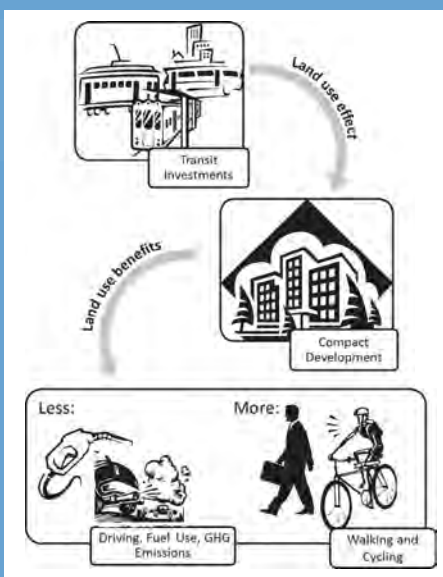

City of Edmonton Transit Strategy

Guiding Perspectives Report

ENVIRONMENTAL SUSTAINABILITY IN TRANSIT

Project Nr: 5216001-000 | May 2016

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ENVIRONMENTAL SUSTAINABILITY IN TRANSIT

TRANSIT STRATEGY GUIDING PERSPECTIVES BACKGROUND PAPERS

City of Edmonton

Project no: 5216001-000
Date: May 2016

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EXECUTIVE SUMMARY

This paper seeks to address a number of the relevant policy issues and challenges associated with improving the medium to long term environmental sustainability of transit in the City of Edmonton. The strategic background to the discussion is the City's Transit Strategy currently underway. This paper is aimed at highlighting some of the strategic policy and resourcing considerations it is likely to face.

Environmental sustainability is a goal that the City has been seeking to address through its current suite of 'The Ways' policies. It relates strongly both to the City's own Operations as well as its role as a transportation network provider and manager. Transit is shown to have an impact on the natural environment, primarily in terms of greenhouse gas emissions, however that impact is shown to be relatively small when compared to the known and growing impacts of the private transportation sector. It is argued that in order for the environmental sustainability of transit to be maximised, the potential contribution of transit to the City's own broader transportation and land use sustainability goals must be clearly defined and evaluated in full.

This 'big picture' approach to environmental sustainability is framed in terms of a sustainable transportation policy framework that recognises and takes account of whole of system effects over time. The distinct advantage of this approach is that with sufficient analysis, a holistic and integrated method from which to make strategic long term transit decisions can be made possible. It will also help to inform and manage the necessary and sometimes difficult trade-offs in terms of existing resource allocation as well as ensure that any new resources will be deployed where they can be used most effectively.

This paper begins by examining the environmental impact of the transportation system at a national and provincial level and then moves to demonstrate transit's impact vis-à-vis private transportation in Edmonton. **Ex-post (after the fact)** versus **ex-ante (forward looking) evaluation** and **performance management using comprehensive indicators** are two key issues that are highlighted for specific attention.

In terms of **evaluation** of competing transportation policy alternatives, the paper seeks to draw on latest research collaboration from the US Federal Transit Administration (FTA); the National Academies, the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), as well as the American Public Transportation Association (APTA), through its Transit Cooperative Research Program (TCRP). This research demonstrates new insights into the benefits of transit as it relates to decreasing energy use and improving household wealth. It is shown that increased transit provision can be expressed both in terms of traditional **ridership benefits** and **land use benefits**. The latter has the distinct advantage of not only potentially increasing transit ridership, but also reducing levels of vehicle ownership and private motorised travel. Importantly, there is emerging and strong evidence to suggest that increased transit provision may in fact help to leverage land use impacts that could eclipse ridership benefits by a factor of as much as 4:1. In other words, there are synergies to improving environmental sustainability of transit and the transportation system as a whole.

Concerning the issue of **performance indicators** and their application in transit, it is argued that existing environmental management systems (EMS), such as the City's existing EMS, *Enviso*, appear to be doing a reasonable job of ensuring compliance with existing emissions regulations and environmental legislation. The relative advantage of a **comprehensive performance indicator** that encompasses temporal (by time period), spatial (by geographic area) or population (per capita) impacts is that a clearer path with interim goals for improving transportation performance and environmental sustainability over time can be spelt out. The LiveSmart initiative in neighbouring British Columbia is demonstrated as a worthwhile example of such an approach. It is emphasised however that no one performance indicator will give an accurate or holistic reflection of performance, particularly given that environmental sustainability cuts across so many aspects of urban life.

To support the points outlined here, the paper examines a wide range of local, provisional and national data sources and examples from other cities in order to make recommendations on environmental sustainability issues that may warrant further consideration as part of the Transit Strategy.

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1 INTRODUCTION

1.1 BACKGROUND AND PURPOSE

The purpose of this paper is to set out a number of relevant policy issues and challenges associated with increasing the environmental sustainability of transit services and operations in Edmonton over time. The paper seeks to do this by explaining the close interrelationship between transit outcomes and whole of transportation sector performance. It suggests that this relationship is of critical importance to help foster a greater understanding of the nature and scope of the long term sustainability policy challenge facing the City now and into the future. The paper should be understood in the context of existing City strategic policy (particularly '*The Ways*' policy framework).

It is hoped that this paper will help to inform relevant policy considerations and discussions as part of the three-phase Transit Strategy that is currently underway in Edmonton. The Transit Strategy is a current City project that is concerned with setting future strategic policy directions for transit in Edmonton for the next 10 years. In this respect, it should be noted that some of the issues discussed here go beyond the current policy timelines of *The Ways* (2009-2019) and are arguably more closely aligned with the longer-term timeframe of the Transit Strategy (currently slated for 2017-2027).

In Edmonton, the majority of existing transit services are provided by the Edmonton Transit Service (ETS). As with many other transit operators in North America, ETS is a government-owned and managed enterprise of the City. In contrast to some cities where informal or privatised transit operates at arm's length or independent of government control, the City maintains a high level of direct operational and planning influence over current and future transit services. In 2016, ETS operates a fleet of 972 buses and 94 LRT vehicles of various ages and specifications.

As will be shown in this paper, transportation powered by fossil fuels using conventional technologies and energy sources is a carbon-intensive activity at present. It is also contributes to the heighted presence of air pollutants in the Edmonton region, such as sulphur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter (PM_{10}) and volatile organic compounds (VOC), all of which have been shown to be hazardous to human health and a number of which contribute to greenhouse gas (GHG) emissions.

Whilst ETS itself requires large quantities of energy and other resources to operate, this paper highlights that ETS' overall energy consumption – and the resulting emissions generated from those day to day operations – is relatively small when compared to energy consumption in the private transportation sector. The nature of the relationship between the two sectors raises the important question of how to devise a long term strategy that is aimed at reducing emissions at the whole of sector level.

As has been noted by American Public Transit Association (APTA 2009), Transit Cooperative Research Program (TCRP 2015) and the Victoria Transport Policy Institute (Litman 2015b), there is a growing consensus that comprehensive evaluation public transit benefits, including the environmental sustainability of transit, ought to extend beyond the direct 'ridership effect' of substituting private vehicle travel for transit travel to encompass other significant land use benefits. Most importantly, these land use benefits have been shown in some cases to outweigh ridership benefits by a factor of up to four to one in many US cities (TCRP 2015). It has also been shown that a well-designed environmental sustainability policy framework can help to capture, quantify, account for and realise these benefits over time.

To address the wide-ranging nature of relevant issues highlighted above, this paper is structured around the following six key discussion points:

1. Defining the notion of environmental sustainability in transit
2. Current primary energy sources for public and private transportation and historical trends
3. Evaluating Transit Energy Efficiency
4. The relevance and importance of a policy framework to achieve environmental sustainability, including relevant Climate Policy and Regulations
5. Measuring and setting benchmarks to lessen the environmental impact of transit
   - → Managing operational impacts
   - → Effective reporting mechanisms against City Goals
   - → Case study: Vancouver, BC
6. Suggested strategies moving forward

2 DEFINING THE NOTION OF ENVIRONMENTAL SUSTAINABILITY IN TRANSIT

The following section serves to establish a working understanding of **sustainability**, **sustainable planning** and **transit** for policy discussion purposes.

2.1 SUSTAINABILITY

The Way We Green (TWWG) is one of Edmonton's six core long term strategic plans that is designed to "*set out principles, goals and objectives and strategic actions and approaches for Edmonton to live in balance with nature*" (City of Edmonton 2011)[1]. Sustainability forms one of the two main focuses of the strategy, the other being resilience.

TWWG nominates the following definition for sustainability, developed in conjunction with The University of Alberta's Office of Sustainability:

"The ability of human society to endure over a prolonged period as an integral part of Earth's natural systems. Sustainability is achieved through the practice of sustainable living." (City of Edmonton, 2011)

2.2 SUSTAINABLE PLANNING PROCESS

Litman (2015a) introduces the notion of a **sustainability planning process** for transportation. This process is designed to help build awareness of how sustainability can be incorporated into the long-term planning process as it relates to human activities:

"*Sustainability emphasizes the integrated nature of human activities and therefore the need for coordinated planning among different sectors, groups and jurisdictions. It expands the **objectives, impacts and options considered in a planning process.** This helps insure (sic) that individual, short-term decisions are consistent with strategic, long-term goals. Sustainable transport planning recognizes that transport decisions affect people in many ways, so a **variety of objectives and impacts** should be considered in the planning process*." (author emphasis).

