THE BIG MOVE

Climate Change and Energy Conservation

December 2008

1. Introduction

This is one in a series of backgrounders that have been produced by Metrolinx to provide further explanation and clarification on the policies and directions of the Regional Transportation Plan (RTP). The RTP is available for downloading at www.metrolinx.com.

This backgrounder elaborates on the performance results discussed in the Regional Transportation Plan (RTP) and shows how infrastructure projects, programs and policies proposed in the RTP can help achieve the provincial greenhouse gas emission reduction targets. This backgrounder also outlines how these opportunities for reductions can be combined with other measures to achieve greater reductions, such as improved fuel efficiency and new fuels with lower carbon content.

Metrolinx wishes to acknowledge the invaluable contribution of IBI Group to the preparation of this backgrounder.

2. Context

The transportation sector is the largest consumer of fossil fuel energy and among the largest contributors of greenhouse gases (GHGs), producing 33 per cent of Ontario's total emissions. With high volatility in fuel prices, our strong dependence on foreign oil, and the daunting challenge of climate change, there are many reasons to reduce transportation energy use and emissions.

In particular, there is a pressing need to address the challenge of climate change. The Intergovernmental Panel on Climate Change (IPCC) has stated that "most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG" and that "many natural systems are being affected by regional climate changes."[1]. The IPCC has recommended that emissions be reduced to stabilize the concentration of GHGs in the atmosphere.

The RTP outlines a series of bold steps to improve the Greater Toronto and Hamilton Area (GTHA) transportation system's contribution to our quality of life, our competitiveness and the quality of our environment. This backgrounder builds on the results regarding GHG emissions and energy use presented in the RTP and illustrates how GHG emission targets for transportation could be achieved.

[1] United Nations Intergovernmental Panel on Climate Change (2007) Climate Change 2007: Synthesis Report, Summary for Policy Makers.

3. Greenhouse Gas Reduction Targets

3.1. Go Green: Ontario's Action Plan on Climate Change

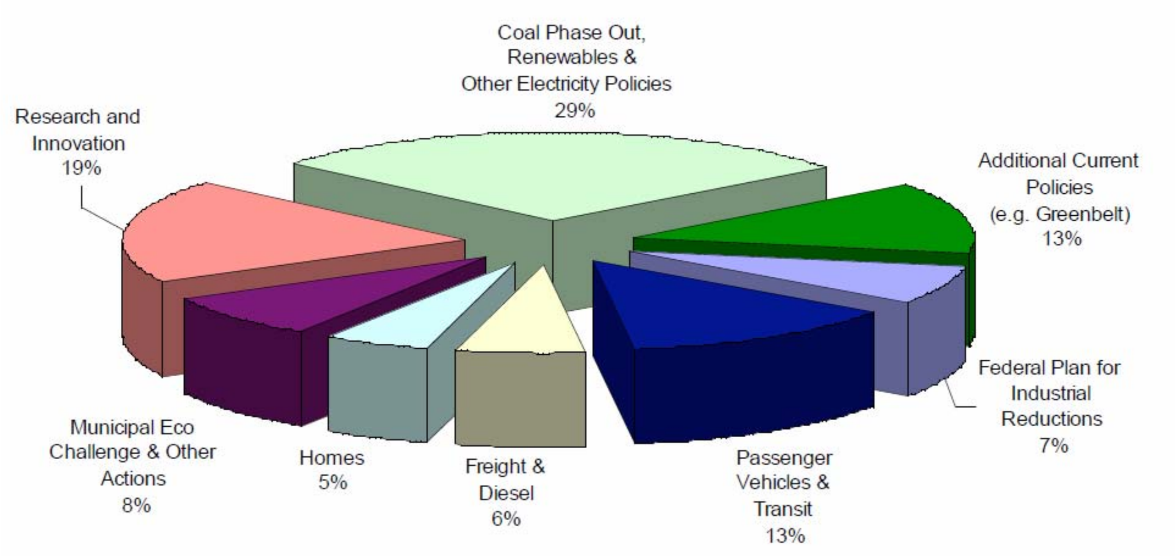
The Government of Ontario has responded to the challenge of climate change by adopting Go Green: Ontario's Action Plan on Climate Change, which sets ambitious targets for GHG emission reductions for all sectors, including industrial, commercial, residential, transportation and power generation:

