

Transportation Demand Management

The Dual Mobility Challenge

Recommendations for Transportation Planning in the Greater Golden Horseshoe

18 September 2008

Final Inquiry

Researched and written by Mohamed Zakzouk (contact author), mzakzouk@gmail.com

Phone: 905.331.0551 Cell: 905.870.8937

Masters of Engineering and Public Policy

McMaster University, Hamilton, Ontario, Canada

Prepared for Dr. Gail Krantzberg, McMaster University
Supervised by Prof. Stefan Siedentop, *Universität Stuttgart*

Contents

Contents	1
Abstract	2
1.0 Introduction	3
2.0 Metropolitan Transit: <i>the Ongoing Challenge</i>	5
2.1 A Brief History of Metropolitan Travel	5
2.2 Public Transportation in Europe: <i>the SCATTER Outlook</i>	6
3.0 Commuting in Ontario: <i>Patterns and Forecasts</i>	8
3.1 Population Growth	10
3.2 Peak Oil	10
3.3 Climate Change	11
3.3.1 Climate Change Mitigation	11
3.3.2 Climate Change Adaptation	11
3.4 Differential Adaptive Capacity	13
4.0 Policy Frameworks and Proposals: <i>the Long-term Shift</i>	14
4.1 Transportation Policy	15
4.1.1 Raising the Cost of Driving	15
4.1.2 Facilitating Occasional Automobile Usage	16
4.1.3 Raising the Cost of Regional Public Transit	16
4.1.4 Diversifying Fare Options	18
4.2 Land Use and Housing Policy	19
4.2.1 Impact Fees on Low-Density Development	19
4.2.2 Decentral Economic Concentration through Industrial Ecology	19
4.2.3 Subsidising Residence in Employment Zones	21
4.2.4 Building Attractive Communities	21
4.2.5 Advancing Tourism Opportunities	22
4.3 System-Responsive Policy Frameworks	22
4.4 Provincial TDM Provisions	25
5.0 Concluding Remarks	26
Acknowledgments	27
References	27

Abstract

Transportation Demand Management (TDM) is essential practice for the success of regional transportation planning in Ontario. In addition to improving public transit infrastructure and encouraging modal shifts for automobile commuters, it is necessary to reduce/eliminate avoidable travel needs through a mix of transportation and land-use policies. This is evidenced by experiences and studies in several European city regions, where improved public transit contributed to urban sprawl, decentralisation, and increasing travel demand and commuting distance. Emerging issues related to population growth, Peak Oil and climate change are further incentive to reduce travel demand. Numerous policy barriers – most notably cultural and psychological constraints, the diverse and complex impacts of transportation-systems, and the uncertainty of some transit-related issues – stand in the way of TDM opportunities. Policy makers must closely monitor social attitudes towards travel and housing options in order to update policy instruments according to the changing requirements and priorities of Ontario’s emerging socio-economic structure.

1.0 Introduction

Regional transportation planning and investment are now a priority in Ontario's Greater Golden Horseshoe, GGH (Ontario Ministry of Public Infrastructure Renewal, OPIR 2006, p.25). Ontario loses more than "\$5 billion in lost GDP" annually due to traffic congestion and delays (2006, p.7). In the Greater Toronto Area (GTA) alone, this amounts to \$2.2 billion annually, in addition to commuter stress and environmental pollution (Office of the Premier 2007). According to Statistics Canada (2006, p.25), the average commuting time to and from work "increased by 16.2% in Toronto between 1992 and 2005." In 2004, GTA commuters "made approximately 10 million car trips per day [] and were responsible for approximately 14 million tonnes of carbon dioxide emissions" (Office of the Premier 2007). Current government investments are particularly focused on the Greater Toronto and Hamilton Area (GTHA) through the *MoveOntario 2020* plan, which is expected to provide "902 kilometres of new or improved rapid transit investment..., [take] 300 million car trips off GTA roads..., [and] cut smog and reduce carbon dioxide emissions by 10 megatonnes by 2020."