The sustainable planning process is discussed further in Section 4.

2.3 TRANSIT

Transit is defined by Vuchic (2005) as:
"...the common carrier type of urban passenger transport. These are transport systems with fixed routes and schedules, available for use by all persons who pay the established fare. The most common representatives are bus, light rail transit, and rapid transit or metro, but there are a number of other modes."

In summary, the notion that ***environmental sustainability*** can be improved ***for transit*** (and transportation more broadly) through the ***effective use of objectives, impacts and options*** in a considered sustainable planning process to ***measure and refine performance*** is a central theme of this paper.

[1] Other relevant policies are summarised in Section 4.

3 CURRENT EDMONTON TRANSIT SYSTEM ENERGY SOURCES AND NATIONAL EMISSIONS TRENDS

As noted in the introduction, the amount of energy used for transportation purposes per time period can be defined in a number of ways. The California Energy Commission illustrates the difference between vehicle operation emissions (sometimes referred to as 'direct emissions') and those emissions that arise from the fuel cycle (or 'indirect emissions') (cf. Figure 1). This distinction is true for all transportation modes that are capital and resource intensive (mostly motorised modes), including the public transit sector.

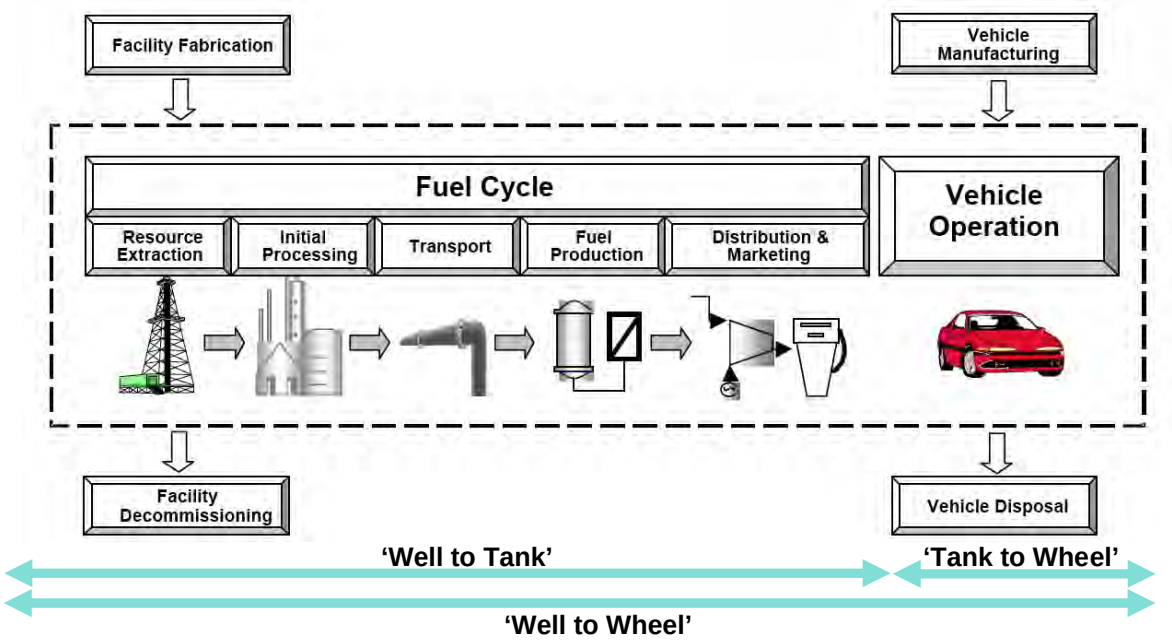

Figure 1 – Fuel Cycle and differentiating between energy use and sources

The *German Federal Ministry for Transportation and Digital Infrastructure's Manual for Calculating Energy Use and Greenhouse Gas Emissions from Public Transportation based on European Norm EN 16258* (Bundesministerium für Verkehr und digitale Infrastruktur 2014) distinguishes between three types of emissions, which have been illustrated as part of Figure 1:

1. **'Tank to Wheel'**: direct energy consumed through the operation of vehicles relating to fuel usage
2. **'Well to Tank'**: includes all indirect energy usage from the source to the fuel tank
3. '**Well to Wheel**': the combined sum of tank to wheel and well to tank process known defined in terms of 'primary energy' (a combined energy and vehicle process). Accounting for losses in the production process as part of this calculation contributes to '**final energy consumed**'.

Ascertaining the environmental sustainability of transit at a City level requires a deliberate decision on the part of the City as to which of these processes are considered relevant for the setting of City environmental sustainability policy. Operators typically report only on Tank to Wheel Emissions, sometimes referred to as a 'Corporate Carbon Footprint'.

The new EN 16258 Norm *'Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers)*' (European Committee for Standardisation 2015) prescribes a standardised GHG accounting methodology for calculating Well to Wheel emissions in Europe based on the applicable fuel cycle source. This component of emissions is regularly assessed to take account of changes to new and emerging energy sources, particularly in the Well to Tank stage.

3.1 LIGHT RAIL TRANSIT

Light Rail Transit (LRT) in Edmonton is powered by electric traction supplied from electrical energy that is generated in stationary power plants predominantly fuelled by burning black coal to heat water that drives turbines and generates electricity which is then fed into a grid of transformers, poles and wires. The main sources of Alberta's electricity are illustrated in Figure 2.

Unfortunately, this existing model works well at ensuring large scale production of electricity at the source, but it also experiences significant losses in transmission and distribution. Furthermore, the coal-fired power generation is responsible for significant GHG emissions. Decentralised or district energy such as co-generation is an example of an alternative model that helps to minimise any losses, increase energy efficiency and reduce GHG impacts. In recent years the City has elected to pay a price premium in order to purchase defined amounts of 'Green Electricity' (particularly biomass, wind and hydro) that also help to reduce the GHG intensity of electricity purchased.

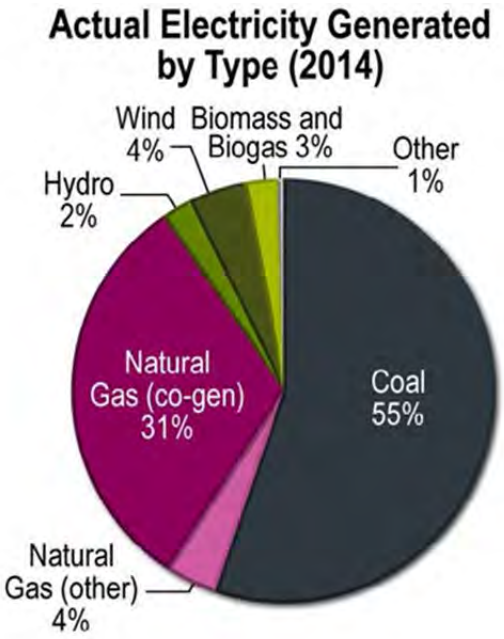

Figure 2 –Electricity in Alberta Generated by type/energy source (2014)

3.2 BUS SERVICES

The current ETS bus fleet is fuelled mostly by diesel compression ignition engines that generate kinetic energy to propel the bus. In additional to conventional diesel technology, there are a limited number of hybrid electric buses (<5% of the fleet) in operation.

The historical resource consumption patterns, measured here in terms of CO_2 emissions (in the case of LRT) and CO_2e (in the case of bus for the sake of comparison) are depicted in Figure 3.

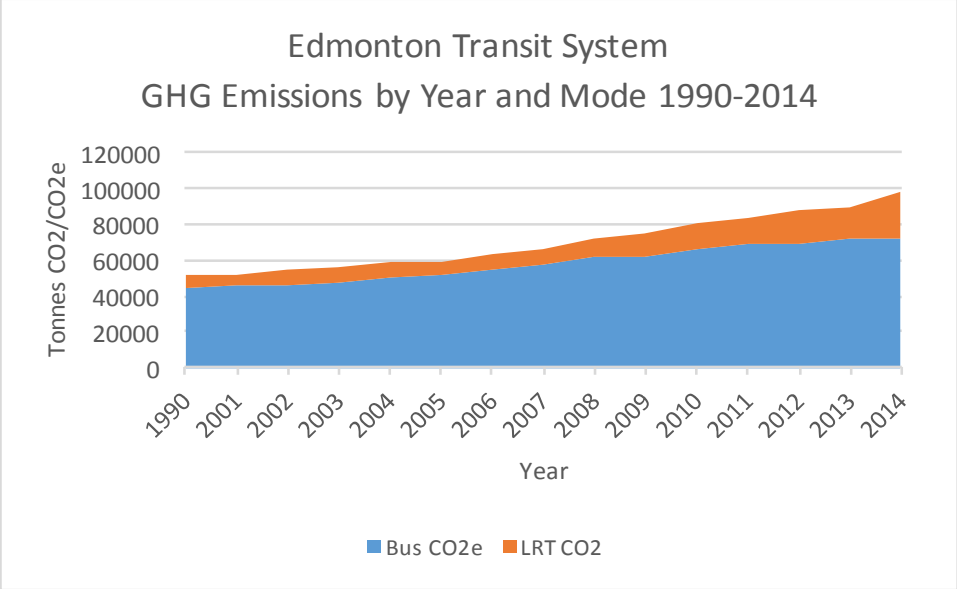

Figure 3 - Edmonton Transit System GHG Emissions by Year and Mode 1990-2014

3.3 MEASURING TRANSPORTATION'S OVERALL CONTRIBUTION TO EMISSIONS

Canada is a signatory to the *United Nations Framework Convention on Climate Change* (UNFCCC) and is duly obligated to prepare and submit an official, annual national GHG inventory, called the *National Inventory Report* (NIR)[2]. This seeks to cover anthropogenic emissions by sources as well as removals by sinks[3]. The NIR contains Canada's annual GHG emission estimates dating back to 1990 and is prepared in accordance with the UNFCCC Reporting guidelines on annual inventories[4].