- By 2014: a reduction of Ontario's GHG emissions to **six per cent** below 1990 levels (reduction of 11 megatonnes (Mt) of carbon dioxide equivalents (CO_2e) relative to 1990 levels);
- By 2020: a reduction of Ontario's GHG emissions to **15 per cent** below 1990 levels (reduction of 27 Mt of CO_2e relative to 1990 levels); and
- By 2050: a reduction of Ontario's GHG emissions to **80 per cent** below 1990 levels.

Several GTHA municipalities have also made commitments to reduce their emissions.

As outlined in the Go Green Plan, the 2014 and 2020 targets will be met by a number of new policies as well as an economy-wide transformation. This requires progress in every sector, as shown in Figure 1. The Go Green Plan estimates that if Ontario were to proceed with "business-as-usual", emissions in 2020 would be 72 Mt higher than 1990 levels. The Go Green Action Plan anticipates a reduction of 99 Mt below business-as-usual, resulting in total emissions of 15 per cent below 1990 levels. The transportation sector will need to account for at least 19 per cent of the 2020 reductions from business-as-usual (13 per cent for passenger vehicles and transit and six per cent for freight and diesel)[2].

Figure 1: Where Emission Reductions Will Have Been Achieved by 2020



Source: *Go Green: Ontario's Action Plan on Climate Change*, August 2007, Government of Ontario

[2] Some transportation-related GHG reductions would be captured under "Other Current Policies", for example reduced driving as a result of improved community design facilitated by the Growth Plan.

3.2. The Greater Toronto and Hamilton Area's Contribution

The Government of Ontario has established targets at the provincial level, but no specific greenhouse gas reduction targets have been set for the GTHA. For the purpose of this analysis, it is assumed that the GTHA will aim for reductions proportional to its 2006 emissions: roughly 50 per cent of the provincial total for passenger vehicles, but less for freight and diesel, since a share of goods movement is inter-regional. To allow for uncertainty and different allocation approaches, the following ranges are provided as broad goalposts for this analysis:

- Passenger vehicles and Transit: reduction of 5 – 7 Mt from the Go Green Business-as-Usual scenario.
- Freight and Diesel: reduction of 0.8 – 2.5 Mt from the Go Green Business-as-Usual scenario

3.3 Options for Reducing GHG Emissions and Improving Energy Conservation

The challenge of adding 2.6 million people to our region while trying to reduce or even hold the line on transportation energy use and emissions should not be underestimated. The RTP will play a key role in meeting GHG reduction targets. However, given the magnitude of the reductions required, a broad spectrum of strategies for reducing transportation GHG emissions will be required.

Reducing GHG emissions from the transportation sector will require a three-pronged strategy pursued concurrently:

- **Promoting modal shift and reducing vehicle travel demand**: shifting auto and truck traffic to lower emitting modes and reducing vehicle kilometres travelled through transit improvements, land use changes, and transportation demand management measures;

- **Improving fuel efficiency**: improving the energy efficiency of vehicles and encouraging more energy efficient driving behaviour; and

- **Reducing fuel carbon content**: substituting gasoline and diesel with alternative fuels that have lower carbon content, such as ethanol, biodiesel, hydrogen, or low-carbon sources of electricity.

