Driving Down Carbon

Reducing GHG Emissions from the Personal Transportation Sector in Ontario

Cherise Burda • Alison Bailie • Graham Haines

the PEMBINA institute
25 years
of Sustainable Energy Solutions

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About the Pembina Institute

The Pembina Institute is a national non-profit think tank that advances sustainable energy solutions through research, education, consulting and advocacy. It promotes environmental, social and economic sustainability in the public interest by developing practical solutions for communities, individuals, governments and businesses. The Pembina Institute provides policy research leadership and education on climate change, energy issues, green economics, energy efficiency and conservation, renewable energy, and environmental governance. For more information about the Pembina Institute, visit www.pembina.org or contact info@pembina.org. The Pembina Institute's engaging monthly newsletter offers insights into its projects and activities, and highlights recent news and publications. Subscribe to Pembina eNews at www.pembina.org/enews/subscribe.

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1. Introduction

1.1 Getting up to Speed on Climate Action

In 2007, the Ontario government set relatively ambitious targets to fight climate change. Ontario's climate plan calls for the reduction of greenhouse gas (GHG) emissions to 15% below 1990 levels by 2020 and 80% below 1990 levels by 2050. Adhering to this commitment will continue to make Ontario a climate change leader in North America.

To date, Ontario has demonstrated considerable action towards meeting these targets. It has regulated the phase-out of all coal-fired power plants by 2014 and a mechanism to procure more renewable energy through its Green Energy Act. Ontario has also implemented laudable land use and transit initiatives, the Places to Grow Act, Metrolinx's The Big Move, as well as the Greenbelt Protection Act.

To measure progress and inform policy direction, Ontario instituted a Climate Change Secretariat (CCS) to ensure the province is accountable to its climate goals. The CCS's most recent 2008–09 annual report found that current government policies would result in meeting just over half of the province's GHG reduction target for 2020. The majority of these reductions would come from coal phase-out and related electricity policies.[1]

The province is in a position to determine how best to achieve more GHG reductions by strengthening policies in sectors other than electricity in order to reach the 2020 goal. Ontario's Environment Commissioner recently identified transportation as an important sector to achieve greater GHG savings.[2]

1.2 Driving Down Carbon Emissions from Ontario's Personal Transportation Sector

Ontario's transportation sector is the largest contributor of the province's total GHG emissions (31%). GHGs from the transportation sector are expected to be the largest and fastest growing source of GHG emissions in years to come. Personal transportation, how Ontarians get around and commute to work and school, accounts for 72% of total road transportation emissions.[3]

Personal transportation emissions can be reduced effectively through land-use planning and urban transportation policies that result in less driving, through changes to vehicle technology such as vehicle efficiency and electric vehicle technology, as well as through fuel quality and pricing policies. The changes that need to happen right now in Ontario begin with government initiatives that are already in place such as Ontario's Climate Change Action Plan,[4] Metrolinx's The Big Move,[5] the Places to Grow Act (specifically The Growth Plan for the Greater Golden

Horseshoe[6]), and the federal government's new draft regulations on vehicle GHG emission standards.[7]

Driving Down Carbon first examines the impact these government initiatives will have on reducing GHG emissions from the personal transportation sector, focusing exclusively on policies that are already in place and underway by the Ontario government for the personal transportation sector. It then explores how to improve these policies and increase the GHG reduction potential from personal transportation.

Personal transportation accounts for 72% of total road transportation emissions in Ontario.
Photo: Ontario Growth Secretariat, Ministry of Energy and Infrastructure

1.3 How This Report Is Organized

Driving Down Carbon follows a sequence of rationale, modelling, results and recommendations that build on the outcome of preceding chapters. It is important to be aware of how the report is organized to understand the context of information presented.

- Chapter Two lists all of the targets from current government policies in the personal transportation sector that are modelled as the Base Case — the current government roadmap. It explains methodology and assumptions around the development of targets according to available information.
- Chapter Three presents the results of the Base Case. Graphically represented, this chapter highlights the GHG emission reductions that will occur under current government policy in the personal transportation sector within the Greater Golden Horseshoe region.
- Chapter Four explores how to improve current policies to achieve deeper GHG reductions from the personal transportation sector, discussing the rationale behind stronger policies and tougher targets that make up the Greener Options case.

- Chapter Five presents the results of the Greener Options case and graphically compares the relative GHG emissions saving with the Base Case and with 2006 GHG levels.
- Chapter Six provides a menu of policy actions that the province should consider in order to meet the improved Greener Options case. These are the types of directional policies that are not target based and cannot be directly modelled but can help achieve improved targets modelled in the Greener Options case.
- Chapter Seven distills the results and lessons into brief conclusions and personal transportation policy directions for Ontario. It recommends four key policy priorities that can be implemented now and will not require massive capital investment.

1.4 Purpose and Focus

Driving Down Carbon addresses two questions:

1. How effective will Ontario's current initiatives be at reducing GHG emissions from personal transportation in Ontario, particularly in the Greater Golden Horseshoe, over the next 25 years?
2. How can these initiatives be improved to reduce GHGs from personal transportation to levels that will get closer to achieving the province's GHG reduction targets?

To answer these questions, *Driving Down Carbon* first models the future GHG emissions assuming that current personal transportation policies are fully implemented but no new initiatives are undertaken. In other words, it models what impact the full implementation of The Growth Plan for the Greater Golden Horseshoe (The Growth Plan), The Big Move and other committed policies related to personal transportation will have on GHG emissions by 2031. This baseline scenario is compared with what emissions from the personal vehicle sector are today to determine whether the province's current initiatives will result in relative increases or decreases and to what extent.

We then set up the model to reflect what would happen if these current initiatives were improved, and if policies and targets were strengthened.

1.4.1 Policy Focus

While emissions from freight and commercial transportation require significant attention in Ontario, this report exclusively examines the potential for emission reductions from the personal transportation sector. The analysis, therefore, excludes freight, road, rail and marine travel.

Focusing exclusively on personal transportation, the report examines GHG emission reductions from two main policy foci:

1. **The Commute:** Emission reductions through policies and actions that decrease the amount of passenger vehicle kilometres travelled (VKT). Policies and actions that result in VKT reductions include urban land use planning and infrastructure, transit planning and infrastructure, and modal shift via initiatives that discourage personal vehicle use and encourage transit use or other non-vehicle travel.

2. **The Vehicle:** Emission reductions from the vehicle itself via technological improvement to vehicles and fuel. These include vehicle efficiency standards, carbon content of fuel and the electrification of cars.

Driving Down Carbon excludes from its modelling both cap-and-trade and a carbon tax. These fuel-pricing policies are broader than just the personal vehicle sector and broader than the transportation sector; modelling their impacts on GHG reductions from the personal transportation sector would require considerably more work than is possible within the scope of this report. The province of Ontario has recently passed legislation enabling a cap-and-trade policy and released reporting regulations, and this report includes a recommendation that the legislation include transportation fuels.[8] Such a policy would be complimentary to the personal transportation policies discussed in this report. The successful development and implementation of this policy is important to move Ontario closer to its 2020 target and direct revenues to sustainable transportation policies and infrastructure.

1.4.2 Scope of *Driving Down Carbon*

1.4.2.1 Geographic Scope

The geographic region included in this analysis is restricted to the Greater Golden Horseshoe (GGH) region. This geographic scope matches the boundaries in The Growth Plan and covers 70% of Ontario's population.

We restricted the analysis to this geographic scope because the provincial government had not released its growth plan for regions outside the Greater Golden Horseshoe at the time of our research. Province-wide policies dealing with personal vehicles were also applied to this geographic scope to maintain consistency in our analysis.

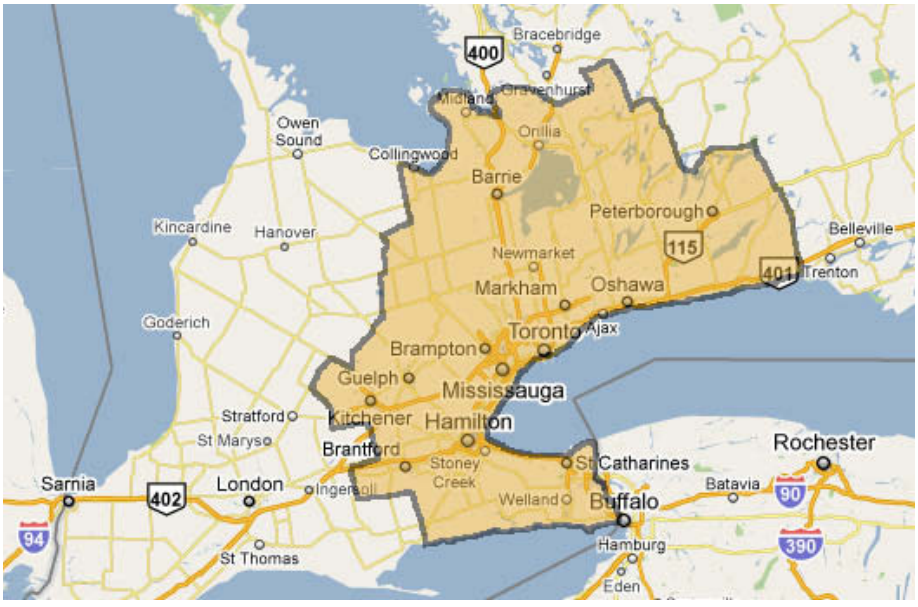


Figure 1: The Greater Golden Horseshoe region

Source: Google Maps, ©2009 Google, Tele Atlas

1.4.2.2 Time Frame Scope

Driving Down Carbon measures future GHG emissions from the personal transportation sector in the Greater Golden Horseshoe region by 2031. This 25-year time frame is in accordance with the planning horizon for recent land-use and transportation initiatives in Ontario, The Growth Plan and The Big Move. During this time frame, Ontarians can expect to see changes resulting from government policies on public transportation and personal vehicles. Changes to land-use, where people live and work, will take longer to fully implement than the technology changes, but many impacts of the land-use changes will also be evident over the next decade.

Ontario's Climate Change Action Plan asserts targets for 2020 and 2050 for GHG reductions along with a number of policies and initiatives to help achieve these targets. Personal transportation related policy initiatives included in the Climate Change Action Plan (e.g., Ontario Bus Replacement Program) have been included in our modelling.

1.4.2.3 Travel Activity Scope

The scope is also limited to travel activities captured by the Transportation Tomorrow Survey,[9] our primary data source. Travel activities included in our scope are:

- Home to work and work to home trips,
- Home to school and school to home trips,
- Other home based trips (i.e. shopping), and
- Non-home based trips (i.e. work to shopping).

Travel activities excluded from the project scope include:

- Most business-related travel (other than the journey to work),
- All fleet-based travel (delivery vans, etc.),
- Travel by visitors (own cars, rental cars and taxis), and
- Travel that is not typical of daily trips, such as vacations.

Between the travel activity scope and geographic scope, the analysis captures approximately 50% of provincial personal transportation emissions in Ontario.

1.4.3 Measuring How to Drive Down Carbon

As discussed above, *Driving Down Carbon* begins by modelling the future GHG reductions from current government initiatives in the personal transportation sector and then explores the impact of improvements to these. Both current and improved policies are assessed or measured quantifiably, whereby a target or number representative of this policy is entered into a model and a GHG reduction can be measured. Policies such as vehicle efficiency standards or land-use density targets can be measured this way.

Many important policies cannot simply be entered into a model to determine a corresponding GHG reduction, such as congestion charges, pay-as-you-drive insurance, live where you work policies or changes to the Provincial Policy Statement governing environmental assessment of

highway development. These policies are necessary to help achieve an improved target. For example, *Driving Down Carbon* measures the impact of increased mode split (more people taking transit) on GHG reductions — this is quantifiable. It would then be necessary for the Ontario government to select and implement the best policy tools that influence commuter behaviour, such as road pricing policies or improved transit service, to achieve the desired mode split.

Therefore, the focus of *Driving Down Carbon* is on measurable targets that can be improved to achieve deep GHG reductions; these improvements are based on strengthening numerical targets within current policies. However, many positive policy improvements that cannot be measured are considered in the final two chapters of this report.

2. Ontario's Current Roadmap: The Base Case

Driving Down Carbon begins by studying the impact that current government policies will have on GHG reductions from the personal transportation sector. To do this, the Base Case modelling includes GHG reductions in 2031 from the full implementation of The Growth Plan, The Big Move, other Ontario policies pertaining to the personal transportation sector, as well as federal policies related to fuel economy of new passenger vehicles (see Appendices B and C for details of modelling methodology and assumptions).

The Base Case models the future carbon emissions from the personal transportation sector in the Greater Golden Horseshoe region, **assuming that these current government policies are fully implemented**.

2.1 Land-Use and Transit Policies

Policies can improve urban form and transit, influence commuter choice, reduce travel distances and make transit a more viable option. The impact of these policies can be measured in how effectively they decrease VKT. Decreases in VKT correspond directly to decreases in GHGs because automobiles are used less. The two primary policies under this category are The Growth Plan and The Big Move transportation plan.

2.1.1 Improved Urban Form

Better urban form, for the most part, is addressed through the province's Places to Grow Growth Plan for the Greater Golden Horseshoe. However, very few of The Growth Plan's policies have numerical targets that can be set, enforced and measured. Direct numerical targets arising out of The Growth Plan include:

- Population projections for all included municipalities (see Appendix B for a summary).
- At least 40% of the new population must be accommodated in the Built-up Area (BUA).[10]
- A minimum density of 50 people and jobs per hectare in Greenfield Areas (GFAs).[11]
- Density targets for Urban Growth Centres (UGCs).[12] These targets are set individually for each municipality (see Appendix B for a summary).

Other policies arising out of The Growth Plan, such as the development of intensification areas or areas of mixed use, do not have specified or enforceable targets and are left up to municipal discretion. Due to the lack of enforceable targets these policies are not directly modelled.

2.1.2 Access to Transit

Two key targets are used in measuring current access to transit in our model:

- Population with access to good transit — either frequent (<15 minute headways) and reliable transit or commuter/regional rail.
- Breakdown of population with access to good transit (between Urban Growth Centres, Built-up Areas and Greenfield Areas). For all communities it is assumed that 100% of the population living in UGCs has access to good transit.

For areas within the geographic scope of The Big Move, the results of Metrolinx's model are used to inform these numbers:

- Percent of population within 2 km of rapid transit.[13]
- Estimated percentage of routes within the existing Built-Up Areas.[14]

For areas outside The Big Move, the estimated percentage of the population with access to good transit is based on transit ridership and assumes that access to transit in the Built-up Area and Greenfield Area will be relatively similar.

Regional rail is a key component in connecting urban centres.

Photo: Ontario Growth Secretariat, Ministry of Energy and Infrastructure

2.1.3 Targets for Other Changes to the Transportation System (Non-transit)

In addition to improving access to public transit, the Government of Ontario has announced several other changes intended to improve the efficiency of the transportation system in the Greater Golden Horseshoe. The policy areas outlined below were included in the modelling provided for The Big Move. Because the modelling has been calibrated to the results of The Big

Move, the impacts of these initiatives have been included. Appendix C provides information on the model calibrations.

2.1.3.1 Highways

The Base Case assumes that highway construction follows current provincial plans for highway expansion. Major projects include the Highway 407 East extension, Highway 404 extension, Highway 410 extension and Highway 417 extension.

2.1.3.2 High Occupancy Vehicle Lanes

The Base Case also includes plans for High Occupancy Vehicle (HOV) lanes, following the approach taken by The Big Move modelling; adjustments to auto occupancy reflect the impact of HOV lanes. As with The Big Move modelling, HOV lanes are assumed to be constructed as planned, as part of the highway construction.

2.1.3.3 Telecommuting

The Base Case assumes that telecommuting increases from current levels, estimated at 5.3% of workers currently working from home, to 8.0% in 2031 to account for policies that will encourage telecommuting.

2.1.3.4 Active Transportation

According to The Big Move analysis, active transportation (walking and bicycling) currently accounts for 13% of all trips under 10 km. In 2031, the Current Directions case assumes that this fraction will grow to 18.5% to account for policies and infrastructure that will encourage active transportation as part of The Big Move plan.

2.2 Vehicle Technology

The Base Case also assumes that Ontario will experience changes to the types of personal vehicles on the road. Advancements to vehicle and fuel technology will have the potential to reduce the carbon intensity of personal transportation. The Base Case includes technological changes through 2031 that are dictated in current policy.

2.2.1 Vehicle Emission and Fuel Economy Standards

According to its Climate Change Action Plan, Ontario will adopt the federal vehicle efficiency standard once it is developed, with the expectation that the federal government will harmonize with standards being developed in the U.S.

At the time of completing this report, Environment Canada had just released draft vehicle efficiency regulations to limit GHG emissions from new vehicles beginning with the 2011 model year. Canada and the U.S. are working towards a common North American approach to reduce

GHG emissions by introducing aligned and progressively tighter regulatory requirements over the 2011 to 2016 model years.[15]

Improved fuel economy is critical to reducing GHG emissions from transportation.

Photo: Roberta Franchuk, The Pembina Institute

The U.S. has set fuel economy standards for model year 2011 and the draft Canadian regulations propose that auto companies in Canada comply with those. At time of publication for this report, the U.S. National Highway Traffic Safety Administration (NHTSA) and EPA were jointly developing a single set of vehicle GHG and fuel economy standards that would apply nationally for the period of 2012 to 2016. Their proposed joint standards are estimated to reach 250 gCO_2/mile,[16] if all reductions are made through fuel economy improvements. Under the Canadian Environmental Protection Act, Canada will follow the same path as the U.S.

Our Base Case assumes that the U.S. moves ahead with its proposed vehicle GHG emission standards for the 2012 to 2016 model years and that Canada harmonizes its regulations to match those (as well as matching the standards for model year 2011). Since the U.S. and Canada have not released any draft standards for model years after 2016, changes to vehicle emission standards after 2016 have not been included in the Base Case.

Fuel economy projections for Ontario vehicles were calculated using these policy assumptions, combined with data on current fuel efficiency of personal vehicles in Ontario, assumptions of average lifetime of vehicles and projections for future vehicle purchases. The results are reported in Table 1.

Table 1: Average fuel economy and vehicle emission standards for vehicle stock in Ontario assumed in Base Case.

	2012	2016	2021	2031
U.S. NHTSA/EPA projected fleet-wide emissions compliance levels under the proposed footprint-based CO_2 standards (grams/mile)				
New passenger cars	261	221	n/a	n/a
New light trucks	352	301	n/a	n/a
Assumed fuel economy for Ontario's fleet of vehicles (L/100 km)				
New passenger cars	6.9	5.9	5.9	5.9
New light trucks	9.3	8.0	8.0	8.0
New cars and light trucks combined	8.1	6.9	6.9	6.9
Total fleet, new and existing vehicles	9.5	8.8	7.9	7.1

Source: U.S. NHTSA/EPA values from EPA-420-F-09-047a, September 2009, Table1, Calculations for estimated fuel economy based on vehicle stock turnover model

2.2.2 Carbon Content of Fuel

Ontario's current policy includes a 5% ethanol in gasoline requirement that came into effect in 2007[17] (O. Reg 535/05, last amended 76/07). The 2008-09 Ontario's Climate Change Action Plan Annual Report removed forecasted reductions associated with the 5% ethanol regulation based on emerging lifecycle analysis.[18] The government report took a similar conservative approach for Low Carbon Fuel Standard, despite the government's public commitment,[19] given the uncertainties associated with a technical pathway to achieve forecasted outcomes with current generation biofuels.

To remain consistent with government modelling and reports, neither the 5% ethanol policy nor the Low Carbon Fuel Standard is included in The Base Case modelling for *Driving Down Carbon.*

2.2.3 Electric Vehicles

The Government of Ontario recently announced a plan for 1 in 20 vehicles to be electrically powered by 2020.[20] Ontario has launched a number of initiatives to encourage consumers to adopt electric vehicle technologies as they become available, including the purchase incentives launched in 2009. It is also developing a green licensing program for electric vehicles, which includes incentives such as access to parking spots and HOV lanes. The Government of Ontario is also working to develop infrastructure including the partnership launched in January 2009 to bring Better Place's Canadian head office to Toronto and to work with a coalition of partners to develop a charging system. Moreover, it is assumed that the federal vehicle emission and fuel

economy regulation above will include electric vehicles as part of the pathway in meeting GHG standards for new vehicles, based on GHG equivalency.