In 2013, transportation was considered the second highest contributing sector to national greenhouse emissions with a total of 170 Mt or 23% of total emissions after oil and gas sectors (192 Mt CO_2e). Buildings, the third most intensive sector, is about half as intensive as the transportation sector (78 Mt CO_2e, or 12% of total emissions).

According to official statistics from Environment and Climate Change Canada (ECCC), transportation sector emissions have increased by 31% from 128 Mt in 1990 to 168 Mt in 2005 and continue to remain on an upward trajectory (cf. Figure 5).

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[2] According to Environment Canada, the NIR is prepared 'with input from numerous experts and scientists across Canada'

[3] ECCC defines a 'greenhouse gas sink is a process, activity or mechanism that removes a greenhouse gas from the atmosphere'

[4] FCCC/CP/2013/10/Add.3, see http://unfccc.int/documentation/documents/advanced_search/items/6911.php?priref=600007789

3.3.1 PROVINCIAL AND NATIONAL EMISSIONS BY SECTOR

According to data from Environment Canada, GHG emissions in Alberta have steadily risen from 174.6 MT CO_2e to 267.2 MT CO_2e (or over 58%) between 1990 and 2013 (cf. Figure 4). At a national level, emissions from the passenger car category appear to have dropped (cf. Figure 5), however closer examination shows emissions from the 'passenger light trucks' category have risen substantially during this period. The ECCC suggests that the strong period of economic growth and low oil prices between 1990 to 1999 was a major influence in shaping vehicle fleet composition (ECCC 2015). Anecdotal analysis of historical vehicle sales data in the Edmonton region suggests that the sharp increase in the proportion of sports utility vehicles (SUVs) as part of the overall vehicle fleet in this period is a likely contributor to increasing transportation emissions, along with the growth of light commercial vehicles. Further analysis would be required in order to draw definitive conclusions.

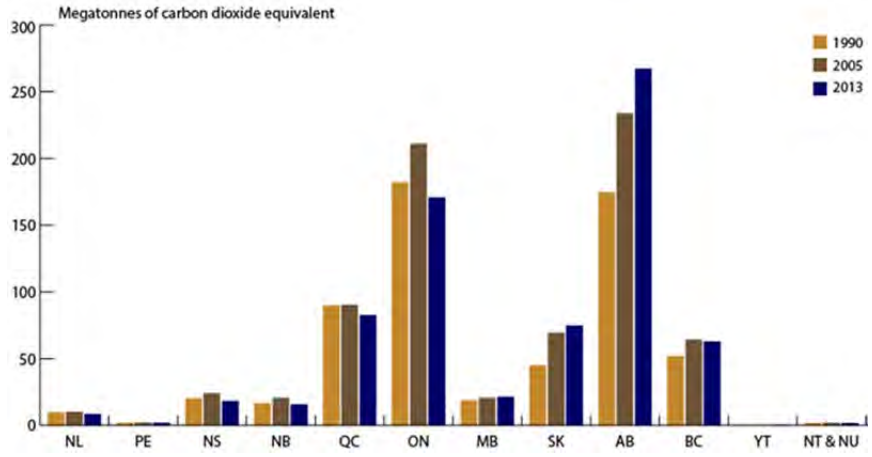

Figure 4 – Provincial GHG Emissions 1990, 2005 and 2013

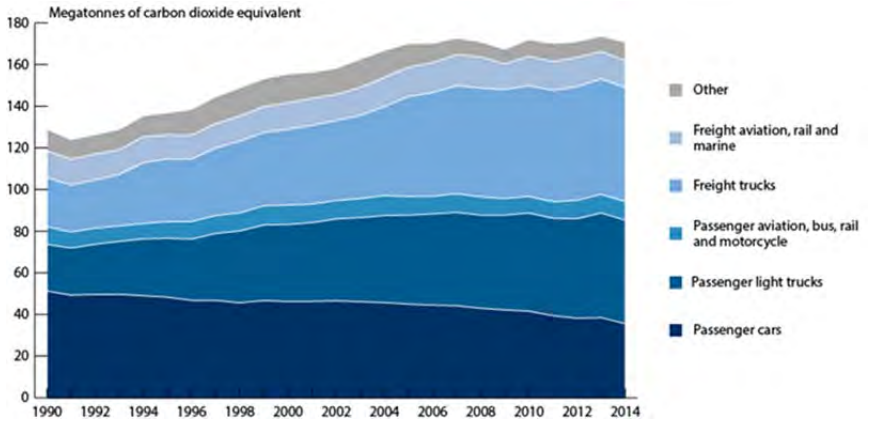

Figure 5 – Canadian Transportation Emissions 1990-2014

It is important to contrast the above trends with the contribution of the transit sector in this period to total transportation emissions.

To this end, Kenworthy/Rinn (2012) used historical data to demonstrate the rate at which transportation energy use (closely related to emissions based on current technologies) in both private and public transportation sectors has grown in the last 25 years (1991-2010/11) in Edmonton.

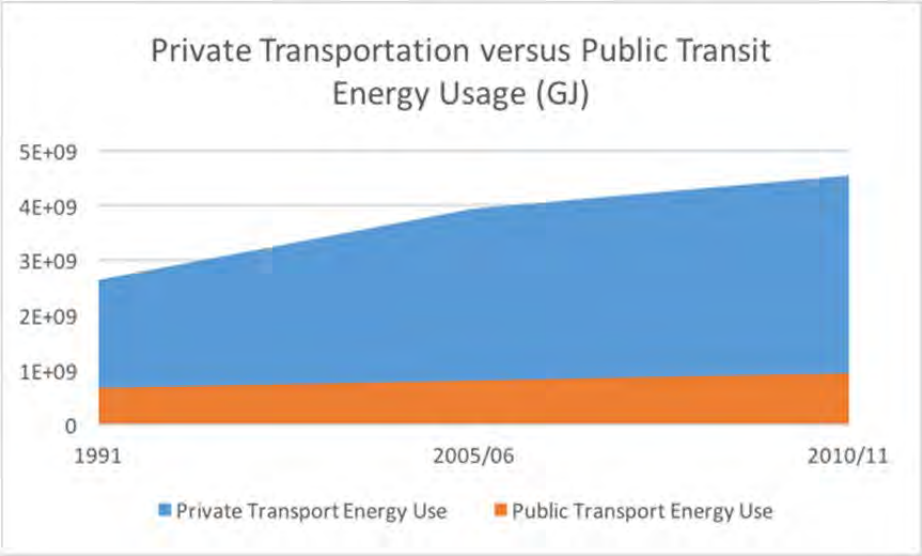

Figure 6 - City of Edmonton Private Transportation vs. Public Transit Energy Usage

Figure 6 demonstrates that private transportation energy use has grown substantially in absolute terms (by some 72% over the period 1990 to 2010/11). Whilst public transportation (transit) energy usage has also increased in absolute terms by approximately 28%, relative to private transportation, the proportion of energy consumption attributable to transit has decreased from 20% to 17.1%.

Kenworthy/Rinn (2012) suggest that private transportation in Edmonton is responsible for **4.85 times** as much energy use as public transportation. By contrast, a 2012 study prepared for the City by the Pembina Institute (Pembina Institute/HB Lanarc 2012) puts 2009 private transportation energy use in Edmonton at as much as **10 times** the amount of public transportation (cf. Figure 7)[5].

[5] A lack of publically available and consistent information makes it difficult to isolate the exact reason for this difference but it may be on account of GHG emissions accounting methodology (well to wheel versus well to tank). The difference may also be attributable to definitions of private transportation (whether commercial and industrial vehicles were included).

