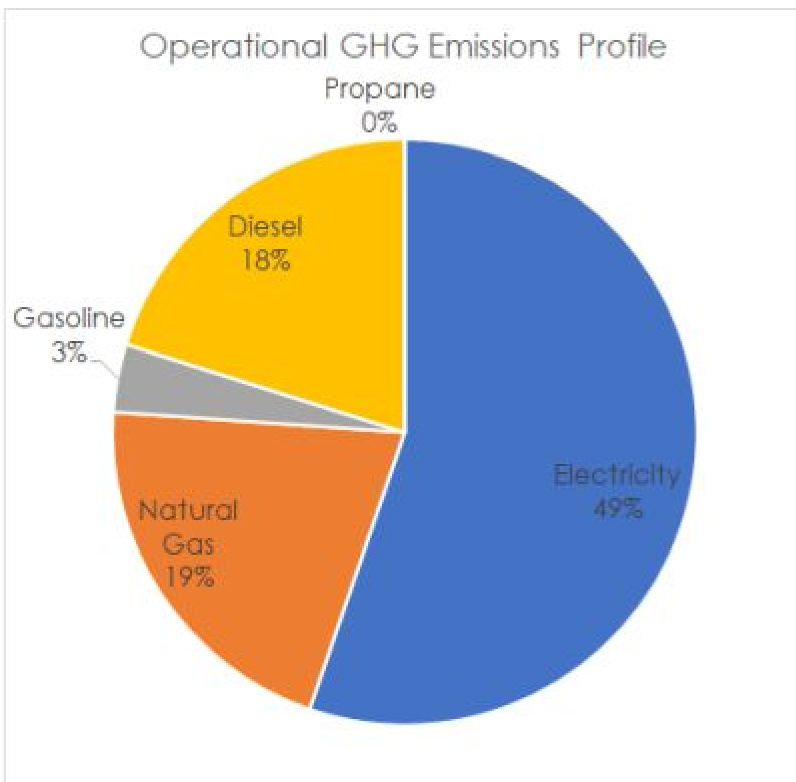

Figure 5: City of Edmonton Greenhouse Gas Emissions from City Operations by fuel type.

While City operations only represent a small proportion of total natural gas, gasoline, and diesel use throughout Edmonton (approximately 1% of emissions); City purchases of biofuels have the indirect benefit of demonstrating leadership to the broader community. City purchases of these fuels also provide greater assurance to alternative fuel suppliers through larger volume, longer-term supply contracts for their products. This would ultimately leverage the purchasing power of the City of Edmonton to provide motivation for the establishment of alternative fuel production in Edmonton or Alberta more broadly.

EQUITY CONSIDERATIONS

Equity issues related to alternative fuels are highly dependent on the specific fuel and practices involved in producing the fuel.

Where alternative fuels are produced using food products (ex. corn, canola, sugar cane, etc.), there is a risk that the increased demand for fuel production could increase the price of these food products and contribute to food insecurity. Increased use of corn for ethanol production was determined to be one factor that contributed to the growth of unrest and led to rioting in Mexico over the price of staples[16]. While this risk would exist for any major food-related feedstocks, there are ample opportunities to rely on organic waste products in Alberta that would avoid this issue. One exception is the use of canola for biofuel production, although recent trade disputes may result in similar impacts to countries importing Canadian canola. It is therefore important to prioritize the use of waste feedstocks over other feedstocks for the production of alternative fuels.

Another equity issue arises due to the use of land for producing crops that are used for alternative fuel production. This mostly relates to alternative fuels that are produced outside of Canada, and may involve practices such as clear-cutting or substandard employment standards. It is well known that some practices employed to produce alternative fuels would result in increased lifecycle greenhouse gas emissions and therefore not provide a benefit. The provincial Renewable Fuel Standard accounts for this by only allowing those fuels that can demonstrate at least a 25% improvement in

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[16] Roundtable on Environmental Health Sciences, Research, and Medicine; Board on Population Health and Public Health Practice; Institute of Medicine. The Nexus of Biofuels, Climate Change, and Human Health: Workshop Summary. Washington (DC): National Academies Press (US); 2014 Apr 2. 7, Ethical and Social Issues. Available from: https://www.ncbi.nlm.nih.gov/books/NBK196458/

lifecycle greenhouse gas emissions to qualify under the standard. To avoid this, once again fuels generated from waste products should be prioritized and any alternative fuels purchased should identify their feedstock, location of production, and demonstrate a greenhouse gas reduction benefit on a lifecycle basis.