Our Base Case, however, does not explicitly include the electric vehicles target for Ontario, following the approach taken by the Ontario Climate Change secretariat in 2009 of excluding electric vehicles in the Base Case. The 5% target is currently considered more of a commitment or ambition rather than an official policy and will likely need a comprehensive strategy to link the initiatives started in 2009 with other actions to fully achieve the target.

The electric Nissan Leaf is expected to be marketed in North America beginning in 2010.

Photo: Nissan Motor Co

Driving Down Carbon's Base Case does include the electrification of municipal buses. The Government of Ontario has set up a $180 million fund to help municipalities replace aging municipal buses. As per the Government of Ontario's assessment, it is assumed that this policy will reduce emissions by 0.16 MT.[21] While the time frame (2020 vs. 2031) and geographic scope (Greater Golden Horseshoe vs. Ontario) differ between our analysis and the Government of Ontario's analysis, insufficient information was available to properly estimate the savings of this policy.

3. Base Case Results: Where Are We Going Now?

3.1 General Results

Under current government initiatives, GHG emissions from personal transportation in the Greater Golden Horseshoe region are expected to decrease modestly over time, from 16.0 million tonnes in 2006 to 12.4 million tonnes in 2031. The reductions are more impressive when compared to Business As Usual — what the GHG emissions would be in the personal vehicle sector without these current government policies.

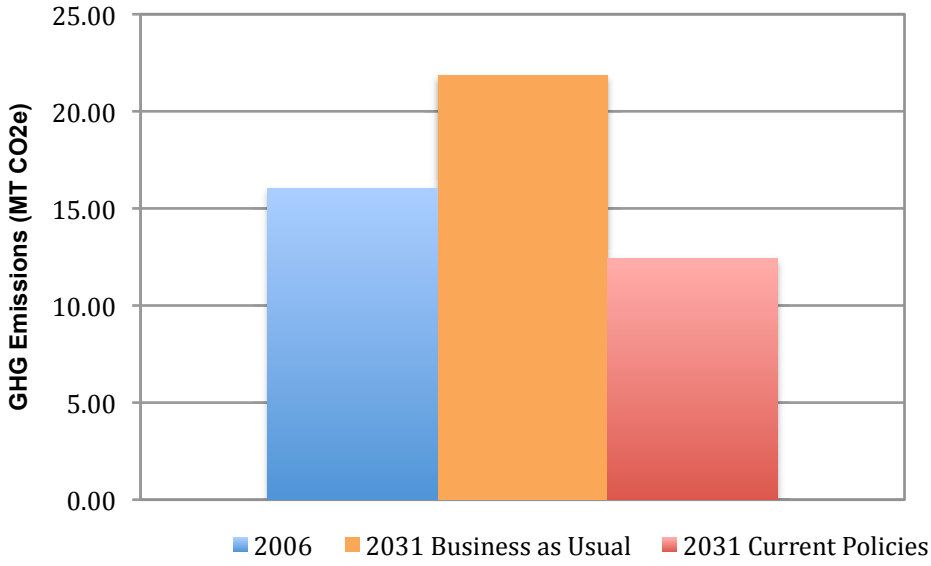


Figure 2: GHG emissions from the personal vehicle sector in the GGH region under different scenarios

The distinction is important — the Business As Usual comparison underscores the significance of current government policies and the need to ensure these policies are properly enforced, fully implemented and not weakened.

The GHG emissions relative to 2006 demonstrate actual progress and how effective these current policies are at reducing GHGs over time, with the objective of meeting Ontario's 2020 and 2050 GHG reduction goals.

3.2 Base Case Results by Policy

Figure 3 shows the GHG savings in 2031 per Base Case policy relative to Business As Usual (what GHG emissions would be in 2031 if no policies were implemented). Approximately 53% of the GHG savings in the Base Case can be attributed to the proposed federal vehicle emission regulations, while land-use and transit initiatives — The Growth Plan and The Big Move — account for approximately 43% of the reductions. The remaining 4% of savings can be attributed to the electrification of municipal buses.

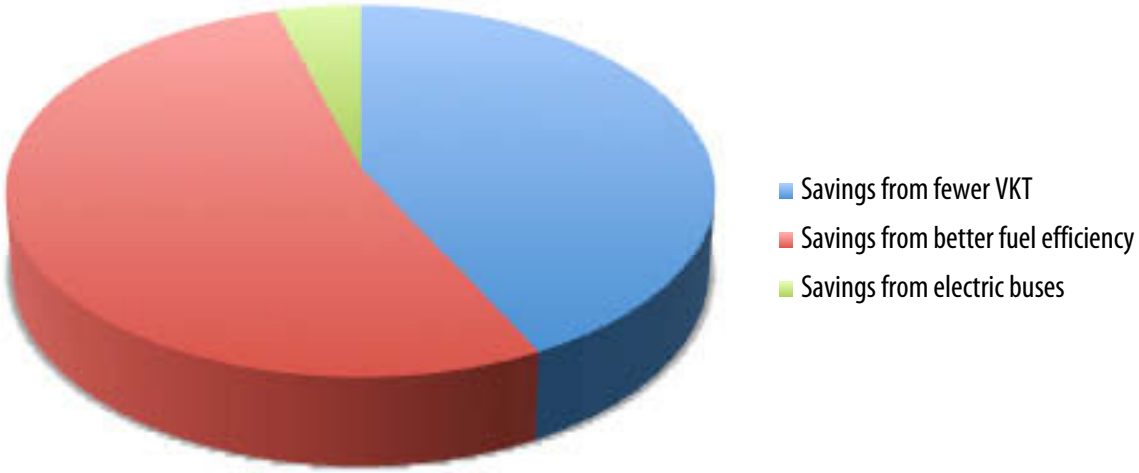


Figure 3: Projected breakdown of GHG savings in the personal transportation sector from 2006 to 2031 resulting from current government initiatives (the Base Case)

When comparing the Base Case to 2006, Ontario's current policies are projected to decrease GHG emissions in 2031 by 22% from 2006 numbers. However, these reductions are only possible through the combined effects of the two main Base Case policy areas: VKT and vehicle efficiency standards. Without the combination of both areas, GHG emissions would continue to increase from 2006 levels.

3.3 Vehicle Kilometres Travelled Results

Current policies that reduce VKT include The Growth Plan and The Big Move. According to the Base Case, these initiatives, if fully implemented by 2031, would reduce the amount of time individuals spend behind the wheel (VKTs per capita) by over 20% compared to 2006. However due to population growth projected for the region, the number of cars on the road will actually increase (total VKTs). As a result, despite the significant gains that The Growth Plan and The Big Move achieve, alone they are not enough to drive GHGs down.

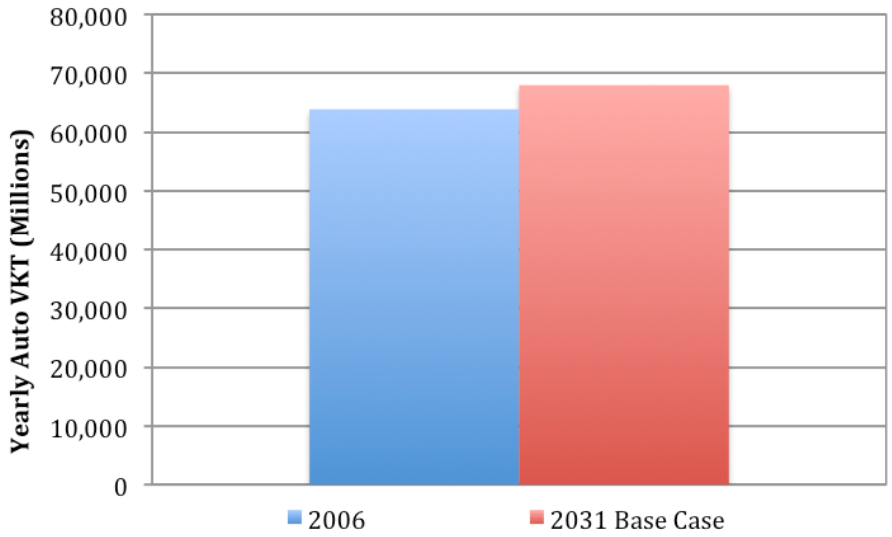


Figure 4: Total VKT in 2006 and 2031 Base Case

The increase in total VKTs is most pronounced in suburban and low-density regions of the Greater Golden Horseshoe.

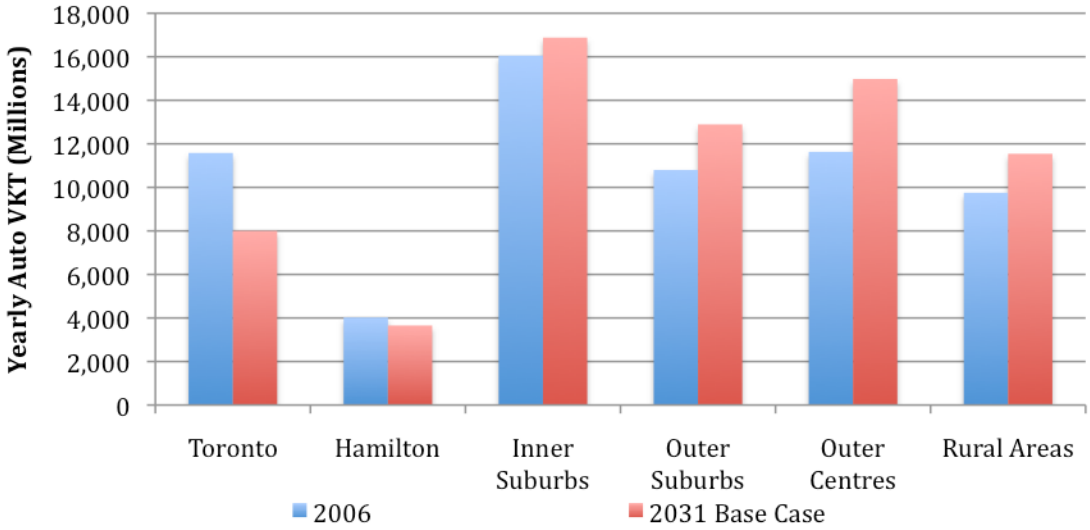


Figure 5: 2006 and 2031 Total VKT by municipality group

Figure 5 presents VKT results by region. The differences can be largely accounted for by higher population projections for the suburban and low-density areas leading to more driving (i.e. Toronto sees only a 15% rise in population whereas the outer suburbs grow by 66%). The greatest increase in Total VKT is in the outer centres which see significant population growth (40%) but are not included in The Big Move and therefore lack long-term rapid transit plans.

3.4 Transit Results

Transit use, similar to auto use, is heavily affected by the policies put forth in both The Big Move and The Growth Plan. Combined, these plans help bring a significant portion of the population

in the Greater Golden Horseshoe close to frequent, reliable transit service. Transit use is measured through passenger kilometres travelled (PKT). This measure represents the total distance travelled by passengers via buses, trains and other transit vehicles. Overall our results show that both per capita transit PKT (+54%) and total transit PKT (+110%) increase.

The increase in total transit PKT corresponds to an overall increase in ridership and should be expected solely on the basis of population growth. However, the increase in per capita transit PKT represents an increase in the likelihood that individuals themselves will ride transit showing that The Growth Plan and The Big Move do an effective job at increasing commuter choice. This increase in per capita transit PKT is illustrated in Figure 6.

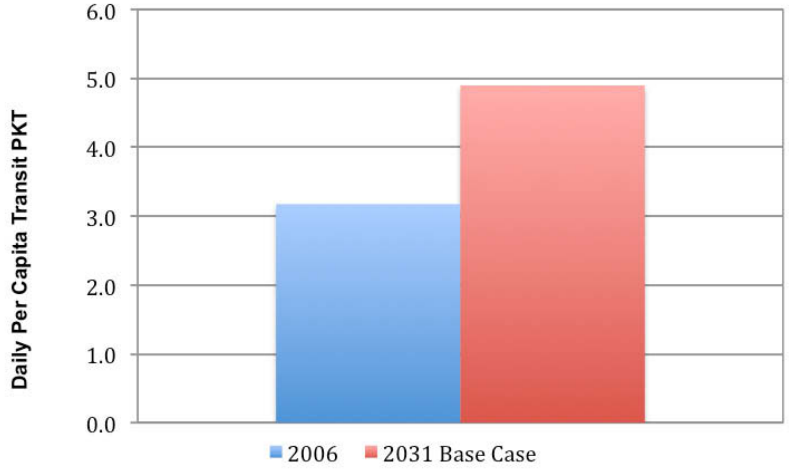


Figure 6: Per capita daily transit PKT— Base Case 2031 compared to 2006

Under the Base Case, people are 54% more likely to make a trip by transit as they were in 2006. Figure 7 below displays per capita transit PKT in each municipality group.

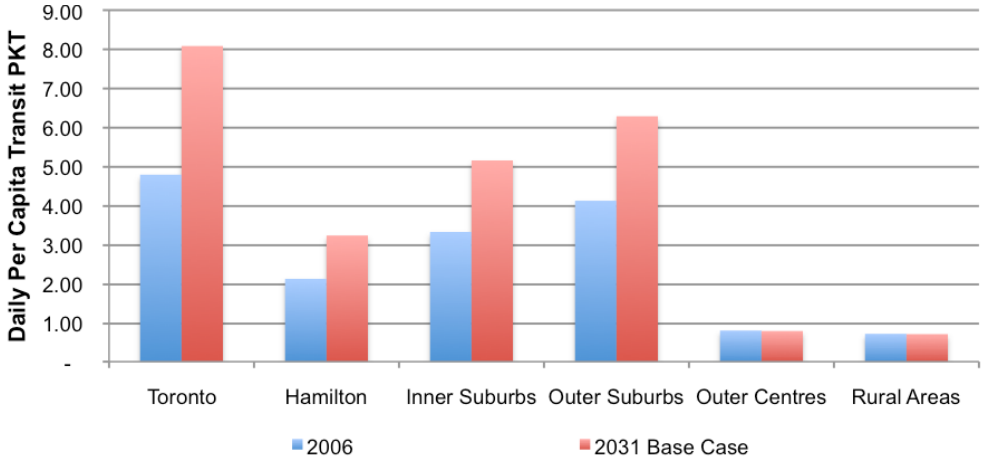


Figure 7: Daily per capita transit PKT by municipality group

Again, these findings underscore the importance of The Growth Plan and The Big Move being fully and rigorously implemented. In both areas outside the scope of The Big Move — outer centres and rural areas — no gains to per capita daily transit PKT are achieved, while in all other areas significant improvements are made.

3.5 Lessons From the Current Roadmap

The Base Case findings show that Ontario's current initiatives will result in significant GHG reductions. Four important conclusions can be learned from the Base Case results:

1. Current policies will make a difference but they need to be rigorously enforced and not weakened.
3. Reductions are only possible from the combined impacts of the two main Base Case policy areas, VKT and vehicle efficiency standards. Either policy area on its own would result in GHGs increasing in 2031 from 2006 levels.
4. These policies can be improved in order to achieve the level of GHGs needed from the transportation sector to meet Ontario's climate change commitments.
2. The greatest opportunities for improving policies and further reducing GHGs from the personal vehicle sector will come from better VKT policies and electrification of vehicles.

Meeting the Base Case

The Growth Plan and The Big Move increase total transit use by over 100% over 2006 values.

It is essential these policies are implemented fully and rigorously.

The Base Case modelling assumes that **all of these current policies are implemented fully and according to their highest rigour**. Historically, GHG emissions from road transportation in Ontario increased 23% between 1990 and 2007.[22] Adding four million people to the Greater Golden Horseshoe region in over 25 years may challenge the implementation of the current provincial initiatives and the goal to reverse past trends of steadily increasing GHGs from personal vehicles.

The current Base Case policies are not "done deals" and some are already under threat. A recent report conducted by the Greenbelt Alliance shows evidence of non-compliance of The Growth Plan by municipalities, including overestimation of population projections to increase urban growth boundaries and expand development in whitefield areas.[23]

With the Provincial Policy Statement coming up for review in March 2010, there is an opportunity to revise the rules of the game and place more authority with the Ministry of Energy and Infrastructure and the Growth Secretariat to properly enforce The Growth Plan and require municipalities to conform. A revised Policy Statement could endow the Ministry and the Growth Secretariat with greater authority over development and infrastructure investments in the Greater Golden Horseshoe (right now they can only comment).

Both The Growth Plan and The Big Move will need strong funding support to reach full implementation. Funding for rapid transit infrastructure and operations should be a top priority in provincial budgets. Since land-use and transportation systems often take many years to fully develop and have impacts that last for decades, they are particularly vulnerable to funding cuts that could stop or seriously delay potential GHG reductions. Similarly, there needs to be a prioritization of investments in support of Places to Grow infrastructure.

The Ontario Climate Change Action Plan's latest annual report shows that current policies in the transportation sector will add up to under 8 megatonnes of reductions, just less than 20% of total reductions from all measurable policy areas in 2020.[24]

Our analysis shows that current government policies in the personal vehicle sector in the Greater Golden Horseshoe will result in 3.6 million tonnes of GHG reductions in 2031 relative to 2006. Because our baseline looks at a different time frame and has smaller geographic and travel activity scopes than the work carried out by the Climate Change secretariat, the results cannot be directly compared.

In reviewing the findings of the Climate Change Secretariat, the Environmental Commissioner of Ontario expressed disappointment with current transportation emissions, stating:

> "The ECO had expected to see a greater focus on initiatives to reduce GHG emissions associated with transportation."[25]
>
> "GHG emission reductions… forecasted in the transportation and building sectors are very modest."[26]

It is clear that there is a gap between current policies and the province's 2020 GHG targets. Given that transportation represents the largest and fastest growing source of GHG emissions, significant opportunities exist to further drive down GHG emissions in the transportation sector.

Driving Down Carbon measures a baseline to examine the impact of current policies and to provide a case against which to assess how policy improvements can further reduce emissions from the personal transportation sector. These improvements are presented in the next chapter.

4. Greener Options to Reach Ontario's Climate Commitments

To go beyond the Base Case, *Driving Down Carbon* models improvements to current policies to achieve greater reductions in GHG emissions. This chapter summarizes the improvements to current policies and the rationale behind these proposed improvements.

The policies and targets that *Driving Down Carbon's* Greener Options case improves includes:

1. Reducing VKT by strengthening targets in The Growth Plan and The Big Move improving policies that influence commuter choice.
   a. Reducing the amount of development in Greenfield Areas and increasing intensification of the Built-up Areas.
   b. Increasing population and employment density in Greenfield Areas.
   c. Increasing the proportion of population and employment close to rapid transit.
   d. Increasing mode split — transit use over auto use via policies that influence commuter choice.
   e. Increasing HOV lanes for highways.
   f. Increasing active transportation (walking and cycling).
2. Reducing fuel consumption and related GHG emissions through improved vehicle technology.
   a. Achieving Ontario's goal for 5% electric vehicles.
   b. Electrifying GO Transit trains.
   c. Continuing to improve vehicle GHG standards post-2016.

4.1 Reducing Vehicle Kilometres Travelled

The analysis of the Base Case shows that The Growth Plan and The Big Move are on the right track for reducing VKT and limiting GHG emissions, but policy needs to drive VKT down further.

The Greener Options case strengthens targets in The Growth Plan and The Big Move and improves policies that influence commuter choice.

4.1.1 Decrease Greenfield Growth and Increase Intensification in the Built-up Areas

The guidelines in The Growth Plan include a stated intensification target for 40% of new growth to occur in the Built-up Areas (BUAs) and 60% of new development to occur in the Greenfield Areas.

The Greener Options Case proposes that this ratio be reversed so that 60% of new population growth is allocated to Built-up Areas and 40% to the Greenfield Areas. This proposed target increase is supported by the following information:

- Higher intensification targets for other jurisdictions
- Municipalities within the Greater Golden Horseshoe that are striving for higher intensification targets
- Research showing that allocating more population to BUAs will reduce VKTs and GHGs.