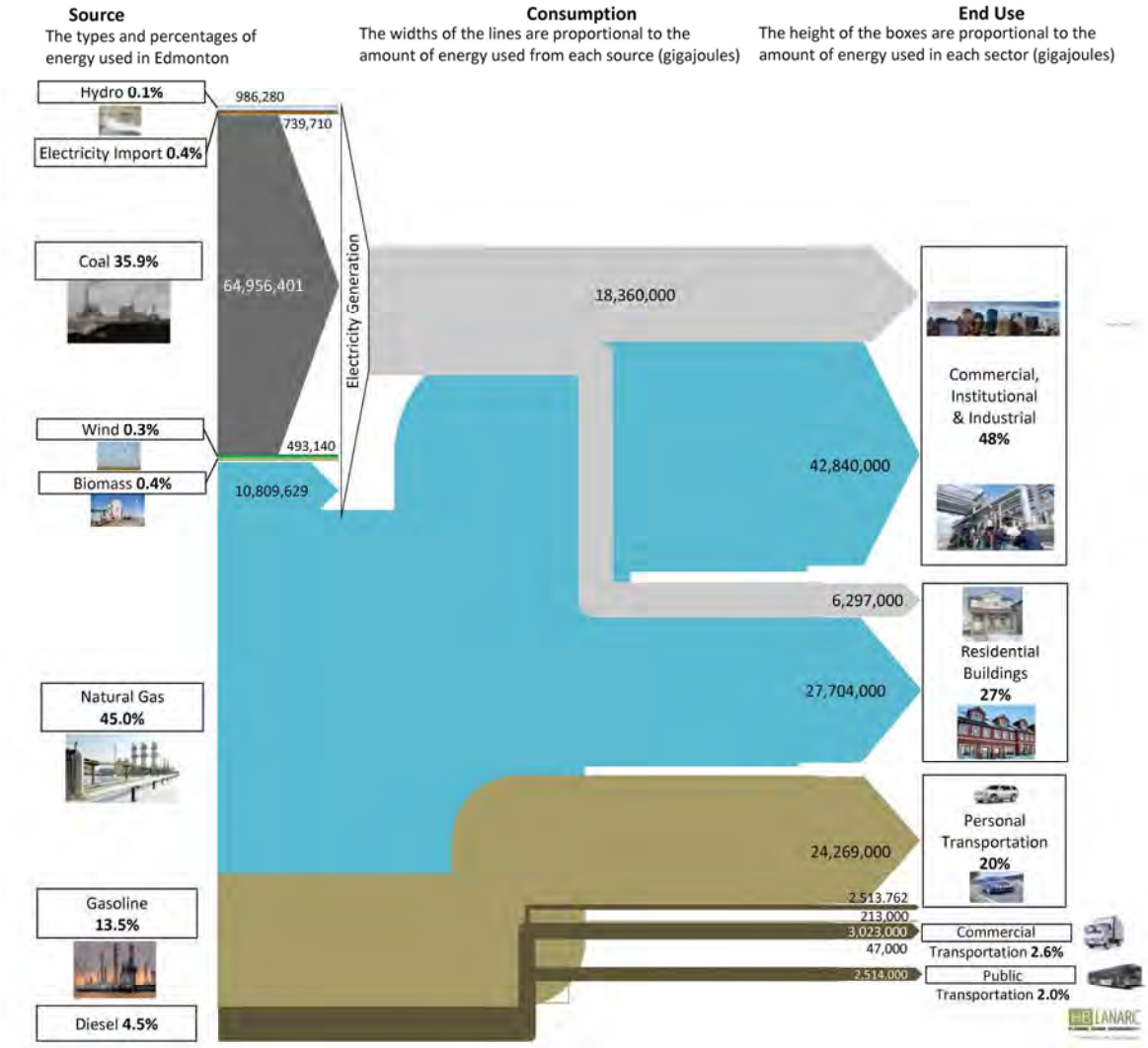

Figure 7 - Energy supply and use in Edmonton (2009)

The above circumstances underline the need to devise environmental sustainability policy that goes beyond a narrow scope of efficiency and ridership improvements in the transit sector towards a policy prescription that has a material impact on future transportation behaviour and clearly seeks to address emissions for the entire sector by maximising transit's relative contribution to reducing those emissions.

4 APPROACHES TO EVALUATION AND TRANSIT ENERGY EFFICIENCY

So far the GHG emissions and energy use data presented here has been confined to historical trends. A wide range of variables contribute to transportation performance outcomes over time. These include time of travel, travel costs, ridership, vehicle occupancy, population and levels of congestion.

4.1 DISTINGUISHING BETWEEN EX-ANTE AND EX-POST EVALUATION

International transportation bodies such as the Organisation for Economic Cooperation and Development (OECD) at the International Transport Forum (2015) draw a distinction between two types of evaluation in transportation analysis: **ex-ante** and **ex-post** evaluation. In the context of environmental sustainability in transit, this distinction is important, especially when considering different policy options to pursue.

A simplified way of distinguishing between the two types of evaluation is as follows:

- **ex-post** is "*based on actual results rather than forecasts*"
- **ex-ante** is the opposite: "*based on forecasts instead of actual results*".

For instance, by obtaining fuel sales data for a geographic area and common GHG accounting standards we are able to calculate **ex-post** evaluation of GHG emissions for a defined time period with relative accuracy. Estimating the impact of a new urban development using transportation modelling techniques, on the other hand, is one such **ex-ante** example where assumptions must be used to produce estimates of travel demand (expected number of vehicles per household) and behaviour (trips per day per person) in a certain area. From this, expected GHG emissions can be calculated and strategies can be devised to minimise expected emissions and other known impacts.

When considering the environmental impact of transit, it is always useful to keep these two distinctions in mind, especially for assessing the merits of local policy goals.

4.2 DISPLACING EMISSIONS

As noted in TCRP Report 176 (2015) and according to APTA's *Recommended Practice for Quantifying Greenhouse Gas Emissions from Transit* (2009), there are three categories of emissions displaced by transit:

1. Avoided car trips through mode shift from private automobiles to transit (known as the **ridership effect**).
2. Congestion relief benefits through improved operating efficiency of private automobiles, including reduced idling and stop-and-go traffic.
3. The land use multiplier, through transit enabling denser land use patterns that promote shorter trips, walking and cycling, and reduced car use and ownership (referred to as the **land use effect** in this research or the indirect effect of transit in some other studies).

4.2.1 THE RIDERSHIP EFFECT

The ridership effect of transit is defined as the interrelationship between ridership, Vehicle Kilometres Travelled (VKT), fuel use, and GHG emissions. It holds that substituting VKT in private vehicles through increases in transit ridership in turn reduces fuel consumption and GHG emissions. Transit also reduces on-road congestion.

By measuring average trip distance by motor vehicle and comparing this to the equivalent journey on transit, Barer, Pinkasovic and Richardson (2012) hypothesised that a 28% per cent saving of CO_2 per motorised trip may be possible, however this required a number of broad assumptions on the makeup of vehicle fleet, bus operational characteristics and also employed optimistic long term fuel efficiency targets. A number of these assumptions are arguably difficult to sustain based on current vehicle fleet and sales trends in Alberta. Conversely, it is also important to acknowledge that increasing per passenger private vehicle emissions does potentially increase the potential CO_2 savings attributable to the ridership effect.

A key consideration with the ridership effect is to consider modal split and whether to devise transportation policy that merely seeks to substitute private transportation motorised trips for public transit motorised trips or instead looks at transportation demand management approaches that encompass changing existing travel behaviour, such as trip chaining[6] (Primerano, Taylor et al. 2008) or reducing the overall amount of vehicle kilometres travelled (VKT).

4.2.2 THE LAND USE EFFECT

The TCRP describes the land use effect of transit as being 'complementary to, but completely separate from the ridership effect'. The following diagram helps to illustrate the nature of the relationship.

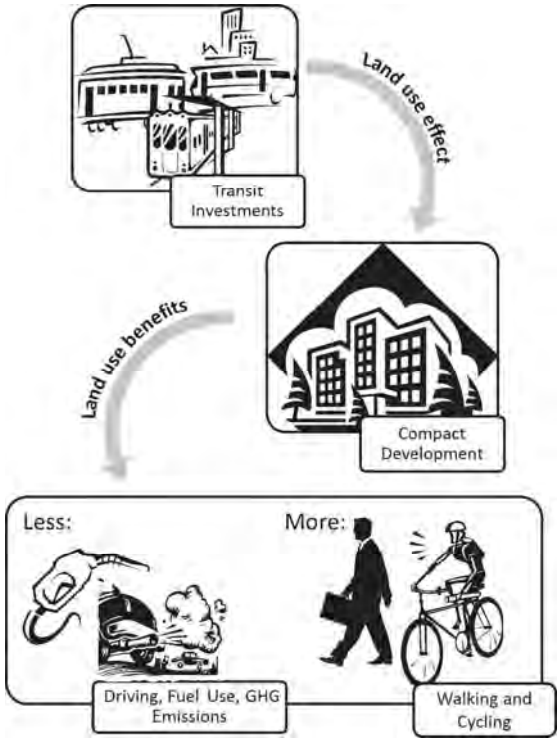

Figure 8 - Land Use Effect of Transit

[6] According to Primerano, Taylor et al: *'An appraisal of the alternative definitions presented above suggests that the two most commonly accepted definitions of trip chains are:*
1. a sequence of trip segments beginning at the 'home' activity and continuing until the traveller returns 'home'
2. a sequence of trip segments between a pair of anchor activities 'home' and 'work' or 'school'.
In these definitions the anchor activity is undertaken by the specific individual traveller whose trip chain is under investigation.