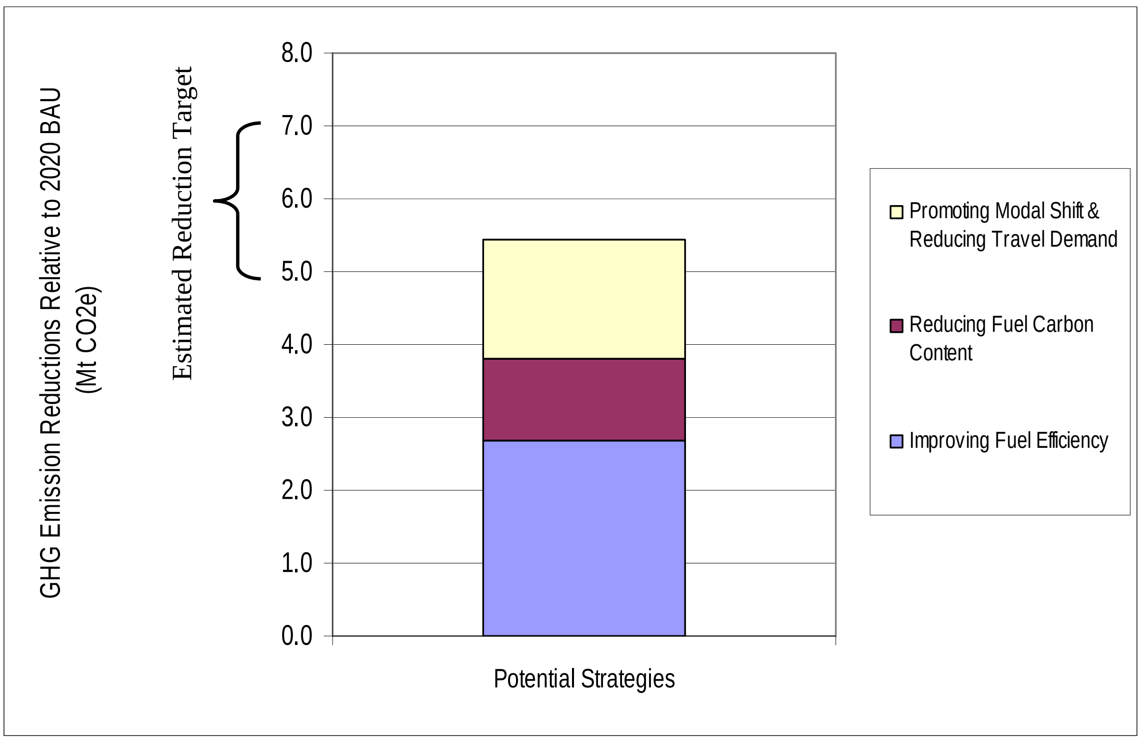
Strategies under each category are explored below for both passenger travel and goods movement to determine how GHG emission targets for transportation might be achieved. The breakdowns below are not targets, but rough order-of-magnitude estimates based on a diverse basket of measures to be pursued together to achieve the necessary magnitude of emission reductions. The RTP proposes a range of initiatives, which, if implemented together, could potentially result in targets being exceeded and/or met faster than required.

4. Passenger Travel

The effect of transportation improvements on passenger travel was determined through transportation demand modelling. Passenger travel estimates were input into Transport Canada's Urban Transportation Emissions Calculator to estimate changes in GHG emissions. The effects of other strategies were determined through benchmarking from the literature and an analysis of potential transferability to the GTHA.

Figure 2 illustrates how potential strategies described below can help the GTHA reduce its GHG emissions from passenger transportation and achieve the target reduction range.

Figure 2: Potential Strategies for Meeting the 2020 GHG Emission Target for Passenger Travel in the GTHA.



4.1. Promoting Modal Shift and Reducing Vehicle Travel Demand

This strategy includes a number of interconnected components:

- extensive transit/transportation infrastructure improvements based on the 15-year regional rapid transit and highway network in the RTP;

- land use measures building on the province's Growth Plan for the Greater Golden Horseshoe that encourage a greater mix of uses and higher densities to reduce the distances that people need to travel – by concentrating development within the existing built-up area, and especially around major transit station areas and intensification corridors, and by building complete communities where people can live and work[3];
- infrastructure investment and land use measures that encourage and support walking, cycling and transit use; and
- an aggressive package of Transportation Demand Management measures to reduce vehicle- kilometres travelled, reduce traffic peaks, increase vehicle occupancy, encourage non-auto modes of transportation, and reduce non-essential travel.

It is important to stress that aggressive transit investment and aggressive TDM measures are mutually supportive and one would not be practical or effective in the absence of the other [4]. Looking to experiences elsewhere, large behavioural changes have been observed when transit and TDM initiatives have been combined. For example, targeted marketing in transit corridors has achieved increases of 30 per cent in transit[5].