One of the most influential factors in reducing VKT and associated GHG emissions is reducing the distance of development to the urban core. Residents in the outer suburbs produce between 2.0 and 2.7 times the GHG emissions of residents in the central area,[27] and for every kilometre from the urban centre, VKT increases by 1.0 km.[28] Under The Growth Plan, these areas will experience the greatest population growth and the greatest GHG emissions by 2031; therefore targets need to be improved to reverse this trend.

Intensification targets for the Greater Golden Horseshoe Region — Ontario's and Canada's most populated region — are lower than those of similarly populated jurisdictions. Examples include 60 to 70% intensification target for the United Kingdom and New South Wales.[29] San Francisco intends to accommodate 56% of the Bay Area's employment and population growth in just 3% of the region's land area.[30]

Under The Growth Plan some regions in Ontario are going further. The Region of Waterloo is aiming for an intensification target of 45%.[31] Similarly, the Region of Durham has directed Whitby and Ajax to accommodate 45% and 54% respectively of all new residential growth from 2015 to 2031 through intensification.[32] Markham's official plan calls for 60% intensification and may go higher.[33] The City of Toronto is at 100% intensification and is planning to accommodate up to 500,000 new residents without expanding its land base.

Greater intensification would make higher orders of transit more feasible, encourage greater redevelopment in the existing BUA, reduce sprawl, make better use of existing infrastructure and allow existing transit services to be strengthened and expanded. In Whitby it was noted that:

> "If planned for properly, intensification can bring many benefits to the Town. It can bring new businesses to service existing neighbourhoods, revitalize older under-utilized lands, and attract a critical mass of new residents to support services like schools and public transit."[34]

However, most municipalities are not voluntarily increasing their targets for intensification, and some are attempting to expand population into the whitefields.[35]

Therefore, the Greener Options case increases The Growth Plan's intensification target to have 60% (from 40%) of all new residential development occurring annually within the region to occur within the BUA. This target is consistent with leading jurisdictions and represents a reversal of The Growth Plan's 40/60 BUA/GFA target to 60/40 BUA/GFA.

Greener Option:	Increase minimum intensification target in The Growth Plan to 60% (from 40%).

4.1.2 Increase Density in Greenfield Areas

For development that does occur in Greenfield Areas, the Greener Options Case proposes increasing the Greenfield Area density target from its current 50 people and jobs per hectare to 70 people and jobs per hectare. The following information supports this improvement:

- A density of 50 residents and jobs per hectare has been shown to represent the minimum density that can support 30-minute wait times for bus service.[36]
- Densities of approximately 78 to 80 people and jobs per hectare are shown to support 15-minute wait times for transit.[37]
- A recent Ontario study shows that an increase to 70 people and jobs per hectare can be achieved without changing the characteristics and structure of the neighbourhood.
- Research showing that compactness is the most important factor for reducing automobile dependence.[38]

The Urban Land Institute, in its recent publication Growing Cooler, writes that people in more compact developments drive 20–40% less and have emission reductions of 7–10% relative to continuing sprawl.[39] Other studies have shown that a 30% reduction in driving occurs every time density is doubled.[40]

Ontario's Transit-Supportive Land Use guidelines recommend avoiding designating additional land for urban development until densities in existing urban areas begin to approach the target levels set in official plans and that target densities should be sufficiently high to support high quality transit service.[41]

Figure 8 illustrates feasible transit service based on population density. The current Places to Grow density target for greenfield development is 50 residents and jobs per hectare, which has been shown to represent the minimum density of transit-oriented development threshold that can support 30-minute conventional bus service.[42] However, transit service headways or wait times longer than 15 minutes during off-peak hours are shown to be a large disincentive for users with other transportation option.[43] As shown in Figure 8, 15-minute headways require a minimum density of approximately 78 to 80 people and jobs per hectare to be feasible.[44]

Achieving a greater level of transit service is especially important to entice existing suburbanites who already have automobile access to shift to transit and so that new populations will have lower vehicle ownership rates and corresponding lower VKT. For example, Ottawa's successful Transitway provides frequent and rapid transit service to suburban locations, with bus stops

located within a five-minute walk for residents. The Bus Rapid Transit Service operates at a three-minute frequency during peak periods and a five-minute frequency during the day.[45]

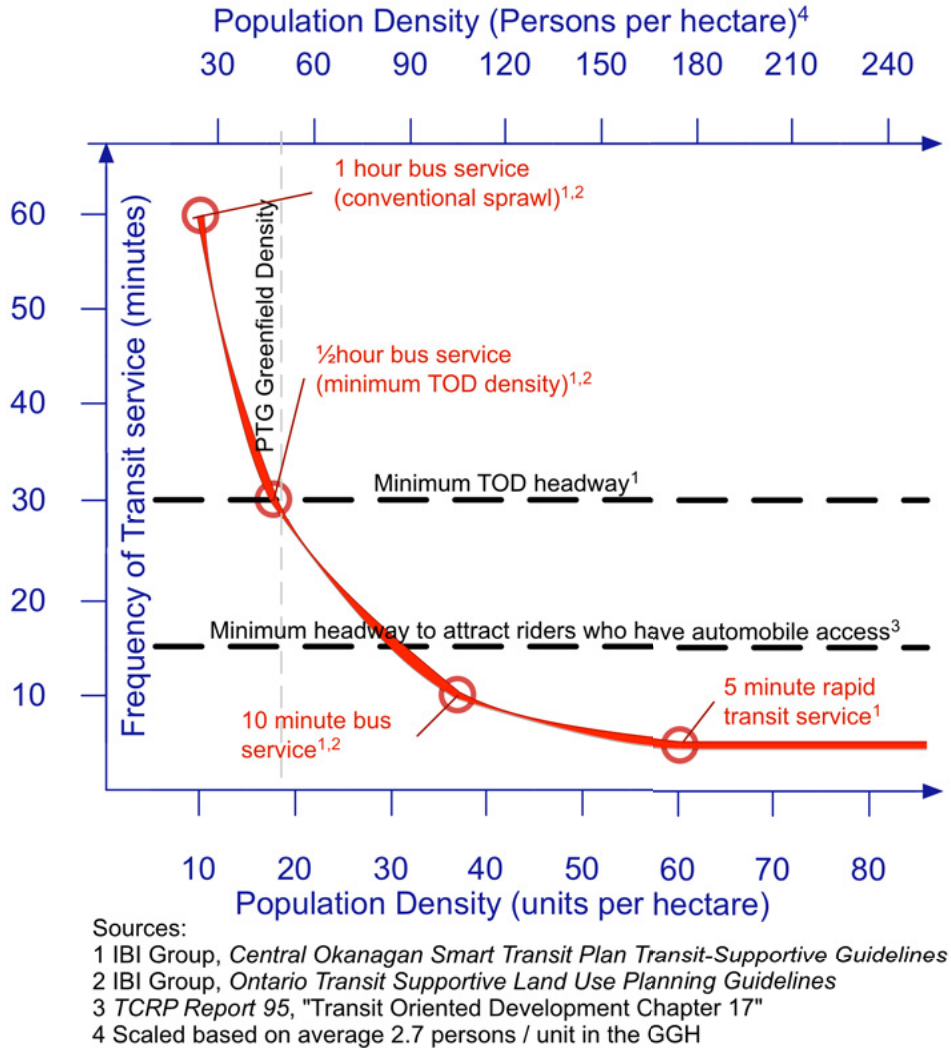


Figure 8: Transit service levels and corresponding density

Further evidence to support increasing The Growth Plan's 50 people/jobs per hectare target comes from modelling conducted by the municipality of Waterloo to examine density increases for the Greenfield Areas to 60 and 70 people/jobs per hectare. This study found that the greatest change in the layout of the suburban neighbourhood occurs when increasing the density from 50 to 60 people/jobs per hectare, as it requires a reconfiguration of road patterns to provide for greater connectivity and facilitate transit. Increases above and beyond 60 would require little further change. The study also found that, with the exception of an increase in the heights of some of the buildings, the look of the neighbourhood changes little as densities increase, even up to 70 people/jobs per hectare.[46] Thus, higher densities and better transit are achieved without significantly changing suburban characteristics.

In addition to supporting effective and frequent transit service, improved densities should foster greater compactness of housing, which is beneficial for energy savings outside the transportation

sector. At least 37 units per hectare would be required to achieve a change from low-density detached housing.[47] This corresponds with 98 people/jobs per hectare, significantly higher than that proposed by Places to Grow.

In summary, the research shows that 60 people/jobs per hectare is the minimum threshold to require reconfiguration of road patterns to accommodate transit, while 80 people/jobs per hectare is the minimum threshold to accommodate 15-minute wait times for transit, the threshold for transit use. The Greener Options case proposes increasing the Greenfield Area density target to 70 people/jobs per hectare, the median of these two important density targets and the level of density increase that can be achieved without changing the characteristics and structure of the neighbourhood.

Greener Option:	Increase minimum density target for Greenfield Areas to 70 people/jobs per hectare by 2015.

4.1.3 Increase Population and Employment Close to Rapid Transit

Currently, The Growth Plan includes density targets for Urban Growth Centres but does not enforce actual density targets for intensification areas (areas of high population and employment along transportation corridors and nodes).

The Greener Options case proposes the establishment of such targets in order to increase the proportion of population and employment close to rapid transit. The following information supports this improvement:

- Access to rapid transit is a major factor in improving commuter choice.
- VKT decreases as population is located closer to the city core, but the same is true for non-CBD employment centres (intensification areas at transit nodes).
- Success in other jurisdictions locating population close to transit in increasing uptake of transit use.

In Toronto it was found that proximity to rapid transit stations and transit service level had a positive effect on transit ridership, and as distance to the nearest rapid transit station increased so too did auto-use.[48] In the San Francisco area, a study found that 33% of residents living close to the Bay Area Rapid Transit system used the system to get to work versus 5% for the rest of the population.[49] A study in Washington, D.C., found that transit ridership declines 0.65% every 100 feet from a transit stop.[50]

Ottawa's regional goals are to have 40% of jobs within 400 m of its Transitway bus rapid transit system. By 1996, the city was able to attract more riders per capita than any similar transit system in North America, including rail systems. It handled a transit mode split of 70% during peak periods to downtown and 30% of trips to suburban employment areas near the Transitway.[51]

One means of improving access to transit is to build more transit lines. This improvement is expected from Metrolinx's The Big Move, which adds over 60 rapid transit routes totalling over 1,200 km.[52] The positive result of this change is measured in the Base Case model. The Greener

Options case expands on this improvement by proposing similar transit development in the Outer Centres, which are currently not included in the scope of Metrolinx. Waterloo, for example, is a municipality outside the Metrolinx scope but within the Places to Grow scope that is developing a transit plan. The Greener Options case proposes transit plans that locate populations close to rapid transit in the Outer Centres.

To go beyond the Base Case, another strategy is to locate a greater proportion of population and employment close to existing and new transit lines. The Growth Plan contains stated objectives to achieve a mix of employment and residents in UGCs and intensification areas. The Growth Plan provides density targets for UGCs, which will result in increasing the percentage of population and jobs close to transit. However, there are no actual targets for intensification areas which are intended to concentrate jobs and residents along transportation corridors or at transit nodes, thus close to transit.

There also are no control measures for curtailing industrial parks, the scattered employment areas located in more affordable, auto-oriented suburban employment lands throughout the Greater Golden Horseshoe, with densities too low to support transit; auto drive trips and total trips outpace population growth in suburban zones.[53] This trend is augmenting reliance on automobiles since it is impossible to serve the dispersed jobs with good-quality public transportation.[54] This has resulted in auto drive trips and total trips increasing at a greater rate than population in suburban zones.[55] It is doubtful that The Growth Plan, with its current targets, will reverse this trend.

The Greener Options case proposes strengthening The Growth Plan's targets to ensure that a greater proportion of new population is located close to transit in intensification areas at transit nodes and along transportation corridors. By virtue, it requires that The Growth Plan include actual targets for intensification areas, assuming that intensification areas are within 2 km or less from a rapid transit node.

The Greener Options case ties this recommendation to that of improving the BUA/GFA split, whereby the increased proportion of population in Built-up Areas is allocated to transit corridors and nodes. In other words, an increase of 40–60% intensification would require that this additional 20% BUA population be allocated within 2 km of transit within the BUA. See Appendix C for methodology and resulting table of density targets for intensification areas.

Greener Options:

1. Develop a long-term transit plan for the outer centres to bring their level of transit access in line with areas included in the Metrolinx plan.
2. Set density targets for intensification areas along transit corridors and nodes.

4.1.4 Increase Mode Split

Increasing mode split — the use of public transit over autos — reduces the amount of driving (VKT). The Big Move currently projects a 2% increase in mode split by 2031 from what exists now. The Greener Options case proposes that it is possible to achieve a 10% increase in mode split

through policies that influence commuter choice, which currently are not included in The Big Move.

Such policies include pay-as-you drive insurance, road pricing, a regional fuel tax and parking policies. Examples to support the implementation of these policies include:

- Parking caps in downtown Portland helped increase transit use in the city from about 20% in the 1970s to nearly 50% by the mid-1990s.[56]
- A study concluded that a congestion charge in Californian cities would decrease GHG emissions by 3.9–8.1%.[57]
- A 2010 Harvard study shows that taxing gasoline results in the highest reductions in GHG emissions relative to other transportation policies[58]
- Research found pay-as-you-drive insurance to be one of the most effective methods of decreasing VKT and promoting mode shift.[59]
- A variety of employer-based transportation demand management programs can increase transit-use, carpooling and active transportation and reduce car trips. For example, a "parking cash-out" law in California that offers a cash allowance in lieu of subsidized parking spaces has reduced car trips by 11%.[60]

If a regional fuel tax were developed for the Greater Golden Horseshoe region, revenues could be invested in transit and smart growth infrastructure.

Both The Organization for Economic Co-operation and Development (OECD) and Ontario's Environment Commissioner recommend road pricing as a solution to congestion and associated costs in lost productivity ($3.3 billion) for the GTA. The OECD notes that Toronto has one of the highest levels of congestion and has one of the highest rates of auto-dependency of OECD countries, yet unlike other OECD countries it has no road pricing policies.[61]

Driving Down Carbon's Greener Options case does not prescribe any specific policies for transportation demand management or for influencing commuter choice; instead it models for a more ambitious mode-split target and proposes the province determine and implement appropriate policies to achieve this increased mode split.

Metrolinx estimates that its recommendations, such as employer-provided metro-passes and improved transit integration with other modes, will lead to a gain of two percentage points in transit ridership from its baseline model (i.e., up to 26.2% from 24.2%). The Greener Options case assumes that the policies proposed by Metrolinx are a good start, but there is ample room for the commuter choice policies discussed above to further increase transit use. With these policies, a 10% increase in mode split should be achievable by 2031 in the Greater Golden Horseshoe region.

Greener Option:	Increase the mode split increase from the 2% Metrolinx target to a 10% increase through additional commuter choice policies.

4.1.5 Reduce Impacts of Highway Development

The Ministry of Transportation has developed an extensive highway construction plan with many projects potentially undermining the efforts of The Growth Plan and The Big Move. Particular highways in the Greater Golden Horseshoe are being extended into the Greenfield Areas to service commuter auto use rather than for goods movement. These highways will leapfrog the greenbelt, induce auto use[62] and adversely affect public transit.[63]

Metrolinx examined the impact of cancelling the expansion of three particular highway extensions in the Greater Golden Horseshoe region — the 407 East, Highway 404 and Highway 427 extensions — as well as other minor improvement documented in the MTO's capital program.[64] These projects all serve a number of suburban communities, encouraging the development of auto-centric neighbourhoods. Metrolinx found that by cancelling these projects the following outcomes would result:

- Decrease in yearly costs for auto drivers ($200/driver/year).
- Decrease of $15 billion in capital costs.
- Decrease of approximately one megatonne of CO_2 emissions per year.

These highway extensions are in various stages of environmental assessment and some have begun construction. It is therefore difficult to factor the absence of one or more particular projects in the Greener Options case. It is expected that, if stronger Growth Plan policies are adopted, fewer highways will be required.

Thus, *Driving Down Carbon* does not factor the elimination of one or more highways in the Greener Options model; however, it is recommended that the province consider halting and forgoing highway projects that service Greenfield development and direct investment to transit. The Highway 404 extension for example, is not included in MTO's current plan and is in a good position to be reconsidered.

Driving Down Carbon also proposes that the MTO's Niagara–GTA and GTA–West corridor studies do not recommend highway development or expansion and instead focus on alternatives, such as rail corridor expansion. New highways along these corridors are not currently included in provincial planning documents, and as modelling done by Metrolinx shows, their addition would lead to an increase in VKTs and GHGs of approximately 10%.[65]

The key policy improvement for highways measured in the Greener Options case is the impact of greater investment in HOV lanes. The Greener Options case proposes converting one lane along the QEW and all 400 series highways and inner-city highways (i.e. Don Valley Parkway, Gardener Expressway, Conestoga Parkway, Lincoln M. Alexander Parkway).

Greener Option:	Greater investment in HOV lanes, converting one lane along the QEW, all 400 series highways and inner-city highways.

4.1.6 Increasing Active Transportation

The Greener Options case proposes doubling the proportion of active transportation — walking and cycling — that is currently projected by Metrolinx. This is supported by the following:

- The average motorist makes 2,000 trips each year that are under 3 km.[66] This is the type of active transportation mode shift that can be encouraged with better and safer cycling and walking infrastructure.
- A recent OECD report[67] concludes that vehicle speeds over 30 km/h make cars incompatible with pedestrians and bicycles. Therefore, reducing and enforcing speeds in certain urban areas is another way to encourage active transportation and walkable cities.

Across the Greater Golden Horseshoe region, active transportation currently accounts for under 10% of all trips. Baseline results show that even following the implementation of The Big Move and The Growth Plan, Ontario will still lag behind several developed countries in regards to active transportation.

The Growth Plan has a vision for compact, mixed-use communities that support greater active transportation, but the plan includes no targets for increased AT mode splits or specific targets for other policies to achieve this result. Setting targets and developing policies can help the Greater Golden Horseshoe region close the gap between itself and leading jurisdictions' active transportation mode splits.

In general, a scale-up in infrastructure for pedestrians and bikers will be required along with policies that can ensure streetscapes are welcoming and safe for pedestrians and cyclists (i.e., cycle paths, rights of way, wide sidewalks, shade trees). *Driving Down Carbon* does not prescribe any specific policies for active transportation; instead it recommends that the province aims to double active transportation trips from 2006 to 2031 in the Greener Options case and that the province study and implement appropriate policies to achieve these targets.

Greener Option: Implement policies to double active transportation between 2006 and 2031.

4.2 Reducing Emissions Through Vehicle Technology

The Base Case results show that significant GHG reductions are achieved through the implementation of the federal regulation on vehicle GHG emissions standards. The Greener Options case explores how improvements in vehicle efficiency and electrification can achieve even deeper GHG emission reductions.

4.2.1 Improving Fuel Efficiency of Vehicles

As noted in Chapter 2, the Base Case assumes that Canada harmonizes with the U.S. EPA/NHTSA proposed fuel economy/GHG standards for model years 2012 to 2016. While stricter fuel economy standards or GHG standards have been proposed by other jurisdictions including the European Union and Japan, attaining U.S. standards for Ontario and Canada is a

significant jump from the current lack of effective standards in Ontario and Canada. The Greener Options case models improvements to fuel economy standards post-2016 until 2031. This proposed improvement is supported by the following:

- Fuel economy should be expected to improve post-2016 up to 2031.[68]
- It is anticipated that zero-emissions electric vehicles will contribute to meeting the vehicle GHG standards.

The Greener Options case models the increased fuel efficiency from 2017 to 2020 based on California's proposed standards (Pavley 2). Improvements beyond 2030 are based on analyses of potential cost-effective uptake of current technologies, combined with electric vehicles. These improvements are presented in Table 2.

Table 2: Estimated fuel efficiency for Ontario's fleet of vehicles

Fuel efficiency (L/100 km)	2012	2016	2021	2031
Base Case, New Cars and Light Trucks Combined	8.1	6.9	6.9	6.9
Base Case, Total fleet, new and existing vehicles	9.5	8.8	7.9	7.1
Greener Options, New Cars and Light Trucks Combined	8.1	6.9	5.6	3.9
Greener Options, Total fleet, new and existing vehicles	9.5	8.8	7.6	5.6

Electric vehicles in Ontario are assumed to contribute to meeting the fuel economy standards, based on GHG-equivalency. Based on this assumption, by 2031 new fossil-fuelled cars and light trucks will meet an average fuel economy of 4.6 L/100km. Electric vehicles will bring the overall average down to 3.9 L/100km, as shown in Table 2.