The TCRP conducted comprehensive ex-post evaluation (cf. Section 4) of existing transit systems by using linear structural equation modeling (SEM) based on data from a sample of over 300 urbanized areas in 2010. This was able to quantify the effect of ridership versus land use benefits to demonstrate the relative contribution of each to Vehicle Miles Travelled (VMT, the equivalent standard measurement for VKT in the USA) reductions. It demonstrates that the land use benefits in terms of VMT reductions range widely, but they can outweigh ridership benefits by a factor of between two and four.

Writing on *Evaluating Public Transit As An Energy Conservation and Emission Reduction* Strategy, Litman (2015b) argues that:

'*most analyses only consider direct impacts and ignore other, indirect ways that transit can reduce vehicle travel, fuel consumption and emissions, although they are potentially larger in magnitude*'. He concludes from this research that '*public transit improvements can provide significant energy savings and emission reductions by increasing operation efficiency, reducing traffic congestion, substituting for automobile travel, and leveraging additional vehicle travel reductions by stimulating more accessible community development*' (ibid)

The results of the TCRP's in depth study, including the comparison of relative land use versus ridership benefits per US city are shown in Table 1.

Urbanized Area	Land Use Benefit (%VMT Reduction)	Ridership Benefit (%VMT Reduction)	Total Benefit (% VMT Reduction)
New York–Newark, NY-NJ-	19%	16%	34%
San Francisco–Oakland, CA	18%	9%	27%
Ames, IA	21%	4%	25%
Portland, OR-WA	19%	4%	23%
Champaign, IL	16%	4%	20%
Washington, DC-VA-MD	12%	9%	20%
Los Angeles–Long Beach,	15%	4%	19%
Seattle, WA	14%	5%	19%
Chicago, IL-IN	12%	7%	19%
Salt Lake City, UT	15%	3%	18%
Philadelphia, PA-NJ-DE-MD	12%	5%	17%
Boston, MA-NH-RI	11%	6%	17%
Eugene, OR	13%	3%	16%
Sacramento, CA	13%	2%	15%
Houston, TX	10%	2%	12%
Austin, TX	9%	2%	11%
Atlanta, GA	8%	3%	11%
Kansas City, MO-KS	5%	1%	6%
Greenville, SC	3%	0%	3%

Table 1 – TCRP Report 1895 Summary Results of Transit land use benefits and ridership benefits for sample cities.

In summary, the most recent research in this area suggests that the Transit Strategy should look beyond the narrow scope of future ridership potential and complement any analysis with comprehensive ex-ante evaluation (cf. Section 4.1) of the potential for land use effects to reduce VKT, GHG emissions and increase the environmental sustainability of transit and the efficiency of transportation sector as a whole over time.

5 THE IMPORTANCE OF A POLICY FRAMEWORK TO ACHIEVE ENVIRONMENTAL SUSTAINABILITY AND IMPACTS OF CURRENT CLIMATE POLICY AND REGULATIONS ON TRANSIT

The previous section serves in part to emphasise the notion that the selection, and deployment of appropriate and technically robust, *environmental performance indicators* to ascertain and quantify the environmental impacts of transit and the wider transportation sector over time are important for policy purposes. These are typically measured on a rolling year by year basis.

Subject to appropriate public consultation and input, policymakers can conduct technical evaluation to formulate policy options for political decision makers (City Councillors) to meet City strategic as well as international commitments (i.e. Compact of Mayors). Employing environmental performance indicators allows for meaningful ongoing public discussion and debate on goals that will address how reduce existing impacts of transportation to more sustainable levels over time

The primacy of quantitative indicators will be demonstrated and emphasised as being the most-straightforward and the most effective way to understand the environmental impacts of transit over time.

5.1 SUSTAINABLE PLANNING PROCESS FRAMEWORK: PLANNING AND OBJECTIVES

As noted in section 2, Litman (2015a) nominates eight types of transportation planning objectives and a range of sustainability goals that support the sustainable planning process. The complementarity between sustainable transportation planning objectives and broader sustainability goals is demonstrated in Table 2.

		Transport Planning Objectives							
Sustainability Goals		Transport Diversity	System Integration	Affordability	Resource (energy and land) efficiency	Demand Management (efficient pricing & prioritization)	Land Use Accessibility (smart growth)	Cost Effective Operations	Comprehensive and Inclusive Planning
	Economic productivity	✓	✓		✓	✓	✓	✓	
	Economic development	✓	✓	✓	✓	✓	✓		✓
	Energy efficiency	✓	✓		✓	✓	✓		
	Affordability	✓	✓	✓	✓	✓	✓		
	Operational efficiency					✓		✓	✓
	Equity/Fairness	✓	✓	✓		✓	✓		
	Safety security and health	✓	✓	✓	✓	✓	✓		✓
	Community development	✓	✓	✓	✓	✓	✓		✓
	Heritage protection	✓			✓	✓	✓		✓
	Climate stability	✓	✓	✓	✓	✓	✓		
	Air pollution prevention	✓	✓	✓	✓	✓	✓		
	Noise prevention	✓			✓				
	Water pollution	✓	✓	✓	✓	✓	✓		✓
	Openspace preservation	✓	✓	✓		✓	✓		✓
	Good planning								✓
	Efficient Pricing				✓	✓		✓	

Table 2 – Transport Planning Objectives and Sustainability Goals

For example, adaptation of a sustainability policy goal that targets energy efficiency has the ability to reinforce transport diversity, system integration, resource efficiency, demand management and land use accessibility transportation planning objectives at the same time.

It is also noteworthy that the **land, water** and **air** challenges noted in TWWG are described as being '***major sustainability*** *and* ***resilience*** *components of a healthy ecosystem*'.

5.2 THE ROLE OF PERFORMANCE INDICATORS

"What gets measured gets done" is a famous quote most often attributed to the Austrian-born American management consultant, Peter Drucker (1909-2005). Performance indicators are a useful and common tool that can help to optimise performance of a 'closed system' where inputs (such as fuel, labour, other resources) can be tracked against outputs (service km of buses, LRT passengers carried by period of time). In the context of modern management theory, performance indicators can be used for a variety of purposes. In transportation management, they are commonly used to track **environmental, social** and **economic effects** of transportation.

Environmental effects include a range of effects on ecosystems and climate, whilst economic effects can encompass both positive (public goods, such as roads) as well as negative externalities, such as traffic congestion. Where performance indicators are used effectively, they can help to quantify, manage, and reduce known impacts over time.

In the context of environmental sustainability goals, Litman (2015a) nominates a number of common performance indicators (cf. Table 3). These are not only applicable to transit, but also to other elements of the transportation system, including competing modes. The table features a number of ***comprehensive indicators*** that combine two or more variables[7]. This allows for more meaningful and precise insights at a local level, provided a robust methodology is in place to capture and compare both the existence of any effects and their magnitude. Cross sector comparisons are also possible.

Sustainability goal	Objective	Potential Performance Indicators
Climate stability	Reduce global warming emissions Mitigate climate change impacts	→ Per capita emissions of greenhouse gases (CO_2, CFCs, CH_4, etc.).
Prevent air pollution	Reduce air pollution emissions Reduce exposure to harmful pollutants.	→ Per capita emissions (PM_{10}, VOCs, NO_x, CO, etc.). → Air quality standards and management plans.
Prevent noise pollution	Minimize traffic noise exposure	→ Traffic noise levels
Protect water quality and minimize hydrological damages.	Minimize water pollution. Minimize impervious surface area.	→ Management of used oil, leaks and stormwater. → Per capita impervious surface area.
Open space and biodiversity protection	Minimize transport facility land use. Encourage more compact development. Preserve high quality habitat.	→ Per capita land devoted to transport facilities. → Support for smart growth development. → Policies to protect high value farmlands and habitat.

Table 3 - Sustainability goals, Objectives and Performance Indicators in Transportation (Litman 2015)

[7] For example, emissions per capita (litres/per person/year), fuel use per passenger kilometre (litres/per person/per vehicle kilometre travelled)

Sustainability goals of particular relevance to transit from the Table 3 include preventing noise and air pollution as well as open space and biodiversity protection.

A comprehensive indicator often provides a better opportunity for the tracking of one or more variables so that it can be monitored over time: be it changing population (per capita), spatial (per land area) or temporal (per unit of time) criteria.

5.3 PROVINCIAL CLIMATE POLICY AND FEDERAL REGULATIONS

The contemporary sustainability agenda has tended to be dominated in recent years by the global imperative of addressing rising GHG emissions levels, both to mitigate the anticipated effects of climate change as well as ensure adaption. The recently legislated *Alberta Climate Leadership Plan* (cf. Government of Alberta 2015) is no exception to this.

In response to the imperative to take action to address emissions, transit operators and City policy makers in Canada and elsewhere have sought to adopt their own local policy commitments to address GHG emissions trends and other environmental impacts outlined in the introduction, often joining forces with other cities to bring about change (cf. Case Study).