In addition, measures that improve transportation options and reduce the need for motorized travel foster "virtuous circles". For example, designing the region and local communities to reduce travel distances and make walking, cycling, and transit more feasible not only provide many environmental, social and economic advantages, as discussed in the RTP, but also facilitate future energy savings by encouraging energy-efficient lifestyles. It also enables the adoption of new "clean" transportation technologies by reducing energy demand. The result is a more resilient transportation system with less energy use and emissions, companies and households that are less vulnerable to changes in fuel costs and availability, fewer traffic injuries and deaths, and a more equitable distribution of mobility options.

Together, promoting modal shift and reducing vehicle travel demand could be expected to reduce GHG emissions by about 1.6 megatonnes.

Opportunities presented in the RTP are based on reasonable and realistic assumptions regarding behaviour, but are not sufficient on their own to meet the Go Green target for passenger transportation. Further reductions could be achieved through a "tipping point" effect: a combined and coordinated effort that includes the transformational land use framework set out by the Growth Plan, an unprecedented investment in transit infrastructure and changing attitudes could result in more dramatic changes in behaviour, which transportation demand models cannot accurately predict.

4.2. Improving Fuel Efficiency

Improved fuel efficiency is also an essential strategy for achieving required reductions in GHG emissions. Expected fuel efficiency improvements depend largely on the standards adopted for new vehicles. The fuel

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[3] Please note that the transportation demand model assumed implementation of the Growth Plan in both the Business-as-Usual and the proposed network scenarios. As a result, the "Promoting Modal Shift and Reducing Vehicle Travel Demand" strategy does not include greenhouse gas reductions solely attributable to the Growth Plan. Once quantified, these can be added to the potential achievable reductions, and allocated to the appropriate Go Green sector, currently "Additional Current Policies"
[4] Cansult and TSI Consultants. 2005. The Impact of Transit Improvements on GHG Emissions: A National Perspective. Transport Canada.
[5] See http://www.travelsmart.vic.gov.au/

efficiency of Canadian motor vehicles is generally consistent with the Corporate Average Fuel Economy (CAFE) standards in the United States. Updated CAFE standards require the average fuel efficiency of new vehicles in 2020 to be approximately 6.7 L/100km (35 miles per gallon), which represents a 25 per cent improvement from current standards of 9.4 L/100 km (25 mpg). Assuming representative rates for the penetration of new vehicles and retirement of old vehicles, the new CAFE standards will reduce fuel consumption per kilometre of the automobile fleet by 12 per cent[6] between 2006 and 2020. By comparison, the California Air Resources Board (CARB) has set a standard of 5.5 L/100km (42.5 miles per gallon) for 2020[7], corresponding to approximately a 27 per cent reduction in fuel consumption per kilometre of the automobile fleet under the same assumptions.

Given these results, a 25 per cent improvement in the fuel efficiency of the light-duty fleet is assumed to be reasonable. Reputable studies have indicated that the technology exists and that such an improvement is achievable by 2020 given policies to ensure the use of cost-effective technologies to increase fuel economy[8,9]. One approach to achieve this efficiency improvement would be to adopt the CARB fuel economy standards.

While the potential benefits of improved fuel efficiency are significant, there are several risks to relying primarily on this strategy to meet GHG reduction targets. First, fuel efficiency is not expected to improve sufficiently to meet reduction targets without substantial behavioural change leading to reduced auto use. Secondly, fleet-wide improvements in fuel efficiency may not correspond directly to emission reductions if those improvements encourage increased travel by reducing the cost of driving; also known as the “rebound effect”. However, this effect is typically small with a 10 per cent improvement in fuel efficiency leading to a one to two per cent increase in vehicle travel[10]. Of greater concern, fuel efficiency improvements can be offset by preferences for larger, heavier and more powerful vehicles, particularly light trucks, as has largely been the case for the last 30 years. It will be equally crucial to ensure, through appropriate policies and programs, that vehicles do not simply become more efficient, but that vehicles and the entire fleet actually consume less fuel.