Greener Option: Follow proposed Environment Canada regulations for vehicle emission standards for 2011 through 2016, with continued fuel efficiency through to 2031.

4.2.2 Electric Vehicles

The Greener Options case proposes Ontario develop a strategy to achieve 5% electric vehicles by 2020, a target that was set out as a challenge by the provincial government in 2009.[69] Striving towards this target is supported by the following:

- A key policy in achieving this target is to include electric vehicles as part of the compliance pathway to meet GHG vehicle emission targets, as discussed above.
- If manufacturers can claim credit for lower GHG from electric vehicles, increased sales of electric vehicles will help manufacturers meet tighter GHG standards.
- Electric vehicles are approximately three times more efficient from an energy perspective than conventional automobiles with an internal combustion engine.[70]

Making a shift to electric vehicles can help significantly reduce transportation-related GHG emissions. For example, a Chevrolet Volt on the current Ontario power grid would be responsible for emissions of approximately 4,500 gCO_2/100 miles.[71] By 2031, this would drop further to 845 gCO_2/100 miles based on expected improvements to the Ontario power grid.[72] By comparison, a 2010 Toyota Corolla has a combined fuel efficiency rating of 6.8 L/100 km, which equates to over 28,000 gCO_2/100 miles.[73]

GHG savings from electric vehicles could be increased by moving Ontario further into a grid powered by renewable energy. These savings also assume that added demand from battery-powered cars will not result in a significant net increase in electricity load. Grid experts estimate that the gap between peak and off-peak demand will be able to accommodate electric vehicles, with the capacity to charge 10,000,000 electric vehicles overnight in Ontario without any need for additional generating capacity.[74,75]

Ontario's proposed goal of 5% electric vehicles by 2020 goes beyond those set both nationally in the U.S. and within the state of California. The current U.S. goal corresponds to approximately one vehicle in 250 based on current numbers.[76] California has a target of putting 7,500 zero emissions vehicles on the road by 2014,[77] though it abandoned a similar target under which 10% of all vehicles were supposed to be emissions-free by 2003.[78]

Policies in other countries are more aggressive. Israel intends to deploy 100,000 electric cars by 2011 supported by 500,000 recharging points and solar energy to meet increased demand on the grid.[79] Lisbon has a goal of 20% electric vehicles and 1300 recharging points by 2011.[80] Denmark plans to deploy electric vehicles by 2011, with 20,000 recharging stations powered by wind.[81]

Our Greener Options case proposes that 5% electric vehicles is achieved. It recognizes current efforts to encourage production and uptake of electric vehicles (as described in the Base Case) and proposes that these efforts be part of a more comprehensive plan to ensure that Ontario is electric vehicle–ready with the right infrastructure and financial policies.

Greener Option:	Based on Ontario government announcements, 5% of personal vehicles on the road in 2020 will be electric. The fraction of electric vehicles will continue to increase through 2031.

4.2.3 Electrification of Public Transportation

Electric personal vehicles are a longer-term solution as they take time to penetrate the market, hence a 5% vehicle stock target by 2020, whereas shifting diesel buses and trains to electric power for existing and priority new transit lines can make an impact in the near term.

In addition to Base Case plans to electrify buses and build LRT lines, the Greener Options case also proposes that GO Transit train service becomes fully electric.

Greener Option:	Full electrification of GO Transit trains.

Policies that influence commuter choice can reduce Vehicle Kilometres Travelled.

Photo: Roberta Franchuk, The Pembina Institute

5. Greener Options Results: Getting up to Speed

The following section presents the results of improved policies in the Greener Options case, comparing GHG reductions from Greener Options to the Base Case and 2006 GHG levels.

5.1 General Findings

Figure 9 below presents GHG emissions from the personal vehicle sector in the Greater Golden Horseshoe that will result from improved policies in the Greener Options case 2031 compared to GHG emissions in 2006 and the 2031 Base Case (current government policies).

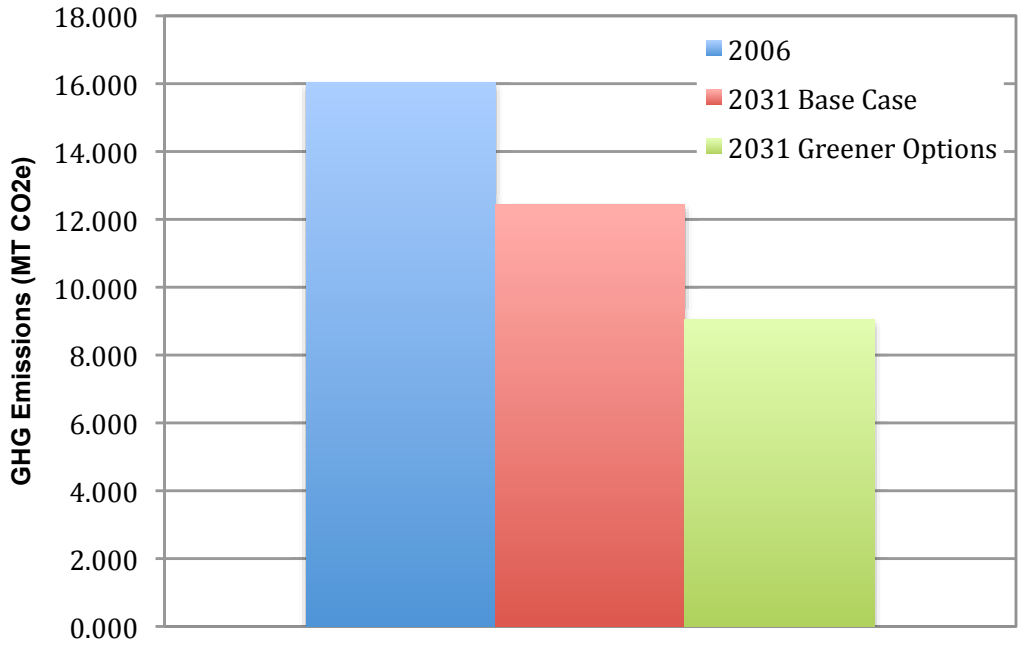


Figure 9 Greenhouse gas emissions for the Greater Golden Horseshoe

The improved policies in the Greener Options Case would result in 27% less GHG emissions from the personal transportation sector in the Greater Golden Horseshoe region than current policies in the Base Case and a 44% decrease from 2006 levels.

Figure 10 below shows the policy breakdown of additional reductions achieved through the Greener Options Case relative to the Base Case. The strengthening of key targets in The Growth Plan together with policies that improve access to transit and commuter choice would be responsible for 39% of the additional GHG reductions. Ensuring that federal regulations for vehicle GHG emissions continue to improve post-2016 would account for 57% of the additional

reductions, with the province's electric vehicle target representing half of that. The breakdown of policy actions is as follows:

- Improved VKT Policies: 39% of additional GHG reductions
  - » Strengthening targets in The Growth Plan: Improved density and intensification targets: 16%
  - » Improving and introducing actions that improve access to transit and commuter choice: 23%
- Continuing to improve efficiency of vehicles, including electric vehicles: 57% of additional GHG reductions
  - » Achieving Ontario's goal for 5% electric vehicles by 2020: 27%
  - » Improving vehicle fuel economy of internal combustion engine vehicles: 30%
- Electrifying GO Transit Trains: 4%

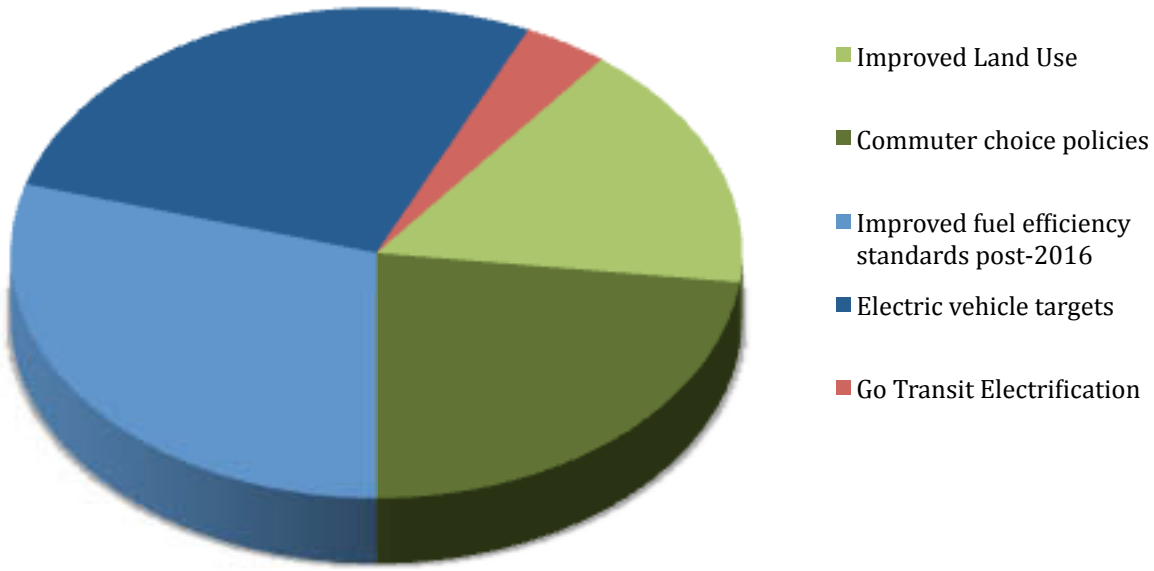


Figure 10: Breakdown of additional reductions by 2031 in Greener Options Case compared to the Base Case

5.2 Getting Out of the Car

As discussed in Chapter 3, current government policies will result in less VKTs per capita; however, under the Base Case total VKTs do increase in 2031 relative to 2006 due to the increased number of drivers projected for the region. The stronger targets and commuter choice policy improvements proposed for the Greener Options case reverse this trend and lead to a decrease in total VKTs (and associated GHG emissions) by 2031, leading to fewer cars on the road and less congestion than exists even today. See Figure 11.

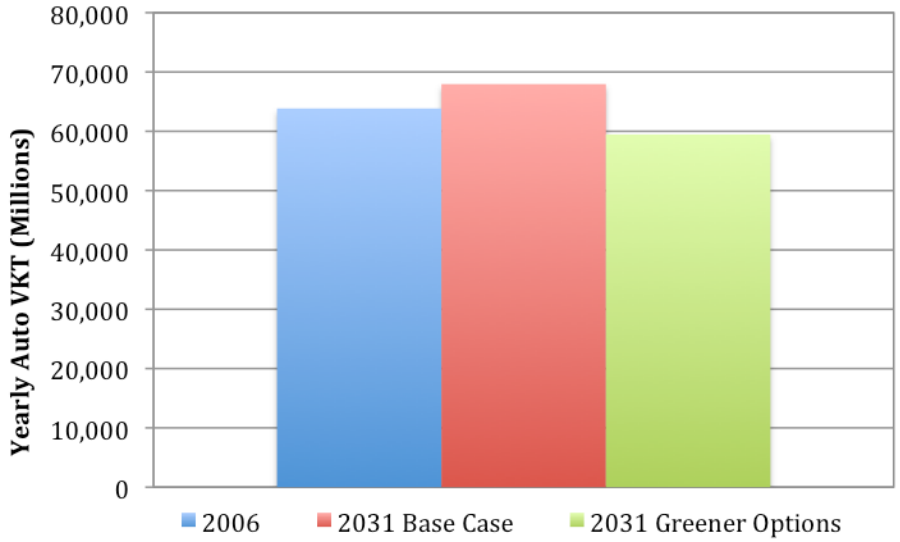


Figure 11: Millions of auto VKT (yearly)

5.2.1 VKT Reductions by Region

While all regions benefit from technological improvements (vehicle efficiency and electric vehicles), differences between municipality types occur from relative impact of the policies that reduce VKT.

Figure 12 shows total annual VKTs for the Greener Options scenario compared to both the Base Case and 2006 results. Under the Base Case all municipalities other than Toronto and Hamilton see rises in VKT in 2031 as compared to 2031. The Greener Options reverses this trend for outer centres and inner suburbs while decreasing VKT in Toronto and Hamilton further.

Even under the Greener Options Case total VKT do not decrease in either the outer suburbs or rural areas. In the case of rural areas this is primarily a result of an inability to provide effective transit in these areas due to lack of population density. The outer suburbs however see increases to VKT primarily due to their increase in population; they are forecasted to grow by over 65%, a huge influx of commuters in these municipalities. To reduce driving in these communities, even stronger policies to improve commuter choice are required.

Getting Intense

In Toronto where 100% of the population is already intense, policies to intensify — or put more population in built-up areas — has little relative gain.

However, for the population-soaring suburbs, higher intensification targets have a big impact. Even under current planning and transit initiatives, the number of cars on the road goes up in the suburbs. By increasing intensification targets, this trend is reversed.

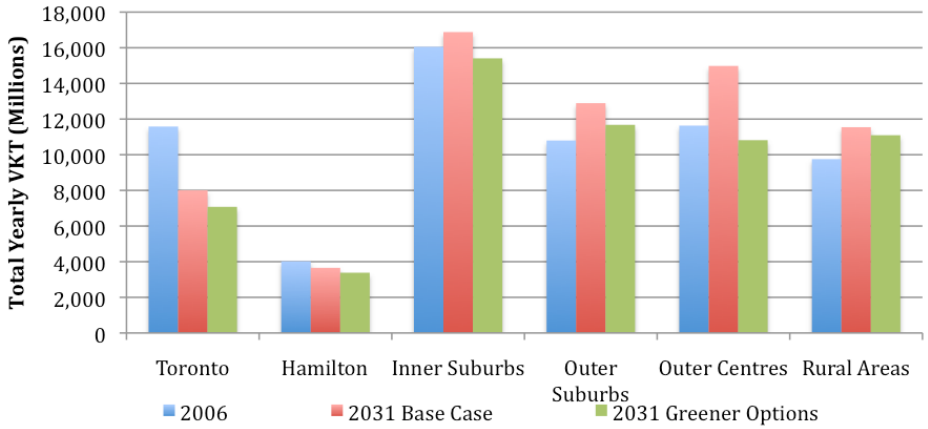


Figure 12: Total VKT by municipality group

Between the Base Case and Greener Options Case, the biggest change occurs in the outer centres. This is because the outer centres are not included in the geographic scope of The Big Move transit plan; therefore, under the Base Case, no major transit infrastructure gains are expected in these areas due to current policies making it difficult to improve commuter choice and reduce VKTs. Greener Options suggests scaling up transit in these outer centres to levels met by The Big Move in other communities significantly improving commuter choice, resulting in the large drop in auto use between the Base Case and Greener Options evident in Figure 12.

5.3 Hopping on Transit

Transit use, similar to auto use, is heavily affected by policies and targets in The Big Move and The Growth Plan affecting access to transit and the additional policies recommended in the Greener Options case that influence commuter choice. Under the Base Case, people are 54% more likely to make a trip by transit as they were in 2006. This value increases to 81% with Greener Options.

Figure 13 shows the improved ability of transit to draw passengers in the various regions of the Greater Golden Horseshoe.

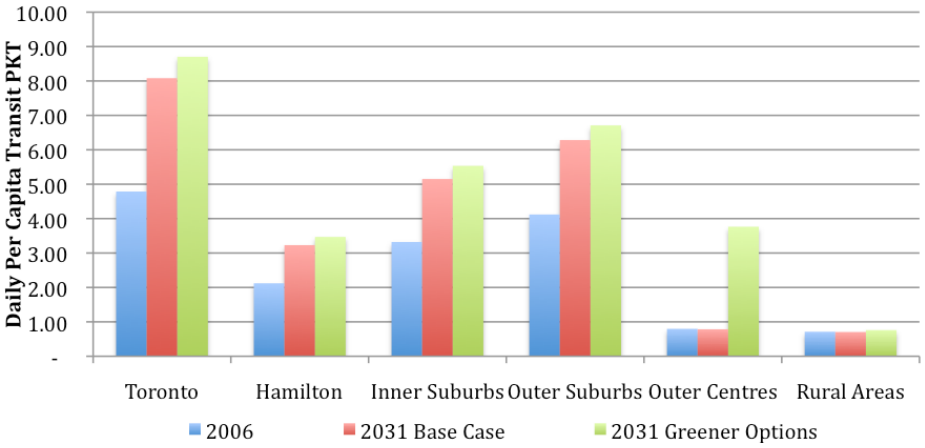


Figure 13: Transit PKT by municipality group

In the City of Toronto by 2031 under both the Base Case and Greener Options, transit PKT surpasses auto VKT. This suggests that by 2031 residents of Toronto will be more likely to make a trip by transit than by driving. While such is already the case in a few select neighbourhoods of Toronto, expanding this trend to extend across the city will be a significant accomplishment and helps to show how far policy can go towards improving commuter choice.

In the outer centres, the introduction of a rapid transit plan under Greener Options has a major impact on transit ridership, more than quadrupling the likelihood of an individual using transit. These communities already have significant built-up areas and downtowns, meaning the introduction of a rapid transit system can significantly improve commuter choice and how people get around in these cities.

5.4 Saving Land

A key component of The Growth Plan is protecting undeveloped land, including agricultural land in the Greater Golden Horseshoe region. Figure 14 shows the relative savings from land conversion for the Base Case and the Greener Options.

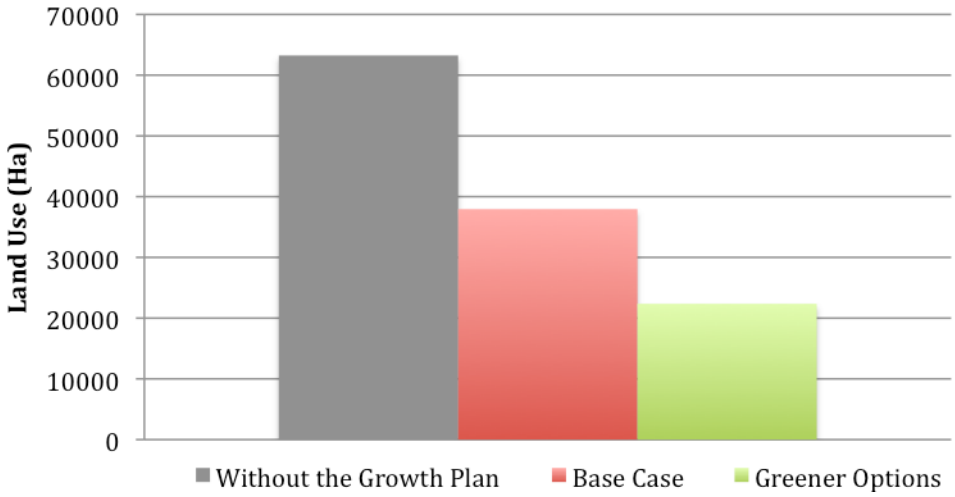


Figure 14: Reductions in land use

Without The Growth Plan, it is estimated that 63,000 hectares of currently undeveloped land in the Greenfield Areas of the Greater Golden Horseshoe will be required to accommodate population growth. This is approximately equivalent to the size of the City of Toronto. The Base Case results in savings of 25,000 hectares. With Greener Options, these savings are increased to over 40,000 hectares.

5.5 Cleaning Up Vehicles

As discussed in Chapter 4, the Greener Options case continues to improve the new federal regulation for vehicle GHG emission standards after 2016. In Figure 10, the total GHG savings for improved efficiency is the combination of the light blue and dark blue wedges. The dark blue

wedge shows what portion of these savings would be due to electric vehicles if the 5% electric vehicle target were met.

It is expected that this uptake of electric vehicles is part of the compliance pathway for meeting the federal regulations for vehicle GHG emission reductions — whether it be more compact cars, SUVs with greater fuel economy or zero emission electric vehicles, the manufacturer's fleet would all add up to the total emissions target. Therefore, electric vehicles are not counted twice; they are included in the vehicle emissions regulation target. If Ontario were to achieve its goal of 5% electric vehicles by 2020, electric vehicles would account for about half of the improved vehicle GHG emissions regulation target proposed in the Greener Options case. The remaining half would be achieved by improving fuel efficiency of internal combustion engine vehicles.