In 2007, Edmonton City Council supported Alberta Urban Municipalities Association's (AUMA) 'Resolution for Support for Municipal Climate Change Initiatives' which states: *"A global reduction in emissions of greenhouse gases (GHG) is necessary to slow climate change and reduce the risks to human health, the physical environment, economy and quality of life."* Most recently, in December 2015, Edmonton joined the 450-strong, UN-backed Compact of Mayors, "*the world's largest coalition of city leaders addressing climate change by pledging to* ***reduce*** *their greenhouse gas emissions,* ***tracking their progress*** *and preparing for the impacts of climate change*" (compactofmayors.org, author emphasis)

5.4 IMPACT OF CLIMATE LEADERSHIP PLAN

In November 2015, the Government of Alberta (GOA) released the *Climate Leadership Plan*. This contains a number of policy initiatives designed to stabilize provincial emissions by 2030 (GOA 2015). The plan includes an economy wide carbon pricing signal, commencing at $30/tonne CO_2 from 2018. This is expected to cover up to 90% of the province's CO_2 emissions. For its part, the province estimates the carbon tax will generate $3 billion per year in provincial revenues.

City administration advised City Council in March 2016 that the estimated impact on City operations is likely to be $4 million per annum at the $20/tonne rate, rising to $6 million per annum at the $30/tonne rate (cf. CR_3207 Corporate Environmental Targets - Impacts of New Provincial Climate Policy).

Based on 2010 energy consumption figures supplied by ETS, MMM|WSP estimates as much as $1.68 million or (42%) of the City's annual carbon tax liability will be attributable to CO_2 emissions originating from current transit operations[8]. This estimate is based on annual diesel consumption of ETS bus operations. It is important to note that this **additional outlay** will represent a permanent and increasing operational cost over time. Any service delivery efficiencies gained through a reduction in diesel consumption would therefore present a tangible and ongoing saving to the City in terms of ongoing operating costs.

[8] Based on a consumption of 25,032,042 L/annum of fuel and a 6.7c/L estimated carbon tax increase on diesel at the $20/t starting price

5.5 ENVIRONMENTAL REGULATORY COMPLIANCE

Another common element for most modern transit operators is an accredited Environmental Management System (EMS). In its most basic form, an EMS serves as a management tool to mitigate known risks to organisations. ETS' EMS, *Enviso*, is designed to monitor regulatory compliance with existing provincial regulation and law. Enviso is designed to monitor compliance with the following legislation and regulations:

1. *Canadian Environmental Protection Act*
2. Ozone-depleting Substances Regulations
3. *Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems*
4. *Fisheries Act*
5. *Hazardous Products Act & Controlled Products Regulation*
6. *Transportation of Dangerous Goods Act & Transportation of Dangerous Goods Regulations*
7. *Dangerous Goods Transportation and Handling Act & Dangerous Goods Transportation and Handling Regulation*
8. *Occupational Health and Safety Act & Occupational Health and Safety Regulations*
9. *Fire Code Regulation & Alberta Fire Code 2006*

At present, Enviso includes a number of standard operating procedures and policies with respect to:

- → Reporting abnormal exhaust 'Air Emissions Operating Procedure'
- → Limited idling
- → Preventative maintenance
- → Chemical spill prevention
- → Random emissions testing
- → 'Increase Ridership Operating Procedure'
- → Worksite Inspection Forms

5.6 CURRENT RELEVANT CITY POLICIES IN EDMONTON

The following is a list of relevant City policies and procedures that influence environmental sustainability in transit outcomes in Edmonton.

Policy/Strategy	Type	Timeframe	How it affects sustainability in transit
The Way Ahead	City Strategy	2009-2019	'Long term City Vision'
The Way We Green	City Strategy	2009-2019	'Environmental Strategic Plan with 12 goals' City Operations and Community GHG targets. Transit operations included as part of Community GHG emissions.
C451G Fare Policy	City Policy	Ongoing	Sets guiding principles for setting fares for transit
C507 Arterial Roads for Development	City Policy	Standing	'Requires developers to construct or pay for the capital cost of arterial roads within a catchment' The requirement to contribute to public transportation does not currently exist.

Policy/Strategy	Type	Timeframe	How it affects sustainability in transit
C585 Community Energy Transition Strategy	City Policy	Ongoing	Policy Statement includes the objective of 'Increased electrification of Edmonton's transportation system with passenger vehicles, buses, light trucks and light rail powered by clean electricity'. Measurable outcomes include: 'Reduced community greenhouse emissions and reduced energy use per person'
C573A Complete Streets	City Policy	Ongoing	Commits the City to Complete Streets principles including 'contributing to the environmental sustainability and resiliency of the City', 'travel options for all users' and 'consider direct and indirect costs'
C572 Designing New Neighbourhoods	City Policy	Ongoing	Commits the City to 'new neighbourhood design' and associated outcomes
C505 Edmonton's Environmental Management System	City Policy	Ongoing	Commits the City to an EMS, adopts principles of quality assurance, shared responsibility, regional co-operation, continual improvement, integrated approach, participatory decision making, sustainability, proactive planning
C512 Environmental Policy	City Policy	Ongoing	Commits the City to environmental stewardship, adopts principles of quality of life, shared responsibility, decision making model, protection of the natural environment, intergenerational equality, public awareness and understanding, citizen consultation and participatory decision making
Energy Transition Strategy	Implementation Plan	2014-2021	Requires certain changes to city operations procurement practices (not including transit vehicle procurement) and an 'evaluation of Edmonton Transit GHG emissions associated with the various technologies, equipment, vehicles and infrastructure used in the transit system' (2015-16).
City Operations Greenhouse Gas Management Plan, supporting TWWG	'Management Plan'	2012-2020	• Factor a social cost of carbon into City investment/procurement decisions • Create 3 principles to guide city operations • GHG Reduction Targets for City Operations (excluding transit) • Notes Emissions from Edmonton Transit's fleet will be reported as part of the Community GHG Inventory. *"A separate strategy addressing Transit's GHG targets and related initiatives is currently under development within the Transportation Department."*
Enviso	Environmental Management System	Ongoing with yearly reporting	• Creates a standardised reporting framework, creates Standard Operating Procedures seeks to help monitor regulatory compliance

Table 4 – Relevant City Policies and Strategies

5.7 SUMMARY OF ISSUES ASSOCIATED WITH EXISTING POLICY

The following is a list of issues of relevant environmental sustainability in transit issues for consideration as part of the Transit Strategy.

5.7.1 CURRENT POLICY LANDSCAPE

At present the inventory of policies that have an impact on the current and future sustainability in transit is already large. For the sake of policy coherence and to try and take proper account of whole of transportation network impacts (public and private) when making decisions on future allocation of transportation resources, the Transit Strategy may wish to consider the following issues when considering how to improve environmental sustainability outcomes,:

1. Likely fiscal impacts on the City's existing capital and operational budget
2. Likely economic impacts of policy changes at the household and neighbourhood level, including economic welfare effects, what form of financial compensation might be possible within the constraints of existing legislation and cost benefit analysis of any changes
3. The likely impacts on City finances of any possible changes to provincial and federal policy
4. The need to reconcile any additional capital and operational expenditure proposed to improve environmental sustainability outcomes with existing fare policy (C451G)
5. The need to readily identify and create community awareness around transit's contribution to Edmonton's overall GHG emissions (it currently forms part of community emissions and is not readily identifiable; see section 5.8.2 below)
6. Ensuring publicly available information concerning Edmonton's EMS is consistent with the Edmonton's Environmental Management System Policy (C505) and Environmental Policy (C512)
7. Policy delineation between emissions testing as a regulatory compliance matter and longer term strategic environmental sustainability performance indicators and targets in transit

5.7.2 DATA AVAILABILITY

Publicly available information on GHG emissions attributable to transit in Edmonton is currently limited, both in terms of the City's online records and reporting requirements of private industry (eg: vehicle fuel sales by area). The Citizen Dashboard and Open Data Blog as part of the Open City initiative are two examples of useful and rich sources of data. However, open source transit data, particularly in terms of resources consumed per time period, is currently limited. This complicates the assessment of impacts consideration of options and setting of objectives as part of a sustainable planning process as explained in section 4. The City's recent commitment to the Compact of Mayors provides an opportunity to increase the amount of publicly available information as well as make improvements to GHG accounting frameworks and adopt an internationally accepted standard, as can be found in British Columbia (cf. Case Study).

5.7.3 REPORTING OF EMISSIONS DATA AND TRACKING PROGRESS

At present, as part of TWWG policy commitments, the City publishes two main categories of GHG emissions: '*Community Greenhouse Emissions*' and '*City Operations Emissions'*. Transit emissions are included as part of Community Greenhouse Emissions and not City Operations. At the time TWWG was released, City Operations emissions were noted as having been calculated in accordance with the International Council for Local Environmental Initiatives (*ICLEI) Local Government for Sustainability protocol*. It is less obvious, however, how the transit portion of community emissions are calculated in public documentation.

In 2014 the ICLEI protocol was superseded by the Global Protocol for Community Scale Greenhouse Gas Emissions Inventories, known as 'GPC'. The Protocol contains the requirement that: '*Cities shall transparently document the methods used in the inventory reports*' but also acknowledges that 'since estimating GHG emissions is inherently technical (involving engineering and science), high quality, transparent documentation is particularly important to credibility. Cities should seek to ensure the quality of these components at every level of their inventory design.'