It should also be noted that there is an ethical motivation for producing alternative fuels from waste that is produced in the City, particularly wastes that are currently not sustainably managed (i.e. landfilled). Dedicating City wastes for the production of alternative fuels would help address this ethical issue and demonstrate improved sustainability of the City.

Alena Buyx, a senior research associate at the School of Public Policy at University College London, provided the following key values to be included in alternative fuel development to ensure ethical practices are adopted and are relevant to the consideration of equity.

- "Biofuel development should not be at the expense of people's essential human rights, including food, health, and water.
- Biofuels should be environmentally sustainable.
- Biofuels should contribute to a net reduction of total greenhouse gas emissions.
- Biofuels should adhere to fair trade principles.
- The costs and benefits of biofuels should be distributed in an equitable way. It should not happen, for example, that the benefits occur in the developed world and the costs occur disproportionately in poor countries.
- If these five principles are respected, depending on certain key considerations, such as absolute cost or whether there are better alternatives, there is a duty to develop such biofuels."[17]

FORESEEABLE ISSUES AND MITIGATION STRATEGY

[17] Roundtable on Environmental Health Sciences, Research, and Medicine; Board on Population Health and Public Health Practice; Institute of Medicine. The Nexus of Biofuels, Climate Change, and Human Health: Workshop Summary. Washington (DC): National Academies Press (US); 2014 Apr 2. 7, Ethical and Social Issues. Available from: https://www.ncbi.nlm.nih.gov/books/NBK196458/

The most pressing issue is related to the technical ability to use these alternative fuels in current equipment. It is necessary to technically validate the use of these fuels for specific purposes to ensure that the equipment using the fuel is not damaged or create other operational issues (such as the reduced cold weather performance of biodiesel). This requires technical evaluation of the alternative fuel, and evaluation of the implication of its use to equipment warranties or maintenance programs. These issues should be resolved through any selection/evaluation process established for the purchase of alternative fuels.

It is essential that if the City purchases these alternative fuels that the reductions that occur are included in the City's greenhouse gas inventory. Where the reduction occurs outside of the City of Edmonton boundary (i.e. renewable natural gas, biodiesel, renewable diesel, and ethanol) it will be important to record and report on the volume of these fuels consumed within the City of Edmonton and claim the associated reductions.

CONCLUSION WITH RECOMMENDED POLICY STATEMENTS

There is an opportunity to achieve reductions in the transportation sector from increasing the use of alternative fuels. This opportunity should not dissuade from the pursuit of EVs and electrification of transportation. Alternative fuel use can complement the EV strategy by achieving some interim reductions from current equipment prior to it's replacement. It is therefore important to note that renewable natural gas, biodiesel, renewable diesel, and ethanol can be used in current transportation equipment at specific proportions, whereas the use of renewable natural gas or hydrogen in the transportation sector does require investment in new equipment.

There is also an opportunity to achieve reductions in home heating emissions from increasing the use of alternative fuels, namely renewable natural gas and hydrogen. Both renewable natural gas and hydrogen can be blended with fossil-based natural gas and reduce greenhouse gas emissions. The use of these fuels in the natural gas distribution system can compliment the Emissions Neutral Buildings efforts by reducing emissions from home heating prior to home retrofits. While reductions associated with the use of renewable natural gas occur outside of the City of Edmonton boundary and would need to be accounted for, hydrogen use would reduce emissions within the City boundary and also generate air quality co-benefits.

1. Advocate to the province to establish a renewable fuel standard for heating fuels to facilitate growth of both renewable natural gas and hydrogen production throughout Alberta.
2. Advocate to the province to increase the proportion of renewable fuels required under the Alberta Renewable Fuel Standard while maintaining operability throughout the year.
3. Undertake an Expression of Interest (EOI) process to have fuel suppliers identify the local supply available at specified costs for alternative fuels that can be substituted or blended and used in current equipment such as gasoline engines, diesel engines, and natural gas furnaces. Successful proponents under the (EOI) would be invited to a competitive procurement process to establish supply contracts for these fuels. This process must also include technical evaluation and validation of these fuels to meet the specifications for appropriate use in current equipment.
4. Continue with implementation of the Waste Management Strategy, and seek out circular economy innovations that consider waste as a resource/feedstock in the creation of alternative fuels. Through this strategy, the City should seek out waste management contracts that include the production of alternative fuels and provides those fuels for use in Edmonton, assisting in maximizing biogas and biofuel production and alignment of the Waste Management Strategy with the Energy Transition Strategy and climate change goals.
5. Establish policy/guidance for new equipment purchases by the City to evaluate equipment options that use alternative fuels, and select those options when feasible.