Regardless of the vehicle mix to achieve a fleet average for vehicle emissions, the findings both in the Base Case and in the Greener Options case are predicated on the effectiveness of the land use policies. Fuel efficiency standards and electrification affect only new vehicles and are subject to the rebound effect, in which some of the efficiency gain is offset by increased use due to lower operating costs. Vehicle technology must be coupled with strong policies that permanently reduce VKT.

Electrifying GO Trains accounts for approximately 0.1 megatonnes of the GHG savings in the Greener Options case. The actual realized GHG savings will depend on the ridership and operations of GO Trains in the future and the energy efficiency of the electrification technology. Metrolinx has commissioned a comprehensive study on the potential benefits and costs associated with replacing diesel with electric propulsion for GO Trains, but those results were not yet available for this report.[82]

Figure 15 presents the relative GHG reductions due to personal transportation technology solutions for the Greener Options case over the Base Case.

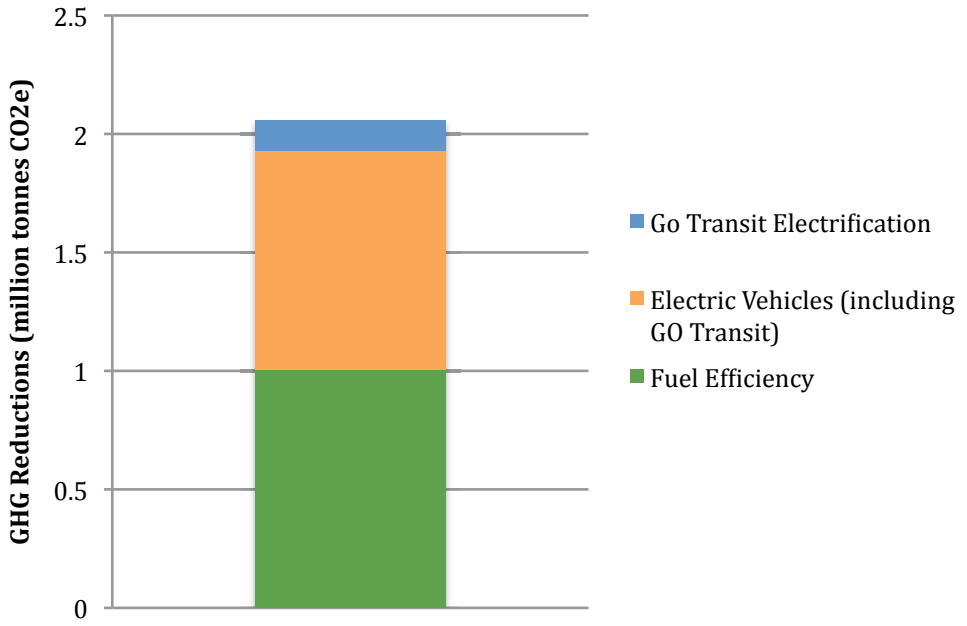


Figure 15: GHG reductions in Greener Options Case from cleaner vehicles and trains in 2031 over the Base Case in 2031.

5.6 Key Results

Table 3: Key results

	2006	2031 Base Case	2031 Greener Options
Population (millions)	8.4	11.5	11.5
Auto Use			
Yearly Auto VKT (millions)	63,840	67,953	59,453
Average Auto Occupancy	1.22	1.27	1.32
Per Capita Daily Auto VKT	20.7	16.2	14.2
Transit Use			
Yearly Transit PKT (millions)	9,775	20,556	24,158
Percent of Population Within 2 km of Rapid Transit	31%	62%	76%
km of Rapid Transit (estimated)[a]	500	1725	2115
Active Transportation			
Active Transportation Mode Split	6.0%	8.5%	12.0%
Land Use			
Greenfield Area Required (Ha)	n/a	38,000	22,000
Technology			
Average Auto Fuel Economy (L/100 km)	9.5	7.1	5.6
Stock of Electric Vehicles	0	n/a[b]	1,000,000
Greenhouse Gas Emissions			
Annual GHG Emissions (MT CO_2e)	16.05	12.44	9.04
Per Capita Annual Emissions (T CO_2e)	1.90	1.08	0.79

Notes:

a. 2006 and 2031 Base Case "km of rapid transit" based on Metrolinx, *The Big Move*, 2008. Greener Options estimated based on comparison to 2031 Base Case values.

b. It is likely electric vehicles will be on the road by 2031 in the Base Case due to stronger fuel economy standards from the federal government and initiatives introduced by the Ontario government.. However, insufficient information was available at the time of this report to estimate the impacts of these initiatives on the number of electric vehicles in Ontario. Further information is needed on how governments will include electric vehicles in fuel economy standards and the customer reaction to the Ontario electric vehicle initiatives.

6. Actions to Meet the Greener Options Case

6.1 Policy Actions for Improving Current Policies

Driving Down Carbon recommends that the province consider improving a number of its current personal transportation policy initiatives to achieve deeper GHG reductions and get closer to meeting its own climate commitments.

The target improvements proposed and modelled in Greener Options are quantifiable, whereby a number can be plugged into a model and a GHG reduction can be measured; for example, increasing the intensification target in The Growth Plan.

However, many policy initiatives cannot be measured, such as actions that influence commuter choice, for example, live where you work incentives or pay-as-you-drive insurance. This final chapter proposes a number of these types of additional policy options, which are not measured in this study but would be helpful in attaining new, stronger targets proposed in Greener Options.

6.1.1 Increasing Intensification and Density Targets

Current Base Case Target: 40% of new development is to occur within the built boundary — GFA density of 50 people and jobs per hectare.

Greener Options Target: 60% of new development is to occur within the built boundary — GFA density of 70 people and jobs per hectare.

Research presented in this report shows that the most effective means to reduce Vehicle Kilometers Travelled is to reduce urban growth boundaries and decrease the distance between home and work. Two target-based policies in The Growth Plan can lead to this objective: intensification and density targets.

In addition to directly changing the intensification target in The Growth Plan, additional policy actions can help lead to this goal:

- Reform the Provincial Policy Statement to encourage smart growth planning.
- Prohibit the expansion of urban growth boundaries and development in whitefield areas.
- Reform development charges to encourage development in the BUAs over Greenfield Areas
- Expand the greenbelt and develop policies to reduce greenbelt leapfrogging.

- Enact stronger laws to protect prime agricultural land. The new Green Energy Act prohibits solar farms from prime agricultural land; the Places to Grow Act could exercise the same rigor.[83]
- Remove municipal zoning bylaws that limit secondary suites.[84]
- Provide support for urban design that reduces auto trips and combines and clusters uses or hubs.

The Greener Options target is for 60% of new population growth be allocated to Built-up Areas.

Photo: Roberta Franchuk, The Pembina Institute

6.1.2 Improving Access to Rapid Transit

Current Base Case Target: No direct target or policy. Proportion of population within 2 km of rapid transit is an outcome of current policies. Outer centres in the Greater Golden Horseshoe are not included in Metrolinx.

Greener Options Target: Set density targets for intensification areas along transit nodes and corridors, and develop long-term transit plans for the outer centres.

The Growth Plan ensures a concentration of jobs and employment close to rapid transit by setting density targets for Urban Growth Centres. Additional policies can encourage population and employment close to transit and support the above targets, including:

- Restricting the development of new employment lands in the GFAs and instead create incentives for employment development in existing Urban Growth Centres and intensification areas (transit nodes).
- Prioritizing and rewarding residential and employment, in particular mixed-use development along exiting and proposed transit lines.

6.1.3 Increasing Use of Transit (Mode Split)

Current Base Case Target: Metrolinx transportation demand modelling estimated the impacts of significant improvements to transit service, expected changes to the road network, and changes to population, employment and land use. On top of the results from this modelling, Metrolinx has suggested a 2% increase in transit mode split by 2031 to reflect the introduction of various measures in The Big Move, such as integrated fare systems, employer-provided transit passes and better integration with other modes that cannot be captured explicitly by the model as currently calibrated.

Greener Options Target: Target an additional 8% increase in transit use over driving by 2031.

Metrolinx's The Big Move will add over 60 rapid transit routes, accommodating new transit-dependent population growth over the next 25 years and resulting in stable GHG emissions over that period of time. In order to achieve absolute reductions and meet the greener targets above, a greater proportion of existing and new population must choose transit over driving. Approaches that may influence commuter choice and increase mode-split include:

- Committed long-term support for transit operation and maintenance (not just capital investment) including support for Metrolinx initiatives, such as fair integration and implementation of the smart card.
- The development of a long-term and comprehensive funding strategy that addresses source funding from the province, the federal government, municipalities, the private sector and user pay methods, and considers options such as provincial fuel price increases, a regional Greater Golden Horseshoe fuel tax, road pricing such as congestion charges, tolls and parking fees, and revenues from cap-and-trade legislation that includes transportation fuels.
- Incentives for transit-use such as pay as you drive insurance, an integrated fare system and recommendations made by Metrolinx under Strategy #5: Create a Consumer First Transportation System.[85]
- Select road- and fuel-pricing policies, such as congestion charges, a regional fuel tax, tolls, parking (both increased cost and decreased requirements) and use funds to support transit and transportation infrastructure.
- Better frequency of service to accommodate minimum ridership in GFAs (15-minute headways) and the BUAs (5- to 8-minute headways)
- Improvements to transit efficiency, convenience and comfort (many policies proposed by Metrolinx).
- More flexible routes, dedicated lanes and rights-of-way for non-subway transit, including tailored routes to address the interests of people from the suburbs.
- Tax subsidies for companies that buy transit passes instead of providing free parking.
- Help to develop employer-based transportation demand management programs to encourage transit-use, carpooling, active transportation and/or telecommuting.

The Greener Options target is an additional 8% increase in transit use over driving by 2031.
Photo: Ontario Growth Secretariat, Ministry of Energy and Infrastructure

6.1.4 Reducing Highway Development

Current Base Case Target: The development of a network of over 450 km of new HOV lanes. Expansion plans for highways go ahead as planned.

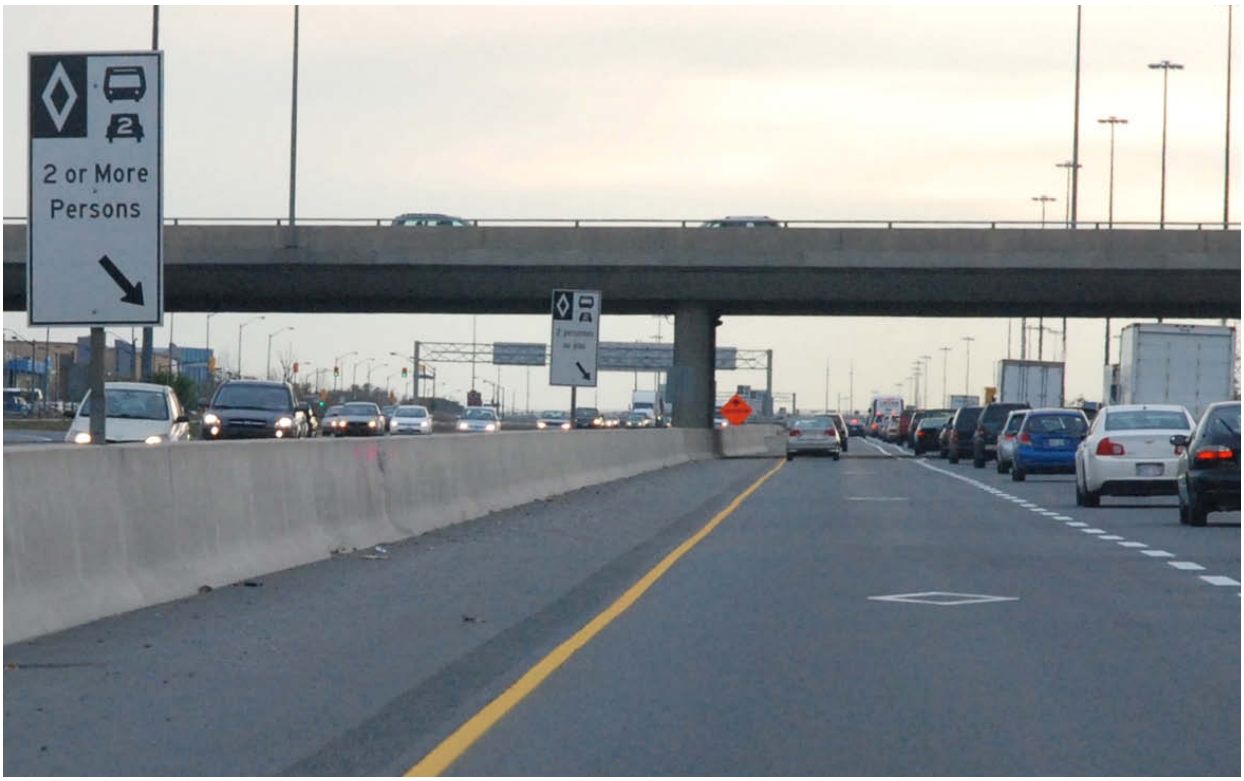
Greener Options Target: More aggressive investment in HOV lanes by converting one lane along the QEW, all 400 series highways and inner-city highways.

Aggressive investment in HOV lanes will help encourage carpooling, effectively reducing the number of total vehicles on the road. The development of employer TDM plans, which encourage carpooling and vanpooling, can improve the use and effectiveness of HOV lanes, furthering benefits from their expansion.

While it may be argued that certain highways are necessary to support goods movement, many of the proposed highway projects for the Greater Golden Horseshoe service distant greenfield regions, accommodating sprawl and in some cases leapfrogging the greenbelt.

In addition to aggressive HOV lanes modelled in the greener options case, a number of policies and investment decisions can mitigate or preclude the impact of specific highway projects:

- Avoid the construction of highways in both the Niagara–GTA and GTA–West corridors. If these projects go forward, emissions would be expected to rise by approximately 10%.[86]
- Limit interchanges for new highways that service movement of goods.
- Reconsider the construction of certain 400-series highway extensions that service greenfield sprawl, in particular Highway 404, which is still in a position to be assessed.
- Ensure that 400 series highways are not further extended.
- Redirect investment from highway projects to transit.



The Greener Options case proposes converting more highway lanes to HOV lanes.
Photo: Roberta Franchuk, The Pembina Institute

6.1.5 Increasing Walking and Biking (Active Transportation Mode Split)

Current Base Case Target: No specific targets are set. Development of The Big Move and Places to Grow will lead to increases in active transportation.

Greener Options Target: Double the 2006 active transportation mode split by 2031.

The Growth Plan has a vision for compact, mixed-use communities that support greater active transportation (AT), but the plan includes no targets for increased AT mode splits or specific targets for other policies to achieve this result. The impacts of policies related to active transportation are difficult to capture in models. Therefore, the Greener Options case proposes the government aim to double the active transportation mode split by 2031. A number of creative policies are available which can encourage living close to work and choosing active transportation, such as:

- Improve safety for cyclists via dedicated bike lanes.
- Introduce live-where-you-work incentives, such as mortgage property tax rebates for purchasing a house within a given proximity to work.
- Strengthen the Provincial Policy Statement to mandate municipalities to require bike lanes, particularly around all schools, ensure streetscapes are welcoming and safe for cyclists and pedestrians, and provide connectivity and direct routes of travel for bikes and pedestrians.

- Introduce incentives for employers to provide end-of-trip workplace facilities (e.g., showers) for active commuters.
- Reward urban design that promotes walkability and compact mixed-use.

Direct and safe cycling routes can help contribute to the Greener Options target of doubling active transportation rates.

Photo: Dylan Passmore via Flickr

6.1.6 Improving Vehicle Efficiency

Current Base Case Target: Ontario will adopt and implement the draft Environment Canada regulations for vehicle GHG emissions, putting Canada on par with the proposed U.S. fuel efficiency/GHG standards for model years 2011 through 2016 and continuing the same trajectory of vehicle economy improvements post-2016.

Greener Options Target: Continue improvements to vehicle fuel economy post-2016.

It is clear that vehicle efficiency standards are going to help Ontario with its climate efforts. A number of policies can help Ontario lead in the uptake of more efficient vehicles and made the new regulations effective:

- Expand Ontario's green licensing program to include fuel-efficient vehicles in addition to electric vehicles.
- Improve the green licensing program benefits beyond access to HOV lanes and priority parking at certain locations. Additional benefits could include purchase rebates, reduced registration fees, further parking benefits and "cash for clunker" type programs.
- Strengthen driver adoption of ecodriving measures, such as improved driving habits that reduce gas consumption and vehicle maintenance that reduces GHG emissions.

The Greener Options target is to continue improvements to vehicle fuel economy.
Photo: Dave Mussell, The Pembina Institute

6.1.7 Electrifying Vehicles and Transit

Current Base Case Target: Electrification of municipal buses.

Greener Options Target: Achieve the Premier's plan for 5% electric vehicles by 2020 and electrify GO Transit trains.

Ontario is a leading province in renewable energy with the recent introduction of the Green Energy and Economy Act. This Act prioritizes green energy and can accommodate the necessary growth in renewable energy sources to power an increase in electricity demand created by a serious commitment to electric vehicles. Moreover, emerging technology can make electric vehicle battery power storage devices that can feed energy back to the grid. A number of policy actions can help Ontario achieve an electric vehicle future and lead North America:

- Avoiding delays in permitting for charging stations and other infrastructure needed to support electric vehicles and ensure building codes support the operation of plug-ins
- Moving forward with green licencing incentive programs for electric vehicles
- Strengthening the Green Energy Act to increase opportunities for green energy to supply anticipated increase in demand electric vehicles based on the above greener targets.
- Ensuring legislation, such as the Green Energy Act, provides the necessary regulatory process to remove barriers to electric vehicle infrastructure, such as bylaws.

The Greener Options strategy calls for a greater use of electric vehicles, including transit buses, such as this one from Vancouver.

Photo: Bobanny via Wikipedia

7. Conclusions and Near-Term Recommendations

7.1 Conclusions

By studying the Greater Golden Horseshoe region, which comprises 70% of Ontario's population and the most advanced planning and transit policies, this study concludes that current provincial polices are ambitious and on the right track, but will also require specific improvements to achieve greater reductions in GHG emissions.

The results also show that achieving modest GHG savings under current policies will require their full implementation and adequate funding, in particular for transit. Recommendations in this report address policy options for the province, however it is noted that federal funding for The Big Move and for smart growth infrastructure for municipalities is necessary to achieve even Base Case results.

The results of the modelling in this report and more detailed modelling conducted by other studies point to the importance of coupling vehicle technology regulations (efficiency standards) with strong policies that reduce VKT. Without addressing both, GHG emissions will continue to grow.

Moving forward beyond the Base Case, this report identifies key policy opportunities to achieve greater GHG reductions from the personal transportation sector in the Greater Golden Horseshoe region:

- stronger targets in The Growth Plan and incentives to reward development in built-up areas that is close to transit and fosters mixed-use, walkable communities
- expansion and electrification of transit
- transportation demand-management and commuter choice policies to reduce time on the road
- fuel taxes and road-pricing mechanisms to encourage less driving and also help fund sustainable transportation efforts
- continued improvements in vehicle efficiency, including electric vehicles
- policies to encourage the manufacture and uptake of more efficient vehicles and more efficient driving habits.

The report also recognizes the opportunity to generate revenue from a broad-based carbon pricing scheme and invest funds into sustainable transportation. Ontario has introduced cap-and-trade legislation. It is necessary that this legislation includes transportation fuels, and that these specific revenues are directed to transit and sustainable transportation projects.

In the short term, transportation demand management and commuter choice policies can go a long way to making an impact on GHG emissions with relatively smaller capital investment or lead time for construction and development. Further study into most effective commuter choice policies is needed.

7.2 Kick-starting Ontario's Personal Transportation Future Now

Continuing with and stepping up initiatives to build transit, change land use patterns and develop infrastructure for the electric vehicle will ensure that emissions continue to decline steadily and permanently in the long term.