5.7.3.1 CITY EMISSIONS DATA EXAMPLE

According to the latest iteration of TWWG targets for the year 2014 Community Greenhouse Emissions include the:
'total amount of greenhouse gas emissions derived from the emissions from landfills and the use of fossil fuels (natural gas, grid electricity, and vehicle fuels) within the City of Edmonton boundary'. (City of Edmonton Community Dashboard 2014)

This data is reported as including transit emissions. Besides a strong upward trend since 2011, the fluctuations within the historical data (cf. Figure 9) makes drawing conclusions and the setting of objectives difficult at the whole of a community level. This underpins the need for more consistent, fine grain analysis of emissions by sector and potentially stronger GHG accounting standards.

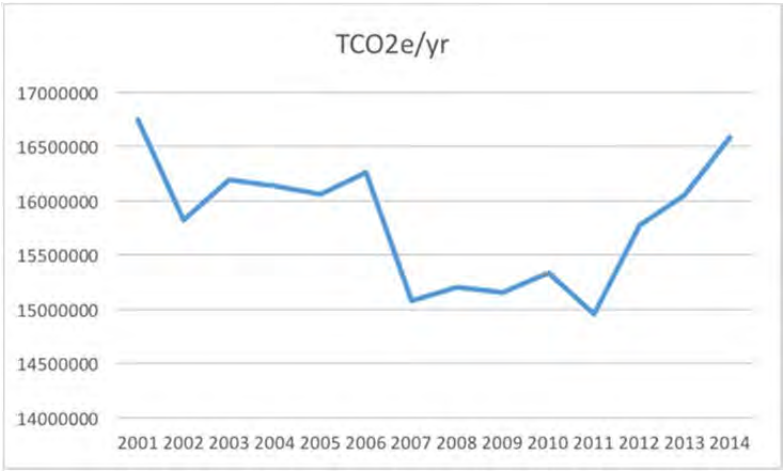

Figure 9 - The Way We Green TCO_2e trend by year 2001-2014

5.8 CASE STUDY: VANCOUVER, BC

Commencing in the early 1990s, efforts begun at city, regional and provincial levels to work on long term policy and legislation to stabilize and reduce CO_2 emissions. Relevant provincial legislation includes the *Greenhouse Gas Reduction Targets Act* and *Carbon Neutral Government Regulation.* Commencing this year, industrial operations emitting over 10,000 tCO_2e must report their GHG pollution on a yearly basis to the Province in accordance with provincial standards. Those operations emitting over 25,000 tCO_2e are required to have their emission reports independently verified.

A related regulation, the Greenhouse Gas Emission Control Regulation, establishes the BC Carbon Registry which is responsible for the issuance, transfer and retirement of compliance units (emission offset units, funded units and earned credits) on an electronic platform. Since 2005 per capita emissions have declined by 15% in British Columbia, despite a 9% increase in population during this period. The picture in the transportation sector is slightly less clear: emissions from surface passenger transportation have dropped while heavy duty diesel emissions have grown.

5.8.1 ROLE OF PUBLIC TRANSPORT PROVIDER: TRANSLINK

In December 2010, Translink, the statutory authority responsible for the regional transportation network in Metro Vancouver, released a Sustainability Report called *'Setting a baseline*' (Translink 2010). The report included the following key elements:

- A 'baseline against which future performance [much of it quantitative] will be measured against both its 30 year transit strategy 'Transport 2040' and Sustainability Policy as a framework'
- Adoption of the International Association of Public Transit's (UITP) Sustainable Development Charter principles including 70 potential reporting indicators which Vancouver piloted. They recommend reporting on three indicators from each list of social, environmental, economic and governance indicators, for a total of 12 indicators.[9]
- 'Assessment of key sustainability risks to the organization's ability to deliver on its mandate'
- A 'materiality process' to determine priority topics, issues, and impacts for reporting'
- Transit specific goals to meet its 30 year sustainability strategy, Transport 2040
- Reporting in accordance with the Global Reporting Initiative (GRI) Sustainability Reporting Framework G3 Guidelines[10]
- Consultation and input from a Stakeholder Roundtable

Two years later, Translink released '*Tracking Progress*', which sought to update the benchmark figures and highlight developing trends.

5.8.2 TRANSLINK CORPORATE POLICIES

In the context of a sustainable planning system, the Translink organisational goals are supported by a number of corporate policies including:

- Environmental Policy, (2003)
- Emissions Policy, (2006)
- Sustainability Policy, (2009)
- Sustainable Decision-Making Tool, (2011)
- Access Transit Strategy, (2003)
- Customer Service Charter, (2009)
- Infrastructure Policy and Transit Passenger Facility Design Guidelines, (2011)
- Sustainable Purchasing Policy, (2011)
- Performance-Based Investment Strategy, (2011)

The policies themselves do not seek to outline targets per se, but rather concentrate on 'objectives' as per the aforementioned sustainability planning process.

[9] These have recently been updated in light of the new Sustainable Development Goals that were adopted at last year's In 2015 COP21, also known as the 2015 Paris Climate Conference.

[10] According to Translink: *"The GRI is a voluntary international standard for reporting that many companies follow to disclose their performance and impacts in a consistent, accountable and transparent fashion. Custom performance measures are included in this report to address issues that relate to the unique dimensions of TransLink and the public transportation industry and are important to our stakeholders."*

5.8.3 ROLE OF MUNICIPAL GOVERNMENT IN BRITISH COLUMBIA

Municipal governments in BC are responsible for planning and implementing localised GHG and energy management strategies. These operate at a geographic level, including by neighbourhood in some cases. One of the key tools used are Community Energy and Emissions Inventory (CEEI) Reports, produced every two years by the provincial government. According to LiveSmart BC:

"CEEI reports fulfill local governments' Climate Action Charter commitment to measure and report their community's GHG emissions profile, establish a base year inventory for local governments to consider as they develop targets, policies, and actions related to BC's Local Government Act requirements, fulfill Milestone One requirements for those local government members of the Federation of Canadian Municipalities' (FCM's) Partners in Climate Protection (PCP) program, as well as supporting local government efforts to monitor progress towards Regional Growth Strategy objectives." (Province of British Columbia 2014)

Importantly for environmental sustainability in transit purposes, CEEI reports include:

1. On-road transportation emissions with comparisons of individual municipalities against the provincial average[11]
2. On road emissions by vehicle class (including transit) with historical comparisons
3. Journey to work data by mode and year

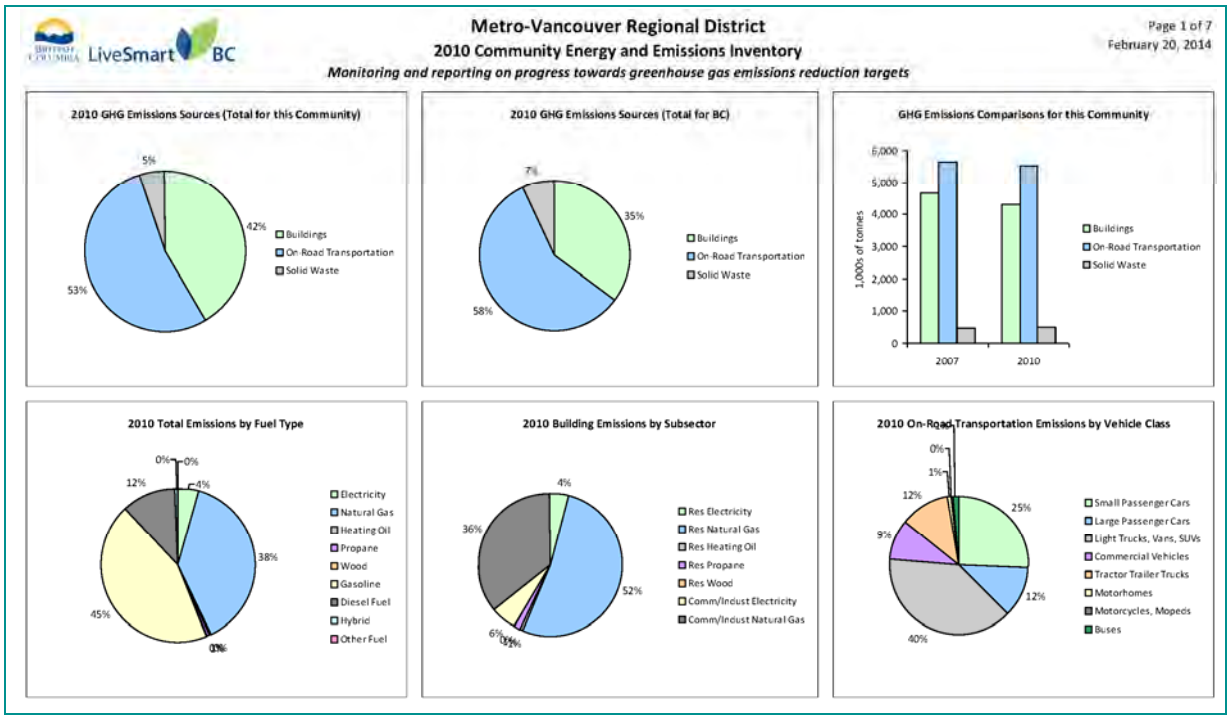

Figure 10 - Metro-Vancouver Regional District 2010 Community Energy and Emissions Inventory

[11] BC Municipalities are on average much smaller in geographic area than city municipalities of Alberta. The Metro-Vancouver region has been used to demonstrate GHG emissions at an urban agglomeration level comparable with Edmonton

BC Climate Action notes the following on their website:

"Vancouver's community GHG emissions have been reduced to 1990 levels. They are on track to reach target of a further 6 per cent reduction by 2012 or sooner. Vancouver has the lowest per capita GHG emissions of any major city in North America. This has been achieved at the same time that Vancouver has undergone significant growth: 27 per cent increase in population and 18 per cent increase in jobs."