Overall, there is great opportunity for Ontario to play a leadership role in the development and manufacturing of transformational vehicle and fuel technologies to contribute to absolute reductions in GHG emissions from passenger vehicles in Ontario and elsewhere. The government’s $1.15 billion Next Generation of Jobs Fund is an element of the province’s plan to partner with Ontario industry in its transformation to a low carbon future through the development of clean cars, clean fuels, and clean technologies.

Under these assumptions, improved vehicle efficiency and technological change could be expected to reduce GHG emissions by about 2.7 Mt.

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[6] This assumes current light-duty fuel efficiency of 8.5 L/100 km, new vehicle annual penetration rate of 8.9 per cent, and a vehicle retirement rate of 6.5 per cent based on three year trends from the NRCan Comprehensive Energy Use Database.
[7] California Air Resources Board. 2008. Comparison of Greenhouse Gas Reductions for the United States and Canada Under ARB GHG Regulation and Proposed Federal 2011-2015 Model Year Fuel Economy Standards.
[8] Transport Canada, Environment Canada, Natural Resources Canada, Department of Finance Canada, Industry Canada, and Marbek Resource Consultants. 1998. Foundation Paper on Climate Change: Transportation Sector.
[9] Greene, DL and Schafer, A. 2003. Reducing Greenhouse Gas Emissions from U.S. Transportation. Pew Center of Global Climate Change.
[10] ibid.

4.3. Reducing Fuel Carbon Content

The Government of Ontario is currently developing a low carbon fuel standard to meet its objective of reducing the carbon content of transportation fuels by 10 per cent by 2020. There are many ways to reduce the carbon content of transportation fuels including the use of biofuels, such as ethanol and biodiesel, as well as greater reliance on electrically powered vehicles, such as plug in electric hybrids (PHEVs) and grid-connected transit (e.g., subway and light rail). In reducing the carbon content of fuels, it is particularly important to consider the upstream emissions associated with fuel growth, extraction, and processing, since the feedstock has a large impact of overall emissions (e.g., corn-based ethanol versus ethanol created from agricultural waste). This is also the case when considering methods of power generation.

A 10 per cent reduction in the carbon content of transportation fuels could be expected to reduce GHG emissions by about 1.1 Mt.

5. Goods Movement

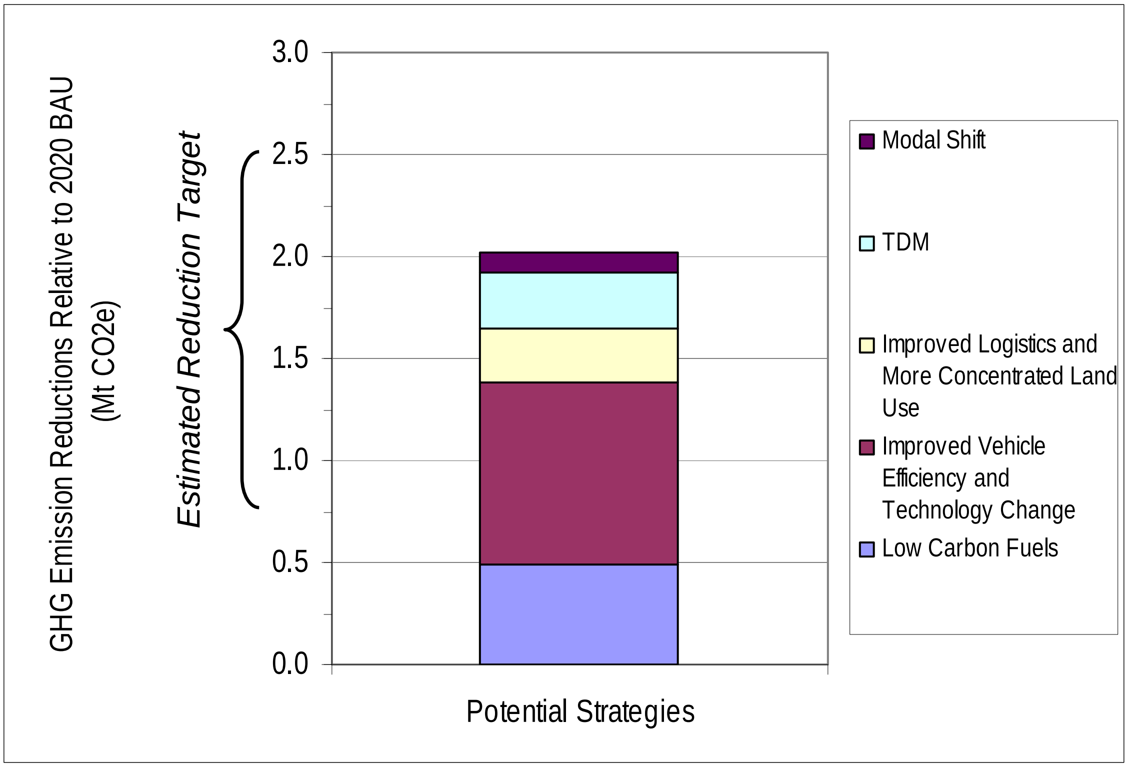
The goods movement analysis herein focuses on options to reduce GHG emissions from road commercial vehicles (i.e., trucking). Emissions from trucking account for approximately 89 per cent of GHG emissions from goods movement in Ontario[11]. Emissions from road commercial vehicles are projected to increase by approximately 44 per cent between 2006 and 2020.