However, to ensure that GHG emissions from transportation begin declining immediately, the province can prioritize four policy actions that are quick to deploy and do not require waiting for significant capital investment:

1. **Transit Funding:** Develop and implement a strategy to fund the expansion, operation and electrification of transit, considering options such as a fuel tax, road-pricing mechanisms, revenue from carbon pricing and redirecting investments from highway projects that service sprawl to transit.
2. **Commuter Choice:** Introduce policies that influence commuter choice and result in less time spent behind the wheel. Types of policies include live-where-you-work incentives, pay-as-you-drive insurance, congestion charges and employer incentives for transit use and active transportation.
3. **Urban Planning:** Strengthen targets in The Growth Plan to limit sprawl on undeveloped land, working with municipalities to reward development that reduces auto dependence and encourages walkability.
4. **Vehicle Efficiency:** Implement policies and incentives that encourage the manufacture and uptake of more efficient vehicles, including electric vehicles and related infrastructure.

Appendix A: Growth Plan Policies

A.1. Land-use Assumptions from The Growth Plan for the Greater Golden Horseshoe

A summary of the key targets within The Growth Plan is shown in Table 4. Very few of The Growth Plan's policies have actual numerical targets that can be set, enforced and measured. Policies with numerical targets included directly in the model are shaded in green.

The grey-shaded cells in the table indicate those guidelines that do not have numerical targets. It was not possible to include these guidelines directly in the modelling, but their intent was captured in the other numeric elements of the Base Case. For example, the guidelines for mixed-use are incorporated with assumptions on population living close to transit and Urban Growth Centres.

The orange-shaded cells indicate Growth Plan policies that provide guidelines for intensification but do not have numeric goals. Our analysis requires that the guidelines be translated to numbers for the model, but The Growth Plan does not provide enough specifications in the policies to justify particular numbers. Each municipality and region will interpret the guidelines to match its own context.

However, the objectives behind the intensification guidelines are key to the success of The Growth Plan. These intensification areas are intended to be in transit nodes or along transportation corridors and likely represent higher density areas. It was necessary to determine the percentage of population within the built-up area (BUA) who will live in dense, compact neighbourhoods that are close to transit, compared to population within the BUA that is spread out and is not close to transit. This determination can help to model the anticipated ratio of population in the BUA that will take transit as opposed to driving.

To assign numbers to intensification areas so that they could be modelled, we used numeric results from The Big Move. Because that transportation plan also includes the effects of The Growth Plan, its results are consistent with the guidelines in orange-shaded cells.

Appendices B and C provide more information about the assumptions included in our model for intensification areas.

Table 4. Growth plan policies and targets

Places to Grow Policy	Places to Grow Target
Portion of growth to Built-up Area	Minimum 40% of new residential development occurring annually, by year 2015 and for every year thereafter.[87]
Portion of growth outside Built-up Area	Maximum 60% of new residential development occurring annually, by year 2015 and for every year thereafter.
Residents and job density outside Built-up Area	50 residents and jobs combined per hectare.[88]
Residents and job density of Urban Growth Centres	Urban Growth Centres will be planned to achieve, by 2031 or earlier, a minimum gross density target of:[89] - 400 residents and jobs combined per hectare for UGCs in City of Toronto. - 200 residents and jobs combined per hectare for UGCs in: Brampton, Burlington, Hamilton, Milton, Markham, Mississauga, Newmarket, Oakville, Oshawa, Pickering, Richmond Hill/Langstaff, Vaughan, Kitchener and Waterloo. - 150 residents and jobs combined per hectare for UGCs in: Barrie, Brantford, Cambridge, Guelph, Peterborough and St. Catharines.
% to Urban Growth Centres and Intensification Areas	"Focusing intensification in intensification areas."[90]
Density of Intensification Areas	"Consistent with the planned transit service levels, and any transit-supportive land-use guidelines established by the government of Ontario."[91]
Residents and job mix in Intensification Areas	"A diverse and compatible mix of land uses, including residential and employment uses that support vibrant neighbourhoods."[92]
Residents and job mix in UGC	"Accommodate a significant share of population and employment growths... serve as high density major employment centres."[93]
Residents and job mix in Mixed Use Areas	"A diverse mix of land uses including residential and employment uses, to support vibrant neighbourhoods."[94]

Appendix B: Population Assignment

The first step in creating our model was to assign both of the 2006 and predicted 2031 populations to the Places to Grow land-use classifications:

- Designated Greenfield Area (GFA)
- Urban Growth Centre (UGC)
- Built-up Area (BUA, excluding UGC)

The population in each of these areas class was allocated based on data from The Growth Plan, its accompanying documentation and assumptions or other land-use planning reports as required.

At the time this study was conducted, plans from the municipalities on how they would conform to The Growth Plan were under review or in the process of being submitted to the Ontario Growth Secretariat and therefore, not approved. As a result the model, inputs were based on the targets and data from The Growth Plan under the assumption the targets are implemented. The Growth Plan has several provisions where individual communities can apply to have lower or higher targets which could modify population distributions, land use areas and settlement boundaries. While these are acknowledged, they are not modelled to maintain consistency in the model and they would not significantly impact the overall trends expressed in the model.

B.1. Current Population

Population data was obtained for single tier and upper tier municipalities from population forecasts conducted by Hemson Consulting presented in Schedule 3 of The Growth Plan. The forecasts are based on 2001 Census data and projected populations were provided for 2011, 2021, and 2031. The population projects follow a linear trend, i.e. linear interpolation was used to project populations for key policy years 2006 and 2015. Populations for some municipalities were aggregated for the years 2021 and 2031. For those municipalities, growth trends from 2001 and 2011 for the individual municipalities were projected, then proportioned so that the sum of their populations was the same as the aggregated projections for 2031 published Schedule 3.

Table 5: Population forecasts

Population (000s)	2001	2006	2015	2031
Region of Durham	530	596	726	960
Region of York	760	909	1130	1500
City of Toronto	2590	2676	2824	3080
Region of Peel	1030	1170	1350	1640
Region of Halton	390	455	572	780
City of Hamilton	510	525	570	660
County of Northumberland	80	83	89	96
County of Peterborough	56	57	59	61
City of Peterborough	74	77	81	88
City of Kawartha Lakes	72	76	85	100
County of Simcoe	254	274	310	375
City of Barrie	108	133	177	253
City of Orillia	30	32	34	39
County of Dufferin	53	58	66	80
County of Wellington	85	88	93	119
City Guelph	110	121	141	202
Region of Waterloo	456	493	568	729
County of Brant	35	37	41	49
City of Brantford	94	98	105	124
County of Haldimand	46	48	51	56
Region of Niagara	427	436	457	511

Source: adapted from Schedule 3 in Growth Plan

B.1.1. Population Assignment

Populations were initially assigned to BUA including UGC, and GFA according to Growth Plan Policies 2.2.3.1, 2.2.3.2, 2.2.3.3. These policies state that by 2015, each single and upper tier municipality must have at least 40% residential development occurring in the BUA. In the

absence of individual municipal and regional growth plans, the modelling assumes this 40% minimum will be achieved for all communities. As per growth plan policies, if an upper or single tier municipality is achieving or has included in their official plans an intensification rate greater than 40% at the time The Growth Plan came into effect, then that rate will be its minimum intensification rate after 2015.

B.1.2. Assumptions and Methodology

B.1.2.1 Intensification 2006–2015

An assumption needs to be made for the intensification between 2006 and 2015 (i.e. prior to the Places to Grow requirement of 40% intensification starting in 2015). This is difficult to establish because spatial data for the BUA is not available to us, and the size of the BUA (and therefore intensification rate) varies depending on when the BUA is established.

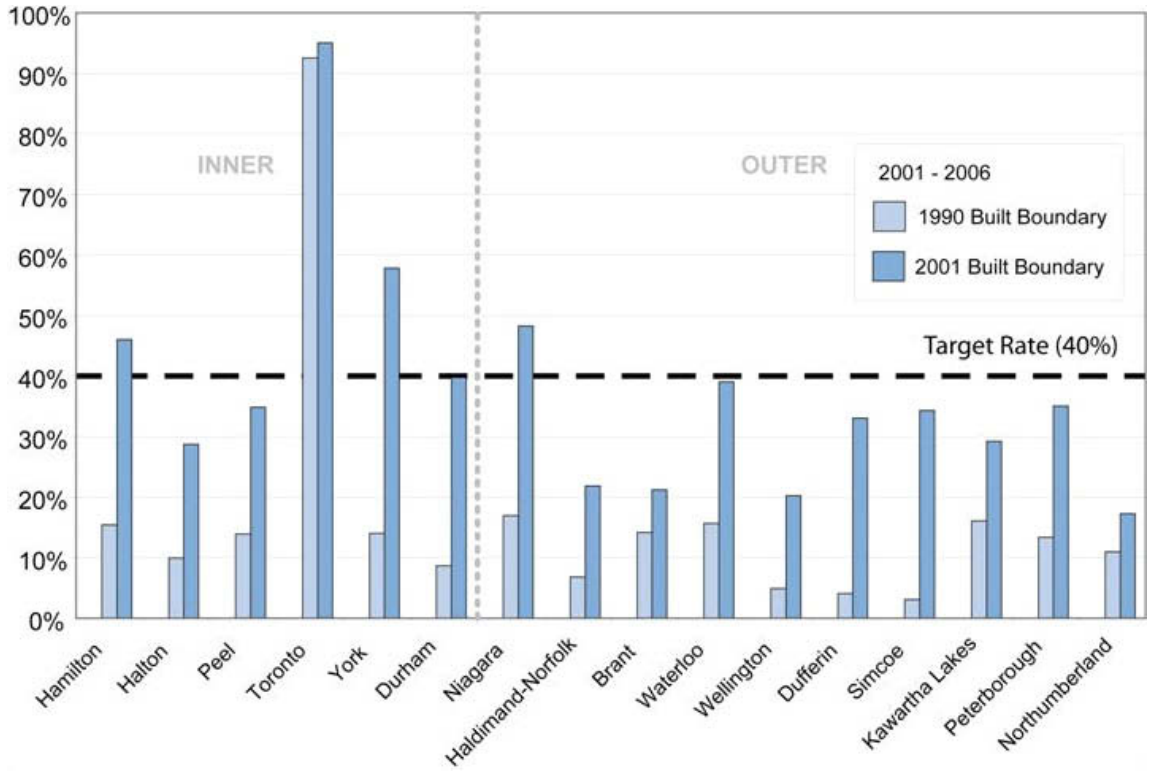


Figure 16: Average intensification rates between 2001 and 2006 based on a 1990 and 2001 built boundary

Source: Neptis Foundation, "Regional Intensification Policies and Targets," January 2009.

The model assumes that the intensification rates between 2006 to 2015 would be similar to those calculated by Neptis relative to the 2001 built boundary. The basis of this assumption is that the Neptis intensification rates are representative of an average five-year intensification after the establishment of a BUA. Applied to a BUA established in 2006, these figures could represent the average intensification to 2011. Since the Growth Plan stipulates that the intensification rate must be maintained, it is assumed that this rate can be carried through to 2015.

The intensification rates provided in the Neptis 2009 report exclude some single tier municipalities (Barrie, Orillia, Peterborough, Guelph, etc.). For these municipalities, intensification rates are the same as their regions (Simcoe County, Peterborough County, Wellington County, etc.).

B.1.2.2 Intensification 2016–2031

A minimum intensification rate for the population for upper and single tier municipalities of 40% was assumed in this analysis. Where the intensification rate assigned between 2006 to 2015 was greater than 40%, the higher intensification rate was used. Due to limited GFA land in Toronto, 100% intensification was assumed beyond 2015.

The resulting intensification rates and population distributions are presented in Table 6:

Table 6: Population distribution to BUA and GFA

	% to BUA		Pop. to BUA (000s)		Pop. to GFA |(000s)
	2006-2015	2016-2031	2006-2015	2016-2031	2006-2031
Region of Durham	40%	40%	51.8	145.6	218.4
Region of York	58%	58%	128.4	342.8	248.2
City of Toronto	95%	100%	140.2	396.6	7.4
Region of Peel	35%	40%	63.0	179.0	291.0
Region of Halton	28%	40%	32.8	116.0	209.0
City of Hamilton	47%	47%	21.2	63.5	71.6
County of Northumberland	18%	40%	1.1	3.7	7.7
County of Peterborough	37%	40%	0.7	1.9	8.7
City of Peterborough	37%	40%	1.7	4.6	9.7
City of Kawartha Lakes	29%	40%	2.5	8.6	10.7
County of Simcoe	35%	40%	12.6	36.3	11.7
City of Barrie	35%	40%	15.4	44.5	12.7
City of Orillia	35%	40%	0.9	2.7	13.7
County of Dufferin	34%	40%	2.8	8.5	14.7
County of Wellington	20%	40%	1.1	4.6	15.7
City Guelph	20%	40%	4.0	17.0	16.7
Region of Waterloo	39%	40%	29.3	93.5	17.7
County of Brant	21%	40%	0.8	3.1	18.7
City of Brantford	21%	42%	1.5	6.5	19.7
County of Haldimand	22%	40%	0.7	2.8	20.7
Region of Niagara	49%	49%	10.4	36.8	21.7

B.2. Urban Growth Centres

The Growth Plan provides specific minimum density targets for UGCs in policy 2.2.4.5. With information about the area and existing population in the UGCs, it is possible to estimate the population growth to the UGCs.

B.2.1. Assumptions and Methodology

The data for the UGC population calculation including the location, size, density and persons to job mix in 2001 came from the technical backgrounder "Proposed Size and Locations of Urban Growth Centres in the Greater Golden Horseshoe."

Not knowing the population density in the UGCs in 2006, it is assumed that no significant development has occurred since 2001 in UGCs and applied the 2001 density numbers to calculate the existing number of jobs and people in the UGCs. This is supported by Canadian census data from 2001 and 2006, which show a decrease in population living in GTA neighbourhoods with a density above 100 people per hectare between these years.

The resulting existing populations in the UGC are presented in Table 7.

Table 7: Existing population and jobs in UGCs

Name	Region	Area (ha)	Density (people & jobs/ha)	% People	% Jobs	People	Jobs
Downtown Oshawa	Durham Region	110	100	27	73	2970	8030
Downtown Pickering	Durham Region	140	50	52	48	3640	3360
Markham Centre	York Region	240	20	19	81	912	3888
Newmarket Centre	York Region	60	55	13	87	429	2871
Richmond Hill/Langstaff	York Region	175	15	56	44	1470	1155
Vaughan Corporate Centre	York Region	160	15	0	100	0	2400
Toronto: Downtown	Toronto	1170	380	19	81	84474	360126
Toronto: Etobicoke	Toronto	70	115	58	42	4669	3381
Toronto: North York	Toronto	155	210	45	55	14648	17902
Toronto: Young-Eglinton	Toronto	160	435	55	45	38280	31320
Toronto: Scarborough	Toronto	170	90	24	76	3672	11628
Downtown Brampton	Peel Region	219	65	50	50	7118	7117
Mississauga City Centre	Peel Region	510	100	62	38	31620	19380
Midtown Oakville	Halton Region	100	30	12	88	360	2640
Downtown Milton	Halton Region	150	35	47	53	2468	2783

Name	Region	Area (ha)	Density (people & jobs/ha)	% People	% Jobs	People	Jobs
Downtown Burlington	Halton Region	125	75	57	43	5344	4032
Downtown Hamilton	Hamilton	165	195	34	66	10940	21235
Downtown Peterborough	Peterborough Region	110	100	24	76	2640	8360
Downtown Barrie	Simcoe County	200	60	39	61	4680	7320
Downtown Guelph	Wellington County	115	95	27	73	2950	7976
Downtown Cambridge	Waterloo Region	50	70	26	74	910	2590
Uptown Waterloo	Waterloo Region	100	75	75	25	5625	1875
Downtown Kitchener	Waterloo Region	115	120	18	82	2484	11316
Downtown Brantford	Brant County	110	60	32	68	2112	4488
Downtown St. Catharines	Niagara Region	115	100	27	73	3105	8395

The new combined growth in the UGC is determined by multiplying the difference between the existing and the target density by the land area.

The key variable is the future population and jobs mix in the UGC. This is important to determine how many people can be accommodated in the UGC. There is no optimal mix specified in The Growth Plan that would result in a successful UGC. The age and existing mix of growth centres is likely to effect how they grow. For simplicity, in our model it was assumed that the rate of new growth in all centres will be balanced at a ratio of 60 persons: 40 jobs.

The resulting new population to be accommodated in UGCs between 2006 and 2031 are presented in Table 8.

Table 8: New population to UGCs between 2006 and 2031

Name	Density Increase	New Pop & Jobs	Population in 2031	Jobs in 2031
Downtown Oshawa	100	11000	9570	12430
Downtown Pickering	150	21000	16240	11760
Markham Centre	180	43200	26832	21168
Newmarket Centre	145	8700	5649	6351
Richmond Hill / Langstaff	185	32375	20895	14105
Vaughan Corporate Centre	185	29600	17760	14240
Toronto: Downtown	20	23400	98514	369486

Name	Density Increase	New Pop & Jobs	Population in 2031	Jobs in 2031
Toronto: Etobicoke	285	19950	16639	11361
Toronto: North York	190	29450	32318	29683
Toronto: Young-Eglinton	0	0	38280	31320
Toronto: Scarborough	310	52700	35292	32708
Downtown Brampton	135	29565	24857	18944
Mississauga City Centre	100	51000	62220	39780
Midtown Oakville	170	17000	10560	9440
Downtown Milton	165	24750	17318	12683
Downtown Burlington	125	15625	14719	10281
Downtown Hamilton	5	825	11435	21566
Downtown Peterborough	50	5500	5940	10560
Downtown Barrie	140	28000	21480	18520
Downtown Guelph	55	6325	6745	10505
Downtown Cambridge	80	4000	3310	4190
Uptown Waterloo	125	12500	13125	6875
Downtown Kitchener	118	13570	10626	16744
Downtown Brantford	90	9900	8052	8448
Downtown St. Catharines	50	5750	6555	10695

Appendix C: Modelling Approach

C.1. The Purpose of Pembina's Transportation GHG Study

The purpose of this study is to determine changes to future GHG emissions from personal vehicle use via key urban design and transportation policy actions. The three main areas studied are:

- Land use (roads built/ sprawl vs. higher densities);
- Transportation behaviour change (driving vs. transit);
- Vehicle emissions (tailpipe standards; vehicle electrification).

We first modelled a Base Case, which estimates how future GHG emissions will change based on current policy and planning initiatives, including The Growth Plan and The Big Move. A second scenario, the Greener Options case, was then developed. It includes actions and policies to improve/reduce GHG emissions over and above the Base Case.

The model that was used for this analysis is intended to provide high-level regional results based on expected behaviour of average residents and employees. The focus of our analysis and the model is major changes to land-use and transportation policies that could be applied through a combination of federal and provincial policies and implemented by regional and municipal governments. The model does not seek to replicate the detailed origin-destination transportation models, such as those used for analysis of the Big Move. Our model synthesizes the results of more detailed modelling and allows users to explore the potential impacts of combining and expanding policies and actions.

C.2. Scope

This project does not cover all of Ontario's personal transportation. As noted below, the project scope has limits on based on geography and type of travel. The project accounts for about 50% of Ontario's personal transportation, based on VKT and/or GHGs

The geographic region included in this analysis is restricted to the Greater Golden Horseshoe region. This geographic scope matches the boundaries in The Growth Plan and covers 70% of Ontario's population.

The scope is further limited to travel by residents for commuting and other typical daily trips. Trips accounted for in the scope include the following:

- home to work and work to home trips
- home to school and school to home trips,

- other home based trips (e.g., shopping)
- non-home based trips (e.g., work to shopping)[95]

The following trips are excluded from the scope:

- most business-related travel (other than the journey to work)
- all fleet-based travel (delivery vans, etc.)
- travel by visitors (own cars, rental cars and taxis)
- travel that is not typical of daily trips (e.g., vacations)

These travel activities were excluded because the data source on current travel activities that was best suited for this analysis, the Transportation Tomorrow Survey, does not capture those activities.