The important role of integrated transportation land use planning and leverage effects through Transit Oriented Development in the case of Vancouver is well documented (Stone 2008, Newman & Kenworthy 2015, Cervero & Suzuki 2013).

5.8.4 LESSONS FROM BEST PRACTICE

From the case study highlighted above, it can be seen that environmental sustainability in transit relies heavily on an institutional and political framework that supports the adoption of sustainability policy process with comprehensive performance indicators that can benchmark progress and target action at a local neighbourhood level. Ideally these are reinforced by more than one level of government (municipal, regional and provincial) and backed up by provincial or federal regulation and legislation.

Whilst not examined in detail, it would appear from the examples shown that legislation is not necessarily a prerequisite for city-level emissions reduction strategies per se; however it does assist cities with creating a more level playing field and helping to regulate emissions-intensive industries. It could be argued for example that most day to day personal transportation choices and behaviour are driven more by immediate travel choices and relative costs of travel. This gives the City some scope to improve environmental sustainability in transit and transportation through existing powers in the *Municipal Government Act* that allow cities some scope to charge user-fees. In light of the Province's new carbon tax commencing in 2018, it could be argued that many existing fees should be changed to take account of that tax's effect on City costs and then passed on to consumers to help drive behavioural change.

6 SUGGESTED STRATEGIES MOVING FORWARD

This concluding section advances a number of ideas to assist with framing the discussion for future environmental sustainability in transit considerations in Edmonton as part of the Transit Strategy.

1. **Determine the policy relevance of environmental sustainability in transit in a manner that is consistent and compatible with existing policy frameworks**

   At present, there is no clear overarching City strategic direction for environmental sustainability as it pertains to transit in Edmonton. Instead City Operations are currently charged with achieving an ambitious 42% reduction in GHG CO_2e to 178,700 tonnes by 2020, however this does not encompass transit, a major source of emissions that the City has direct responsibility for.

   Instead, as noted earlier, transit is accounted for as part of community emissions and 'Outcome 9: Edmonton is an environmentally sustainable and resilient city'. The corresponding target for the corresponding measure (Measure 91) is a 'downward trend'. The absence of a quantifiable target for either private or public transportation emissions diminishes the scope of the City to make strategic decisions on the basis of existing City policy. Such a quantifiable target could help the City work towards achieving a greater level of environmental sustainability in both transit and the wider transportation sector.

   Instead, the current transit target is that 'Edmontonians use public transit and active modes of transportation with a goal of increasing per capita transit ridership from 101.2 trips per capita in 2012 to 105 by 2018'. In addition to this, a Journey to Work target that encompasses public transportation, car passenger and active modes target of 25.9% has been adopted (from 23.7% of all journeys in 2012) (all quotes sourced from The Way Ahead 2014). The Transit Strategy may wish to consider whether environmental sustainability and GHG emissions considerations in transit are adequately captured by this target or whether the transit component of this target needs to be better defined as part of the Transit Strategy.

   As noted in Section 4, a sustainability planning process is one that assesses objectives, impacts and options in a considered planning process. This helps insure that individual, short-term decisions are consistent with strategic, long-term goals.

2. **Devise appropriate and achievable transit environmental sustainability performance indicators**

   Section 3 advanced the notion that environmental sustainability of transit is linked to energy efficiency of the transportation system as a whole both through increasing ridership as well as leveraging land use effects.

   Section 4 noted that transportation performance indicators can measure environmental, social and economic effects. A framework that encompasses sustainable transportation goals is one that goes beyond solely focussing on transit and examines performance at a whole of transportation sector level but section 5 also noted that concentrating on impacts at a local level can help to better understand behaviour and outcomes in the community.

It is therefore recommended that any future performance targets dealing with environmental sustainability of transit should encompass:

- → A clear and transparent decision making process on 'what's in/what's out'
- → Clearly identify transit's contribution to desired transportation performance outcomes
- → Seek to target transportation performance as a whole at a neighbourhood level, broken down by mode and per capita
- → Consider how any city targets might tie in with provincial targets, but also be prepared to consider and set own targets for transportation if none are forthcoming from other levels of government
- → Choosing a consistent accounting standard that is consistent with the Compact of Mayors commitment and includes provision of data that is consistent with the City's Open Data Initiative

3. Choose appropriate Comprehensive Performance Indicators

Using the example of the road transport sector, Wadud and Greszler (2010) note that there are three basic ways to reduce GHG emissions within **an individual transportation sector.**

Wadud and Greszler GHG emissions reduction approach	Potential Performance Indicator for Transit
1. Increase energy efficiency through technological innovation and improved operational efficiency of vehicles, transport logistics, and transportation infrastructure	→ MJ per Vehicle Kilometre travelled → Reduce levels of SO_2, NO_x, CH_4, VHC and PM_{10}
2. Decrease GHG intensity of the fuel, and	→ CO_2 per Vehicle Kilometre travelled
3. Reduce transportation activity.	→ Transportation Demand Management (Road Pricing, changing travel habits) → Walking and Cycling trips per capita

Table 5 – Wadud and Greszler transportation sector GHG approach

Table 5 represents examples of effects that could be captured at an operational level for transit and dealt with as part of existing Environmental Management Systems (EMS). Importantly, they do not measure transit's contribution to the overall transportation task and are specific to an individual transportation mode. To a large extent, Enviso is already responsible for monitoring transit vehicle performance in Edmonton through the existing emissions testing regime. The existing EMS could readily be adopted to accommodate long term fuel efficiency performance targets if desired.

In contrast to the individual sector targets in Table 6, Section 5 examined the use of comprehensive indicators to capture transportation effects of multiple sectors at a local level. This concentrates on the performance of each mode and its current and future contribution to the transportation task. The LiveSmart case study example from Vancouver included 'On Road Emissions by Vehicle Class' (cf. Figure 10) with a specific geographic focus. LiveSmart does not include a mode specific transportation target per se, however it does have the benefit of allowing for the identification of public versus private transportation emissions at the community level.

For example, the City of Vancouver has adopted ambitious modal split targets for downtown Vancouver. Using this data, it is also possible to work closely with communities to develop local neighbourhood per capita targets and also help them to better understand the relationship between land use and transit and the substantial land use benefits, as outlined here, that can accompany transit oriented development (TOD).

The Transit Strategy may wish to give consideration to devising community targets that identify emissions and other relevant sustainability targets (air quality standards, noise pollution) on both a per capita and on a community basis. These would be arguably more tangible and achievable than a whole of city ridership target, as is currently found in *The Ways*. Table 3 provides a number of examples of a number of comprehensive performance indicators that could be considered as part of the Transit Strategy and future environmental sustainability policy considerations.

This approach would empower local organisations such as community leagues to have visibility of their community's transportation performance and provide them with useful information to take action at a local level, as demonstrated in the City of Vancouver example. With proper oversight, the City for its part could introduce local incentives for communities to change their transportation habits over time. These could partner with existing community-based urban mobility programs such as car sharing and transferable periodical tickets for transit. Travel behaviour '*Travelsmart'* programs, as found in the USA and Australia are examples programs that could be adopted to help drive behavioural change.

7 CONCLUSION

This paper has sought to address a number of the relevant policy issues and challenges associated with increasing the environmental sustainability of transit services and operations in Edmonton both at present and into the future. It has argued that transit has a major role to play in improving both the environmental sustainability of Edmonton but that the environmental performance of the transit sector itself is relatively minor when compared to the wider transportation sector. It has examined a wide range of local data sources and examples from other cities to make recommendations on issues that may warrant consideration as part of the Transit Strategy.

It has been argued that the environmental sustainability of Edmonton is inextricably linked to the performance of the transportation performance of the city as a whole. Transit benefits can be expressed in traditional ridership benefits, which have are known to reduce the amount of kilometres driven by private motor vehicles, however it was suggested that there is emerging and strong evidence to suggest that increased transit provision may in fact help to leverage land use impacts that could eclipse ridership benefits by a factor of as much as 4:1. This has the potential to not only increase transit ridership but also reduce vehicle ownership and motorised travel, which will contribute substantially to environmental sustainability goals and reduce the economic and social effects of transportation as well.

Finally, concerning the issue of performance indicators and their application in transit, it is important to recognise again that transit performance is closely linked to whole of transportation system outcomes and that no one performance indicator will give an accurate or holistic reflection of performance outcomes. It was suggested that current performance indicators in The Ways do not necessarily provide ETS and the City with a clear path and interim goals for improving whole of system performance over time.

With good compliance monitoring, the existing Environmental Management System, *Enviso*, should be sufficient in ensuring compliance with existing legislative and regulatory requirements. However it has been shown that there is serious merit in the Transit Strategy considering comprehensive performance indicators that help to define the relative contribution of transit to improving environmental sustainability of both transportation and land use and their relative benefits over time.

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