Estimates of trucking emissions are less accurate than for passenger travel given the data gap on trucking movements in the GTHA. In addition, future trucking demand is very dependent on the evolution of the economy, the strength of individual industries and prevailing business practices, such as “Just-in-Time” deliveries. For example, the auto manufacturing industry generates a significant amount of commercial truck traffic, while more service- and knowledge-based industries, such as biomedical devices, generate less overall demand by weight, but more urgent, small and frequent specialized deliveries.

A number of strategies are proposed to work towards meeting the GHG reduction target for goods movement, as shown in Figure 3, including modal shift, aggressive TDM, improved logistics and more concentrated land use, improved vehicle efficiency, and low carbon fuels. The goods movement strategy that the RTP proposes will explore further strategies to meet the target.

[11] Natural Resources Canada, Comprehensive Energy Use Database. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/comprehensive_tables/index.cfm?attr=0

Figure 3: Strategies for Reducing GHG Emissions from Goods Movement by 2020 in the GTHA



5.1. Promoting Modal Shift

While rail consumes about 80 per cent less energy per tonne-kilometre than trucking for goods movement[12], there is relatively little opportunity for a substantial shift other than for longer distance freight movements. The greatest opportunity for improving the efficiency of freight transport may be to facilitate quicker freight transfer between modes[13].

In addition, opportunities for shifting some truck traffic to short sea shipping (on the Great Lakes) merit further consideration[14]. The marine mode is the most energy efficient and least polluting, using approximately half the energy per tonne-kilometre as compared to rail[15]. Shifting truck traffic to marine could help to reduce border congestion, mitigate highway traffic volumes, and reduce energy use and emissions. However, due to current high pilotage and harbour fees, and onerous customs and immigration requirements, such ventures have not been successful to date[16]. The goods movement strategy proposed to be completed in the RTP will explore these opportunities in further detail.

A five per cent shift in heavy-duty truck traffic to rail or marine could be expected to reduce GHG emissions by about 0.1 Mt.

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[12] Transport Canada, Environment Canada, Natural Resources Canada, Department of Finance Canada, Industry Canada, and Marbek Resource Consultants. 1998. Foundation Paper on Climate Change: Transportation Sector.
[13] Greene, DL and Schafer, A. 2003. Reducing Greenhouse Gas Emissions from U.S. Transportation. Pew Center of Global Climate Change.
[14] Global Insight and Reeve and Associates. 2006. Four Corridor Case Studies of Short-Sea Shipping Services. Prepared for U.S. Department of Transportation. Transportation Research Board Annual Meeting, Washington, DC.
[15] Wright, C. 2004. Short Sea Shipping Opportunities on the Great Lakes. 26th Annual Interferry Conference. Grand Bahama Island.
[16] Ibid.