C.3. Modelling Approach

The modelling approach is based on a spreadsheet model developed for Canada in 1999 and used to evaluate costs and GHG reductions from policies that impact urban form, travel behaviour, and vehicle technologies.[96] The underlying rationale for the model is that the characteristics of a neighbourhood will influence the travel behaviour of its residents. Travel behaviour and GHG emissions associated with travel are also impacted by many other factors, such as socio-economic characteristics of individuals, job-work locations, incentives or disincentives for different travel modes, and fuel efficiency of vehicles.

Our challenge was to develop a model that allowed us to include the key factors that influence travel in a way that can be easily modified to reflect potential changes to public policy. The main variable tracked is the amount of GHGs emitted in personal transportation.

We accomplished this objective through the following steps:

1. Define development classes that capture key attributes influencing travel behaviour and are able to reflect current and potential future land-use and transportation policies.
2. Estimate population living in each neighbourhood type, including changes over time.
3. Estimate travel behaviour (distance and mode) for a typical resident in each development class.
4. Calculate GHG emissions based on transportation behaviour.

C.4. Base Case Modelling

C.4.1. Defining Development Classes

Development classes are defined both by neighbourhood and city characteristics.

Neighbourhood characteristics

- Attributes of urban form (density, building types, proximity of residences to services, access to non-car vehicle modes) are grouped into categories that reflect major differences in travel behaviour. Using categories that combine attributes is appropriate for analyzing changes to urban form since changes to single attributes (i.e. only density or only mixed-use) is unlikely to result in significant GHG reductions. Also, it is difficult to separate density effects from land mix effects when evaluating the impacts of changes to urban form since density may serve as a proxy for other urban characteristics.
- We have developed five groups that align with definitions used in Places to Grow legislation.
  - » Designated Greenfield – Transit Areas;
  - » Designated Greenfield – Non-transit Areas;
  - » Urban Growth Centres (UGC);
  - » Transit Corridors and Nodes (Intensification Areas within the BUA); and,
  - » Non-Intensified Areas within the BUA.

The defining attributes of the development classes are summarized in Table 9.

Table 9: Development class neighbourhood characteristics

	Urban Growth Centres	Transit Corridors and Nodes	BUA Non-intensified	Greenfield Transit Areas	Greenfield Non-transit
Density	150 to 435 persons and jobs per hectare.	80 to 100 persons and jobs per hectare.	50 persons and jobs per hectare.	Approximately 80 to 100 persons and jobs per hectare.	40 persons and jobs per hectare.
Access to transit	Rapid transit within 2 km of all residences.	Rapid transit within 2 km of all residences.	Further than 2 km from rapid transit.	Rapid transit within 2 km of all residences.	Further than 2 km from rapid transit.
Location	City centres (downtowns, uptowns, etc.).	Inside the BUA, within walking distance of well-served transit.	Inside the BUA, poor access to rapid transit.	Outside the BUA, within walking distance of well-served transit.	Outside the BUA, poor access to rapid transit.

City characteristics

- These refer to attributes that influence travel behaviour throughout the city. The key attributes are distance to main centres of employment (do significant fraction of population commute outside the city boundaries?), public transit links to other cities (GO Train) and highway connections to other cities.
- We have grouped cities into the following six categories:
  - » Toronto (primary centre).
  - » Hamilton (secondary centre).
  - » Inner Suburbs (York and Peel): regions connected to Toronto's rapid transit system via their own local transit systems.

» Outer suburbs (Durham and Halton): regions are not directly connected to Toronto via local transit, but included in the Metrolinx plan.
» Outer Centres (Niagara, Waterloo, Guelph, Peterborough, Orilia, Barrie, Brantford): cities not included in the Metrolinx plan.
» Rural Areas (Kawartha Lakes, Orangeville, Peterborough county, Dufferin, Simcoe, Brant, Wellington): cities that do not include Urban Growth Centres in Places to Grow requirements.

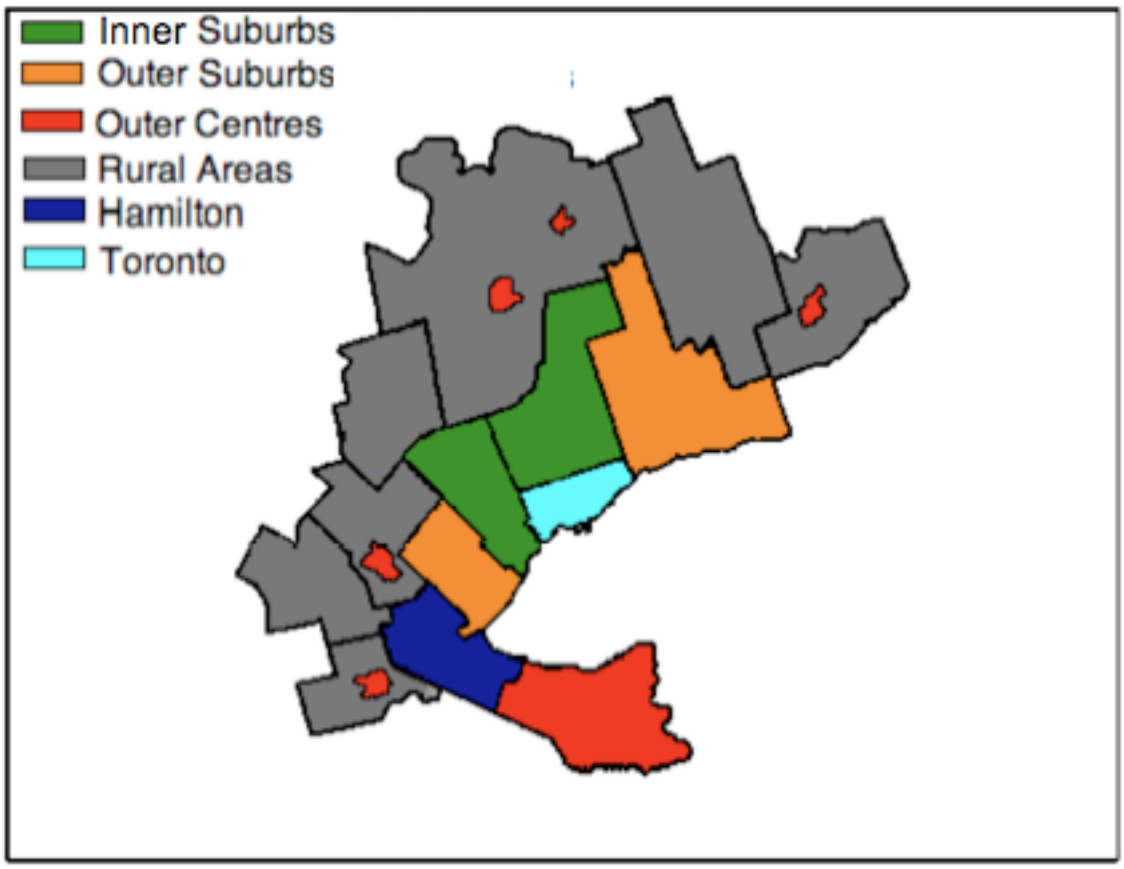


Figure 17: Development class city groups

The combination of five development classes and six city groups provides the model with 30 unique neighbourhood types.

C.4.2. Estimate Population in Each Development Class

The population assignment in Appendix B was used as a starting point. The key step was to separate the BUA and GFA into transit areas and Greenfield areas. For municipalities in the Metrolinx plan, it is assumed that the population within 2 km of rapid transit, a metric presented in the Metrolinx Modelling Backgrounder, was indicative of the population in transit areas and corridors.

Metrolinx presented a 5% range for population within 2 km of rapid transit. The midpoints of these ranges are shown in Table 10 below (% Close to Transit), along with more detailed population breakdowns. Note that residents in UGCs are considered close to transit.

Table 10: 2006 population breakdown of municipalities in the Metrolinx plan

	Population	% Close to Transit	UGC	BUA-Tr	BUA-No Tr
Toronto	2,676,000	62.50%	145,743	1,526,758	1,003,500
Hamilton	525,000	12.50%	10,940	54,686	459,375
York	909,000	27.50%	2,811	247,164	659,025
Peel	1,170,000	27.50%	38,738	283,013	848,250
Halton	455,000	27.50%	8,171	116,954	329,875
Durham	596,000	12.50%	6,610	67,890	521,500

Population was similarly broken down for the 2031 population. Using the projected population within 2 km of rapid transit in 2031 for each municipality. Because 2031 includes greenfield developments as well, transit access was split between all three classes (UGC, BUA-Tr, GFA-Tr). Appendix C of the Big Move Modelling Backgrounder was used to estimate the ratio of transit built in the Greenfield Areas, which estimates the percentage of new rapid transit lines within the existing BUA. For simplicity, it is assumed that 100% of new transit in Toronto would be in the BUA, 95% in Hamilton and 90% in each of Peel, York, Halton and Durham.

Table 11: 2031 population breakdown of municipalities in the Metrolinx plan

	Population	% Close to Transit[a]	UGC	BUA-Tr	BUA-NI	GFA-Tr	GFA-No Tr
Toronto	3,080,000	97.50%	221,043	2,781,958	69,620	0	7,380
Hamilton	660,000	67.50%	11,435	411,791	165,225	22,275	49,275
York	1,500,000	72.50%	71,136	907,614	273,030	108,750	139,470
Peel	1,640,000	72.50%	87,077	983,024	278,900	118,900	172,100
Halton	780,000	72.50%	42,596	466,354	62,010	56,550	152,490
Durham	960,000	67.50%	25,810	557,390	158,400	64,800	153,600

Note:
a. Based on: Metrolinx, Backgrounder: Modelling, December 2008, Appendix B.

For the outer centres, a regression analysis was developed to relate the population within 2 km of rapid transit in the municipalities in the Metrolinx plan to their ridership numbers. This allowed us to relate the transit ridership numbers in the outer centres to the expected population in their

transit corridors and nodes. These areas are not within 2 km of rapid transit, but like the transit areas in the Metrolinx plan area they are expected to be served by frequent transit.

Table 12: 2006 population breakdown of outer centres

	Population	% Close to Transit	UGC	% BUA-Tr	BUA-Tr	BUA-No Tr
Niagara	435,917	3.83%	3,105	3.12%	13,597	419,215
Waterloo	493,250	8.41%	9,019	6.58%	32,474	451,757
Guelph	121,000	15.38%	2,950	12.94%	15,659	102,392
Peterborough	76,500	11.07%	2,640	7.62%	5,829	68,031
Orillia	31,500	4.10%	0	4.10%	1,292	30,208
Barrie	132,500	6.08%	4,680	2.54%	3,370	124,450
Brantford	98,000	4.58%	2,112	2.43%	2,379	93,509

In regards to future transit access, there are discussions of light-rail plans outside the Metrolinx plan area, for example in Waterloo, but we have not modelled for a significant increase in transit access for either rural areas or outer centres. However, our model does expect that transit will expand in these areas as population increases, effectively maintaining the status quo in regards to population with access to transit outside the UGCs in outer centres. As a result, for the 2031 population breakdown in these municipalities it was assumed that both the greenfield transit areas and BUA transit areas would account for a similar proportion of the overall population in 2031 as the BUA transit areas did in 2006 (%BUA-Tr in table above).

Table 13: 2031 population breakdown of outer centres

	Total	UGC	BUA-Tr	BUA-NI	GFA-Tr	GFA-No Tr
Niagara	511,000	6,555	14,540	451,613	1,194	38,292
Waterloo	729,000	24,439	37,024	525,336	9,362	142,202
Guelph	201,901	6,745	18,461	124,195	6,794	52,500
Peterborough	87,719	5,940	5,708	69,204	523	6,866
Orillia	39,225	0	1,414	33,041	196	4,770
Barrie	252,961	21,480	3,993	153,006	1,894	74,482
Brantford	123,794	8,052	2,401	96,496	409	16,844

For rural areas, all existing population plus new BUA and new GFA population are assigned to non-transit areas. No significant transit infrastructure exists or is expected for these communities.

Table 14 shows the 2031 Base Case overall population breakdown by region type.

Table 14: 2031 Base Case population breakdown

	Total	UGC	BUA-Tr	BUA-NI	GFA-Tr	GFA-No Tr	% close to transit
Toronto	3,080,000	221,043	2,781,958	69,620	0	7,380	98%
Hamilton	660,000	11,435	411,791	165,225	22,275	49,275	68%
Inner Suburbs	3,140,000	158,213	1,890,638	551,930	227,650	311,570	73%
Outer Suburbs	1,740,000	68,406	1,023,744	220,410	121,350	306,090	70%
Outer Centres	1,945,599	73,211	83,541	1,452,891	20,373	315,584	9%
Rural Areas	936,401	0	0	800,112	0	136,289	0%
Total	**11,502,000**	**532,307**	**6,191,670**	**3,260,188**	**391,648**	**1,126,188**	**62%**

C.4.3. Estimate Travel Behaviour for Each Neighbourhood Type

We used a two-step process to determine travel behaviour for each of the neighbourhood types. For this analysis, travel behaviour is defined by total amount travelled (measured by PKT) and the mode used for travel (i.e., car, bus, rapid transit, walk or cycle).

Step 1 – City Travel Behaviour

We used data from the Transportation for Tomorrow Survey (TTS) to determine the amount travelled by the average person in each city. TTS provides information on mode and length of trip in 2006. This information is combined into the city categories provided above. Note that the TTS data is collected based on surveys, which ask respondents to describe all of the trips made by household members on the previous day. Since not all residents are queried, expansion factors developed by the survey creators are used to estimate total daily travel. The analysis used the Manhattan distance[97] for trips.

The travel behaviour assumptions are reported in the following tables.

Table 15: Toronto travel behaviour

Mode	Avg. km	Trips	Total km	Mode Split	PKT Split
Auto Drive	11.51	2,518,553	29,000,987	52.6%	58.8%
Auto Passenger	10.59	696,192	7,372,028	14.5%	14.9%
Transit (GO + Local)	10.57	1,108,242	11,708,992	23.2%	23.7%
Walk/Cycle	1.52	391,868	596,486	8.2%	1.2%
Other	9.28	71,579	664,267	1.5%	1.3%
Total	10.31	4,786,434	49,342,761	100.0%	100.0%

Table 16: Hamilton travel behaviour

Mode	Avg. km	Trips	Total km	Mode Split	PKT Split
Auto Drive	14.57	702,017	10,228,112	66.6%	73.2%
Auto Passenger	13.40	178,478	2,391,325	16.9%	17.1%
Transit (GO + Local)	13.73	75,231	1,032,980	7.1%	7.4%
Walk/Cycle	1.29	65,406	84,487	6.2%	0.6%
Other	7.03	32,659	229,660	3.1%	1.6%
Total	13.25	1,053,791	13,966,563	100.0%	100.0%

Table 17: Inner suburbs travel behaviour

Mode	Avg. km	Trips	Total km	Mode Split	PKT Split
Auto Drive	14.62	2,859,853	41,814,871	68.2%	72.1%
Auto Passenger	11.91	702,573	8,366,064	16.8%	14.4%
Transit (GO + Local)	21.31	308,123	6,565,536	7.3%	11.3%
Walk/Cycle	1.23	202,786	249,907	4.8%	0.4%
Other	8.57	119,423	1,023,558	2.8%	1.8%
Total	13.84	4,192,758	58,019,936	100.0%	100.0%

Table 18: Outer suburbs travel behaviour

Mode	Avg. km	Trips	Total km	Mode Split	PKT Split
Auto Drive	17.17	1,577,225	27,081,774	71.4%	73.8%
Auto Passenger	13.81	359,542	4,963,570	16.3%	13.5%
Transit (GO + Local)	37.93	104,530	3,964,618	4.7%	10.8%
Walk/Cycle	1.24	111,481	138,118	5.0%	0.4%
Other	9.65	56,057	540,927	2.5%	1.5%
Total	16.61	2,208,835	36,689,007	100.0%	100.0%

Table 19: Outer centres travel behaviour

Mode	Avg. km	Trips	Total km	Mode Split	PKT Split
Auto Drive	13.47	2,247,811	30,284,746	71.0%	77.1%
Auto Passenger	12.42	562,121	6,983,234	17.8%	17.8%
Transit (GO + Local)	11.52	91,311	1,051,857	2.9%	2.7%
Walk/Cycle	1.32	168,951	222,632	5.3%	0.6%
Other	7.82	93,877	733,839	3.0%	1.9%
Total	12.41	3,164,071	39,276,307	100.0%	100.0%

Table 20: Rural suburbs travel behaviour

Mode	Avg. km	Trips	Total km	Mode Split	PKT Split
Auto Drive	22.10	810,559	17,913,141	73.6%	78.1%
Auto Passenger	20.79	186,427	3,876,589	16.9%	16.9%
Transit (GO + Local)	61.44	5,608	344,565	0.5%	1.5%
Walk/Cycle	1.18	38,776	45,827	3.5%	0.2%
Other	12.54	59,744	749,025	5.4%	3.3%
Total	20.82	1,101,114	22,929,147	100.0%	100.0%

Notes:
Avg. km = average trip length made by this transportation mode
Trips = Daily trips made by this mode
Total km = Total daily km made by this mode
Mode split = % of trips made by this mode
PKT split = % of km travelled made by this mode

Step 2 – Neighbourhood Travel

Since Rural Areas do not have any planned growth centres or transit improvements within their bounds, it is assumed that their travel behaviour will remain roughly the same in 2031 as it currently is. However, for all other city types, a method is required to predict neighbourhood travel. The first step of this process is to determine how travel behaviour differs between neighbourhood type. To assist with this process, a model developed by the IBI Group is used, based on City of Toronto data from the 1996 Transportation Tomorrow Survey.[98]

The IBI model has defined nine default neighbourhood types that capture key attributes. These nine neighbourhoods types are designated by urban form, neo-traditional, medium density and suburb density, as well as distance from Toronto's Central Business District (CBD) - Inner area, inner suburb and outer suburb. Key defining attributes of each of the nine neighbourhood types are shown in Table 21.

Table 21: IBI model neighbourhood types

	Neo-traditional			Medium Density			Suburb		
	Inner Area	**Inner Sub**	**Outer Sub**	**Inner Area**	**Inner Sub**	**Outer Sub**	**Inner Area**	**Inner Sub**	**Outer Sub**
Road Layout	Rect. Grid	Rect. Grid	Rect. Grid	Grid + Curve	Grid + Curve	Grid + Curve	Curve	Curve	Curve
Road Length	5	5	5	5	5	5	4	4	4
Intersections	26	26	26	25	25	25	12	12	12
Arterial Roads (km)	0	0	0	0.4	0.4	0.4	0.8	0.8	0.8
Bike routes (km)	0.5	0.5	0.5	0	0	0	0	0	0
Housing mix (1=full)	0.915	0.915	0.915	0.961	0.961	0.961	0	0	0
Housing Density (1 km rad.)	43.48	43.48	43.48	21.69	21.69	21.69	3.667	3.667	3.667
Jobs (1 km rad.)	7,317	7,317	7,317	1,893	1,893	1,893	0	0	0
Grocery stores (1 km rad.)	15	15	15	3	3	3	0	0	0
Household size	2.792	2.792	2.792	2.792	2.792	2.792	2.792	2.792	2.792
Distance to CBD (km)	5	10	30	5	10	30	5	10	30
Jobs (5 km rad.)	400,000	120,000	60,000	400,000	120,000	60,000	400,000	120,000	60,000
Dist. To Transit Station	1	2	10	1	2	10	1	2	10
Dist. To commuter rail	5	5	2	5	5	2	5	5	2
Trans. Veh. Service hrs	50	35	15	45	30	10	35	25	5

Source: CMHC, Tool for Evaluating Neighbourhood Sustainability, Developed by IBI Group.

While the IBI model provides travel behaviour for neighbourhood types, those types do not correspond directly to the neighbourhood types in this report, particularly because the IBI model is defined strictly on data for the City of Toronto. Neighbourhood types were mapped to those of the IBI model as per Table 22.

This mapping does not predict actual transportation behaviour. Instead, it allows the creation of relationships between neighbourhoods to predict travel behaviour. For example, if households in NT-Core drive half as much as households in MD-Inner this would tell us that people living in downtown Toronto drive half the distance as those in sprawl areas of Toronto. These relationships combined with the overall travel behaviour for each city type allows us to determine the specific transportation behaviour for every neighbourhood in 2006.

Table 22: Neighbourhood mapping

City Type	IBI Neighbourhood Type				
	UGC	**Transit Corridors**	**BUA non-intensified**	**Greenfield Transit**	**Greenfield**
Toronto	NT-Core	MD-Core	MD-Inner	MD-Core	MD-Inner
Hamilton	NT-Inner	MD-Inner	ST-Inner	MD-I+5km	ST-I+5km
Inner Suburb	MD-Inner	ST-Inner	ST-Outer	ST-I+5km	ST-O+5km
Outer Suburb	MD-Inner	MD-Outer	ST-Outer	MD-O+5km	ST-O+5km
Outer Centres	NT-Outer	MD-Outer	ST-Outer	MD-O+5km	ST-O+5km

* +5km indicates that instead of using a default neighbourhood type for Greenfield Areas, the same basic neighbourhood types as BUA neigbourhoods were used but the distance to the CBD was increased. This is meant to reflect the fact that their overall form will be similar to established neighbourhoods, but will differ in that they are slightly further from CBDs.

C.4.4. Estimate Overall 2031 Travel Behaviour

Overall, the assumption that neighbourhoods behave the same in 2031 as 2006 was made (i.e. someone living in Hamilton's UGC in 2006 has the same travel behaviour as someone living in that UGC in 2031). One small change to neighbourhoods was made: a 10% increase in the density of UGC and BUA neighbourhoods. To account for this change, the attributes of the neighbourhood types in the IBI mode were changed, adjusting their ratios slightly in comparison to 2006. The travel behvaiour of these adjusted neighbourhood types were used in the analysis for 2031.

Given the model assumes that people behave the same in 2031 and 2006, the primary change in overall transportation behaviour between 2006 and 2031 occurs as a result of a change in the population breakdown/distribution. Due to The Growth Plan's focus on UGCs, a larger proportion of people live in these areas than in 2006. Likewise, as a result of the Metrolinx plan, a much more significant portion of the population will live within 2 km of rapid transit in 2031 as compared to 2006.

C.4.5. Calibrating Results with The Big Move

A number of changes were made to the 2031 results to coincide with work done by Metrolinx. Following their Modelling Backgrounder, factors were adjusted, such as auto occupancy, active transportation mode split to account for policies that would are not captured in traditional models.[99]

Furthermore, the model under-predicted transit usage. Because the model bases future transportation behaviour strictly on current transportation trends, it is ineffective at capturing the effects of a massive transit scale-up in areas outside the City of Toronto where transit use is currently low. For this reason transit ridership numbers were scaled up in the Metrolinx area in 2031 to align with the increase predicted by Metrolinx whose model is much more adept at predicting this increase. This scale-up of transit use leads to a corresponding decrease in auto use.

C.4.6. Estimate GHG Emissions by Travel Mode

By combining population and travel behaviour projections, the model produces estimates of future travel by mode (VKT by personal vehicles and public transit). The next step was to estimate GHG emissions based on the GHGs emitted per VKT for each mode. The GHG emissions depend on the vehicle technologies as described in the following sections.

C.4.6.1 Vehicle Fuel Efficiency and Electric Vehicle

Energy consumption of cars will differ from today's cars as new technology, features and consumer desires lead to changes in vehicle choice and the fuel economy of vehicles. For the future number of cars, assumptions were based partly on analysis completed by Natural Resources Canada in 2007. Canada's Energy Outlook provides projections of future energy use by sector and province. It also provides some of the assumptions that drive the projections.

To determine the impacts of efficiency of new vehicles and uptake of electric vehicles, a simple model was developed with the following approach:

Basic Approach

This model is a simple vehicle stock turnover model used to track energy consumption and resulting GHG emissions from light duty vehicles in regions of Canada from 1990 through 2030. The model disaggregates the data into car and small truck categories based on definitions from Natural Resources Canada. Key assumptions for cases are the growth rate of new vehicles, the average lifetime of a vehicle and the fuel efficiency of retired vehicles. The key assumption that varies between scenarios is the fuel efficiency of new vehicles each year from present through 2031. These are input for each scenario.

The following table details data sources used for this work:

Data Sources
1. Natural Resources Canada, Office of Energy Efficiency Comprehensive End Use Energy Database. Accessed January 8, 2009, most recent year that data are available is 2006. Available at oee.nrcan.gc.ca/corporate/statistics/neud/dpa/comprehensive_tables/index.cfm?attr=0 Summary: The Comprehensive Energy Use Database provides an overview of sectoral energy markets in Canada and in each region of the country. The database is updated annually. This database provides estimates for vehicle stock, number of new vehicles per year, vehicle usage, vehicle fuel efficiency (new vehicles and average for stock), energy consumption and GHG emissions for each year from 1990 to most recent year available. The primary data sources for light duty transportation data in the database are reports from Statistics Canada, combined with NRCan's Transporation End Use Model (June 2007). oee.nrcan.gc.ca/corporate/statistics/neud/dpa/comprehensive_tables/index.cfm?fuseaction=Sources.display We used this source for all historic numbers, the historic values also provide a starting point for the projections.
2. Natural Resources Canada, Analysis and Modelling Division Canada's Energy Outlook: The Reference Case 2006. The publication provides projections of future energy use by sector and province. It also provides some of the assumptions that drive the projections. The growth rates from Canada's Energy Outlook are used for vehicle fuel efficiency, vehicle usage and number of new vehicles as guidance for projections in the Reference case here. The growth rates for these variables refer to national values. Provincial growth rates were not available, so national values have been used for all regions, with some adjustments for vehicle stock growth. All growth rates were applied to historic values to help calibrate the model to the starting year and province.
3. Environment Canada, Canada's Greenhouse Gas Inventory 1990-2006. Data provided in spreadsheet form by Liette Cormier on May 28, 2008. This data source provides GHG emissions by sector and province, including disaggregation to light duty vehicles (gasoline, diesel and other) and light duty trucks (gasoline and diesel. This data source was not used in the model. The values for the GHG emissions by source differed from the NRCan Comprehensive End Use Database. An inquiry to NRCan was made regarding this issue. The NRCan data source provided a single comprehensive source for historic data, while the Environment Canada report did not estimate the driving factors behind the emissions.
4. Electric Vehicles. Energy consumption for new electric vehicles (plug ins) is estimated to be 0.2 kWh/km from BC Hydro Long Term Acquisition Plan, Exhibit B-10 is the Evidentiary Update to the 2008 LTAP. Page 10. The stock turnover model was used to account for uptake, use and retirement of electric vehicles. Electric vehicles are assumed to have a similar lifespan and average annual driving distance as gasoline or diesel vehicles.

Efficiency of New Vehicles

At the time of completing this report, Environment Canada had just released draft vehicle efficiency regulations to limit GHG emissions from new vehicles beginning with the 2011 model year. Canada and the U.S. are working towards a common North American approach to reduce GHG emissions by introducing aligned and progressively tighter regulatory requirements over the 2011-2016 model years.[100]

The U.S. has set fuel economy standards for model year 2011 and the draft Canadian regulations propose that auto companies in Canada comply with those. At time of publication for this report, the U.S. National Highway Traffic Safety Administration (NHTSA) and EPA are jointly developing a single set of vehicle GHG and fuel economy standards that would apply nationally for 2012 to 2016. Their proposed joint standards are estimated to reach 250 gCO_2/mile,[101] if all reductions are made through fuel economy improvements. Under the Canadian Environmental Protection Act, Canada will follow the same path as the U.S.

Our Base Case assumes that the U.S. moves ahead with its proposed vehicle GHG emission standards for the 2012 to 2016 model years and that Canada harmonizes its regulations to match those (as well as matching the standards for model year 2011). Since the U.S. and Canada have not released any draft standards for model years after 2016, changes to vehicle emission standards after 2016 have not been included in the Base Case.

Using these policy assumptions, combined with data on current fuel efficiency of personal vehicles in Ontario, assumptions of average lifetime of vehicles and projections for future vehicle purchases, fuel economy projections for Ontario vehicles are calculated (Table 23).

Table 23: Average fuel economy and vehicle emission standards for vehicle stock in Ontario assumed in Base Case

	2012	2016	2021	2031
U.S. NHTSA/EPA projected fleet-wide emissions compliance levels under the proposed footprint-based CO_2 standards (grams/mile)				
New passenger cars	261	221	n/a	n/a
New light trucks	352	301	n/a	n/a
Assumed fuel economy for Ontario's fleet of vehicles (L/100 km)				
New passenger cars	6.9	5.9	5.9	5.9
New light trucks	9.3	8.0	8.0	8.0
New cars and light trucks combined	8.1	6.9	6.9	6.9
Total fleet, new and existing vehicles	9.5	8.8	7.9	7.1

Source: US NHTSA/EPA values from EPA-420-F-09-047a, September 2009, Table1, Calculations for estimated fuel economy based on vehicle stock turnover model.

Further Improvements in New Vehicle Fuel Efficiency

As noted in section three of the main report, the Greener Options case includes energy efficiency improvements for new vehicles after 2016. Estimates of future average energy efficiency levels that could be achieved in Ontario, with support from provincial or federal policies, are based on analysis from the U.S. Since Canada has stated its intentions to align with U.S. standards for new

vehicles,[102] it is expected that U.S. analysis of potential future standards is appropriate for this report.

For model years 2017 to 2020, the average energy efficiency for new vehicles assumed in the Greener Options case are based on Pavley Phase 2 standards, as proposed by the California government. These standards are designed "to obtain a 45% greenhouse gas reduction from 2020 model year vehicles"[103] in California.

The Greener Options case then projects that energy efficiency improvements will continue at a similar rate each year through 2031. This annual improvement in energy efficiency, approximately 4% per year, would lead to an average energy efficiency of new cars and trucks in 2031 of 3.9 L/100 km, see Table 24. Assuming that almost 20% of new vehicles will be electric and that these electric vehicles will count toward meeting the energy efficiency standards, the improvement in fossil fuelled (gasoline and diesel) vehicles is slightly lower. It is estimated that new gasoline and diesel vehicles will need to achieve 4.6 L/100 km in 2031. This is equivalent to approximately 51 mpg. Studies in the U.S. have demonstrated that this is possible cost-effectively with current technology (mix of conventional and hybrid vehicles).[104]

Table 24: Potential fuel efficiency for Ontario's fleet of vehicles

Fuel Efficiency (L/100 km)	2012	2016	2021	2031
Greener Options, New Cars and Light Trucks Combined	8.1	6.9	5.6	3.9
Greener Options, Total fleet, new and existing vehicles	9.5	8.8	7.6	5.6

Note: Electric vehicles in Ontario are assumed to contribute to meeting the fuel economy standards, based on GHG-equivalency. It is estimated that in 2031, new fossil-fuelled cars and light trucks will meet an average fuel economy of 4.6 L/100 km, with electric vehicles bringing the overall average down to 3.9 L/100 km, as shown in the table above.

Public Transit Fuel Mix, Efficiency and GHG Emissions

The GHG emissions from increased public transit service are included in the Current Directions case based on increases in transit ridership. The relationship between the amount of travel on public transit and GHG emissions is not one-to-one; it depends on the amount of travellers on each bus, train or part of system. However, a basic estimate for GHGs from public transit is based on assumptions for ridership by type of transit as reported in Table 25. As shown, the estimated GHG emission factor for public transit in 2006 is 0.050 tonnes of CO_2e per thousand PKT, decreasing to 0.037 tonnes CO_2e per thousand PKT in 2031.

Table 25: Assumptions for GHG emissions from public transit

	2006		2031	
Energy efficiency	**MJ/100 PKT**	**MJ/100 VKT**	**MJ/100 PKT**	**MJ/100 VKT**
Trolley buses	87	1,131	Efficiency the same for all transit vehicle classes except conventional buses	
Light rail (electric)	78	1,825		
Light rail (diesel)	214	5,019		
Subway/Metro (electric)	58	1,357		
Heavy rail (diesel) [a]	92	2,886		
Conventional buses (diesel) [b]	162	2,112	138	1,792
Electric GHG emission intensity (tonnes / GWh)	180[c]		30[d]	
Mix of technologies over time (% of PKT)				
Ligh rail (electric)	5%		12%	
Light rail (diesel)	0%		13%	
Subway/Metro (electric)	60%		58%	
Heavy rail (diesel)	22%		9%	
Conventional buses (diesel)	14%		8%	
Average GHG emission factor for all public transit[e] (tonnes/1000 PKT)	**0.050**		**0.037**	

Notes:
a. from Metrolinx, personal communication to Pembina Institute, March 23, 2010
b. information directly from Transportation Canada, Urban Transportation Emission Calculator
c. from Env. Canada GHG inventory (2009)
d. from Integrated Power Service Plan for plan 1A (the reference case)[105], values for 2027
e. calculated based on assumptions above

C.4.7. Base Case Caveats

Two caveats in the Base Case include assumptions for how The Growth Plan and The Big Move are carried out.

At the time of this research, specific information on how individual municipalities will respond to The Growth Plan was not available. While municipalities were required to bring their official plans to conformity with The Growth Plan by June 2009, progress on their submissions through this time was mixed. In many cases, the publically available reports lacked sufficient detail, while in other cases the individual plans may not conform to the guidelines in The Growth Plan. As such, the limited information available during our analysis could change significantly following the Growth Secretariat's review, thus making them invalid for analysis purposes.

In the absence of specific information of how municipalities will respond to The Growth Plan, our modelling approach assumed that the specific targets and forecasts in The Growth Plan will be met by all municipalities. While evidence to date shows that the plans produced by a number of communities will not meet the targets,[106] the provincial government has not provided any revisions to The Growth Plan. For the purpose of quantifying the Base Case, it is assumed that municipalities, regional districts, the provincial government and citizens will continue to work together to revise and implement plans that will meet the targets, but recognized that additional incentives and disincentives may need to be applied.

We have also assumed that The Big Move will be implemented as currently planned. This assumption may not hold up over time since the plan calls for investment of $50 billion.[107] At the time of this report, funding with only $11.5 billion has been dedicated through the Move Ontario 2020 initiative.[108] However, it was beyond the scope to anticipate the extent of likely implementation for the transportation plan and assuming full implementation provides the best case to explore further action.

C.5. The Greener Options Scenario

C.5.1. Changes to the Model

To account for improvements in land-use planning the population breakdown between neighbourhood types was changed with more people living in the UGC, BUA and close to transit per the recommended policies in Chapter 3. Table 26 shows the breakdown of the 2031 Greener Options population. This table can be compared to Table 14 above which has the overall breakdown in the Base Case scenario.

Table 26: Greener Options 2031 population breakdown

	Total	UGC	BUA-Tr	BUA-NI	GFA-Tr	GFA-No Tr	% close to transit
Toronto	3,080,000	221,043	2,781,958	69,620	5,535	1,845	98%
Hamilton	660,000	11,435	423,491	165,225	44,888	14,963	73%
Inner Suburbs	3,140,000	158,213	1,956,030	551,930	355,371	118,457	79%
Outer Suburbs	1,740,000	68,406	1,112,224	220,410	254,220	84,740	82%
Outer Centres	1,945,599	73,211	1,113,423	494,621	198,258	66,086	71%
Rural Areas	936,401	0	0	828,752	0	107,649	0%
Total	11,502,000	532,307	7,387,124	2,330,558	858,271	393,739	76%

To account for changes to transportation behaviour (i.e. auto occupancy, transit ridership), the model adjusts the 2031 transportation model outputs to account for the improved policies. For example to account for increase auto-occupancy overall auto passenger kilometres travelled

remained steady (as this indicates total distance travelled in automobiles) while auto VKT drops to account for more people ride-sharing.

To account for changes to fuel efficiency and the electric vehicle target, vehicle turnover accounts for improved fuel efficiency and the uptake of electric vehicles. Electrification of GO Transit is modelled through the emissions factor for public transit. Heavy rail is estimated to have an emissions factor of 0.0057 tonnes per thousand PKT, assuming a 25% increase in fuel efficiency[109] and the electric GHG intensity shown in Table 25. The overall emissions factor for public transit in 2031 under the Greener Options case drops to 0.031 tonnes per thousand PKT.

C.5.2. Modelling Caveats for Greener Options Case

The model is designed as a means for accounting the impact of actions, rather than a truly dynamic policy and behavioural model. The model includes the actions — changes in residential and job location, mode shares and technologies — and the resulting GHG emissions. Policies are not explicitly represented. Different policies could be implemented to achieve the same action. For example, to increase the average fuel economy of vehicles, a government could set a mandatory fuel economy standard, provide incentives to purchase more energy efficient cars, or impose a fuel tax to discourage purchases of inefficient vehicles. The model does not directly mimic or evaluate the different policy approaches.

Our analysis, however, does not exclude policies. The actions described in the Greener Options scenario will need strong government leadership to implement and enforce. Recommendations for which type of policies to implement are based on research and evaluation of such policies in other jurisdictions.

Endnotes

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[11] Greenfield Areas are those areas outside the already developed urban areas as defined by the Minister of Public Inftastructure Renewal. See: Ontario, *Places to Grow*, Section 6.

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[85] Metrolinx, *The Big Move.*

[86] Metrolinx, *White Paper #2,* 65, Table E-4.

[87] Ontario, *Places to Grow,* Policy 2.2.3.1.

[88] Ibid., Policy 2.2.7.2.2

[89] Ibid., Policy 2.2.4.5.a, b & c

[90] Ibid., Policy 2.2.2.1.b

[91] Ibid., Policy 2.2.3.6.h

[92] Ibid., Policy 2.2.3.7.b

[93] Ibid., Policy 2.2.4.4.c & d

[94] Ibid., Policy 2.2.7.1.c

[95] Data Management Group, *2006 Transportation Tomorrow Survey: City of Toronto Summary by Wards*, Department of Civil Engineering, University of Toronto (2009), www.dmg.utoronto.ca/pdf/tts/2006/toronto_wards06.pdf.

[96] Sadownik et al., *Community Measures in the Buildings and Transportation Sectors: GHG Reductions in the Short and Long Term,* final report for the Municipalities Table of the National Climate Change Process (1999), Appendix A.

[97] Manhattan distance assumes that travel occurs on a grid. Typical travel distances reported in the TTS are straight line distances.

[98] For a description of the model see IBI Group, *Greenhouse Gas Emissions from Urban Travel*.

[99] Metrolinx, *The Big Move: Modelling Backgrounder*, Table 3.

[100] Canada, "Canada Moves to Reduce Emissions from New Vehicles."

[101] 250 grams CO_2/mile equals 155 grams CO_2/km – equivalent to 35.5 mpg or 6.7 L/100 km.

[102] Environment Canada's consultation draft regulations on GHG standards for new vehicles state: "The purpose of these Regulations is to reduce greenhouse gas emissions from passenger automobiles and light trucks by establishing emission standards and test procedures that are aligned with those of the United States." www.ec.gc.ca/ceparegistry/documents/regs/ghg/ghg_toc.cfm

[103] California Air Resources Board, *Comparison of Greenhouse Gas Reductions for the United States and Canada Under U.S. CAFÉ standards and California Air Resources Board Greenhouse Gas Regulations: An Enhanced Technical Assessment* (2008) www.arb.ca.gov/cc/ccms/reports/pavleycafe_reportfeb25_08.pdf

[104] For a summary of several recent studies, see Union of Concerned Scientists, *Setting the Standard: How Cost-Effective Technology Can Increase Vehicle Fuel Economy* (2008), www.ucsusa.org/assets/documents/clean_vehicles/ucs-setting-the-standard.pdf

[105] Ontario Power Authority, *Integrated Power System Plan: Consideration of Safety, Environmental Protection and Environmental Sustainability* — Exhibit G, Tab 3, Schedule 1, powerauthority.on.ca/Storage/69/6450_G-3-1_corrected_080505__mm_.pdf

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[107] Metrolinx, *Draft Investment Strategy* (2008), www.metrolinx.com/Docs/DraftRTPandIS/Metrolinx%20Draft%20IS.pdf

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[109] From Evert Andersson and Piotr Lukaszewicz, *Energy Consumption and Related Air Pollution for Scandinavian Electric Passenger Trains,* Department of Aeronautical and Vehicle Engineering, Royal Institute of Technology, Stockholm (2006), www.kth.se/fakulteter/centra/jarnvag/publications/Energy_060925.pdf