5.2. Freight-Specific Transportation Demand Management, Improved Logistics and More Concentrated Land Use

The energy efficiency of freight logistics can be improved by changes in vehicle load factors (i.e., how much of the capacity of a truck is used during shipment), space utilization, scheduling, packaging and handling systems, and numerous other supply-chain factors. The more concentrated land use pattern associated with the Growth Plan and RTP can also be expected to contribute to logistics improvements by reducing average trip distances for deliveries and service calls, and assisting in more efficient grouping and scheduling of such trips. There are many opportunities for improving logistics to reduce GHG emissions from trucking. For example, about 80 German cities have set up “City Logistic” projects whereby shipments are consolidated outside the city limits and better organized within the city[17]. More generally, faster and greater adoption of advanced logistics, particularly by smaller firms, presents significant untapped potential.

In terms of fuel consumption, load factor is the most important determinant of environmental performance. Most truck fuel goes towards moving the truck rather than its payload. A half-loaded truck uses more than 90 per cent of the fuel used per kilometre by a fully loaded truck[18]. As a result, opportunities to consolidate loads and use fewer trucks have significant potential to reduce fuel consumption and GHG emissions. Approximately one third of total truck capacity on Ontario roads is not used[19]. This value is expected to be higher for the GTHA given that shorter-distance trips were found to have lower than average load factors, particularly for private trucks (as opposed to for-hire vehicles).

In combination with rising fuel prices, some form of road or truck pricing across the region has the potential to reduce truck traffic through greater consolidation of trips or shifts to other modes, such as rail. A number of studies have estimated the price-elasticity of freight truck traffic in the range of -0.4 to -0.8, meaning that a 10 per cent increase in shipping costs would reduce truck traffic between four and eight per cent[20].

A five per cent reduction in vehicle kilometres travelled is considered readily achievable given aggressive TDM focused on goods movement. This strategy works in synergy with promoting modal shift and improving logistics, as discussed above.

Overall, improved logistics and more concentrated land use, including increasing load factors, are considered to have the potential to reduce truck kilometres travelled by at least 5 per cent and provide GHG reductions of approximately 0.25 Mt. A 10 per cent reduction in vehicle kilometres travelled from TDM would yield a further 0.25 Mt for a total of 0.5 Mt.

5.3. Reducing Fuel Carbon Content

As discussed, the Government of Ontario is currently developing a low carbon fuel standard to meet its objective of reducing the carbon content of transportation fuels by 10 per cent by 2020. Biodiesel presents a

[17] See Victoria Transport Policy Institute TDM Encyclopedia, Freight Transport Management: Increasing Commercial Vehicle Transport Efficiency, http://www.vtpi.org/tdm/tdm16.htm
[18] www.trucktires.com/gentech/w-F.thm as reported by the Centre for Sustainable Transportation. 2001. Sustainable Transportation Monitor, No. 4.
[19] 1999 National Roadside Study
[20] Thomas Bue Bjørner (1000), “Environmental Benefits from Better Freight Transport Management: Freight Traffic in a VAR Model,” *Transportation Research D*, Vol. 4, No. 1, January 1999, pp. 45-64., James Luk and Stephen Hepburn (1993), *New Review of Australian Travel Demand Elasticities*, Australian Road Research Board (www.arrb.com.au)., Hagler Bailly (1999), *Potential for Fuel Taxes to Reduce Greenhouse Gas Emissions from Transport*, Transportation Table of the Canadian National Climate Change Process (www.transport-canada.com/programs/Environment/climatechange/english/climatechange/ttable/menu.htm).

promising opportunity for reducing the carbon content of trucking fuels; however, the fuel feedstock and manufacturing process need to be considered carefully in comparing alternatives.

A 10 per cent reduction in the carbon content of transportation fuels could be expected to reduce GHG emissions by about 0.5 Mt.

5.4. Improving Vehicle Efficiency and Encouraging Technology Change

Significant improvement in truck fuel efficiency is possible by 2020. For heavy-duty vehicles, fuel-saving devices, such as aerodynamic improvements, speed limiters, and anti-idling devices, can deliver an estimated 22 per cent fuel savings in the short-term without changes to the engine[21]. Fuel efficiency for short-distance stop-and-go transport can be improved by about 50 per cent using technologies such as hybrid-electric vehicles[22]. Other initiatives such as truck stop electrification – which reduces idling – are potential sources of further reductions.

On the more ambitious end, the U.S. Department of Energy, in collaboration with other federal agencies and truck manufacturers and suppliers, established the 21st Century Truck program in 2000 to dramatically improve the fuel economy of trucks in the United States. With a combination of engine, aerodynamic, rolling resistance, and materials technologies, the plan called for a 50 to 75 per cent improvement in fuel economy for light trucks, a 40 per cent improvement for medium-sized trucks, and a 60 per cent improvement for over-the-road tractor trailers, which were believed to be achievable with "aggressive development and implementation of technologies currently being considered but not yet commercially viable"[23].

Based on these findings, a 20 per cent improvement in the fuel efficiency of the commercial truck fleet is feasible; however there is still the challenge of achieving sufficient penetration of more efficient trucks into the fleet during the next 12 years. While fuel efficiency improvements will be driven by increasing fuel prices, as in the case of passenger vehicle technology, incentives and disincentives will be needed to encourage and speed up the adoption of fuel efficient technologies, for example by encouraging fleet renewal. Through their purchasing power, governments can accelerate market transformation by creating a critical mass in demand for new generation technologies and vehicles. Fleet average fuel efficiency standards similar as those on the passenger vehicle side could also be adopted. These currently do not exist for commercial fleets. Input from the industry, including shippers, logistics companies, service providers and vehicle manufacturers will be essential to finding new and creative ways to achieve the targets.

Improved vehicle efficiency and the adoption of new technologies could be expected to reduce GHG emissions by about 0.9 Mt.

[21] Backgrounder: Truck Efficiency and GHG Reduction Opportunities in the Canadian Truck Fleet. Report of the Study Conducted by the Rocky Mountain Institute (RMI) for the Canadian Trucking Alliance (October 2007)
[22] Greene, DL and Schafer, A. 2003. Reducing Greenhouse Gas Emissions from U.S. Transportation. Pew Center of Global Climate Change.
[23] Ibid.

6. Conclusion

To mitigate the impacts of climate change, GO Green: Ontario's Action Plan on Climate Change sets ambitious targets for reducing GHG emissions. Meeting GHG reduction targets for the transportation sector will require strong behavioural change and significant technnological innovation. Making it happen will require a mix of infrastructure and policies in a variety of inter-related areas: land use, transportation demand management, active transportation, logistics, pricing signals, vehicle efficiency, etc. Most of these measures assume existing technology and can be implemented immediately. In particular, "virtuous circles" arise from the concurrent pursuit of measures that reduce the need to travel and favour modal shifts.

Improved technology will be a critical component of achieving our GHG reduction targets. Ontario has the potential to develop many of these green technologies. For example, there is a major role for the auto industry in improving fuel efficiencies and selling made-in-Ontario vehicles across North America to meet increasing demand for fuel efficient vehicles. To foster such economic opportunities, Ontario has created the Next Generation of Jobs Fund to support the development, use, and sale of green technologies and businesses in Ontario. The challenge will be to achieve the necessary penetration of more efficient vehicles in the fleet by 2020, particularly for goods movement. In the short-term, it will be of crucial importance to make rapid and immediate moves towards implementing available leading-edge technologies and approaches. Policies will also be required to ensure that efficiencies from improved vehicle technology are adopted and not erased by increased driving or the purchase of more powerful and larger vehicles. Definitive targets and implementation schedules will need to be established, and industry co-operation assured.

Key conclusions of the technical analysis include:

1. Aggressive but credible strategies proposed in the RTP provide a reasonable basis for achieving significant GHG reductions. The GTHA lends itself to a wide range of initiatives to reduce emissions, many of which are linked to significant changes to our transportation system and the way we design our communities, as championed by the Growth Plan and the RTP.

2. Promoting modal shift, reducing vehicle travel demand, improving fuel efficiency and reducing fuel carbon content will all need to be pursued concurrently to achieve the necessary reductions.

3. Owing to the rapid increase in GHG emissions from goods movement between 1990 and 2006 and expected increased demand for commercial trucking into the future, meeting the GHG reduction target for goods movement will require a deeper understanding of industry trends and concerted efforts between governments and the various players that influence demand for goods movement: shippers, logistics companies and service providers.