The government is also launching extensive land-use planning policy to manage growth in the GGH under the *Places to Grow Act* (OPIR 2006). Guiding planning principles include: compact development, provisions for sustainable communities with complete living requirements, growth management that supports economic prosperity, conservation/protection of natural resources, and the promotion of public and stakeholder engagement (2006, p.10,41). Policy 1.6.5.5 of Ontario's *Provincial Policy Statement, 2005* (PPS) instructs that "transportation and land use considerations shall be integrated at all stages of the planning process" (Ontario Ministry of Municipal Affairs and Housing, OMAH 2005, p.12).

These policies come amid emerging socio-economic and environmental obstacles – namely population growth, Peak Oil and climate change – with different implications for land-

use and transportation policy. Coupled with compound interactions between mobility patterns and urban growth, these obstacles challenge the question of what should be expected of transportation services. The inquiry highlights the critical role of transportation demand management (TDM) by asking the question: Why should TDM be emphasized in regional transportation planning, and how should this emphasis materialize in different policy areas?

The paper establishes a long-term policy framework that emphasizes the management of travel demand at the source. The main argument is that improvement in regional public transit services and infrastructure alone is not sufficient to address congestion and transportation demand issues because it induces higher mobility needs through urban decentralization and sprawl, which triggers unfavourable consequences in other policy areas (Batty *et al.* 2003; Chin 2002, p.10; Gayda *et al.* 2005). TDM instruments must integrate land-use and transportation policy to address the root-causes of travel needs, particularly frequent, long-distance commutes that could be reduced or avoided through more efficient urban structures and/or more sensible attitudes towards regional travel. This policy strategy could also advance Ontario's growth objectives and adaptive capacity to various emerging issues.

The argument is presented in three sections. First the historic development of travel demands relative to the expansion of metropolitan regions is briefly disclosed, and relevant experiences in some European cities and findings from Europe's *Sprawling Cities and Transport* (SCATTER) research project are highlighted. Then, Ontario's mobility patterns and commuting behaviour are discussed in view of three emerging issues: population growth, Peak Oil and climate change. Finally, policy proposals are presented that build on existing provincial policies and plans. While most of the discussion and recommendations apply to the GGH, some focus is given to the GTHA since it is the primary focus of Ontario's public transit investments.

2.0 Metropolitan Transit: *the Ongoing Challenge*

“Ways of thinking evolve – they have a history and understanding this history enables us to understand the nature of the assumptions we are making now as we approach important practical issues” – Ralph D. Stacey (2003, p.18)

2.1 A Brief History of Metropolitan Travel

The urbanization trend at the beginning of the twentieth century augmented urban populations, which overcrowded urban cores and triggered an out-migration of housing to city suburbs (Chin 2002, p.8). This was aided by social and technological changes. As Chin (2002, p.8) explains, “technological and economic progress created greater fluidity in the population, with changes in transport and technology allowing the outward dispersal of manufacturing, retail trade and housing, and increases in the standard of living, increasing the spatial demands of the city dwellers.” By the 1950’s, official municipal boundaries started to grow, and “[later] suburbanization [was] either annexed or incorporated as separate towns.” (2002, p.7)

In Canada, federal programs from 1945 to 1968 focused on developing a housing industry which primarily emphasised “[provisions] of single detached owner-occupied housing for middle income families.” This trend was a response to the “economic and demographic pressures of economic reconstruction, the needs of returning veterans, and the pent-up demand from the 1930s and 1940s.” (Carroll and Jones 2000, p.278)

The growing spatial structure of North American cities generated travel demands that were accommodated by the development of the automobile and more extensive highway systems¹ (Batty *et al.* 2003, p.2; Chin 2002, p.10). According to Batty *et al.* (2003, p.2), this increased the possibility of sprawling from the city by facilitating the out-migration of city services and activities to the suburbs. In the meantime, urban populations continued to grow, generating more sprawl and travel demands (2003, p.2).

¹ There is debate that public subsidy (rather than free markets) had a bigger role in promoting automobiles (Chin 2002, p.10).

Similarly, increased mobility in the U.K. has been the main contributor to suburban growth, this time through public transit. As Chin (2002, p.10) explains, the growth of London's suburbs "began with the extension of the rail network to the suburbs in the 1860's, producing a radial pattern of growth along the lines of transportation. The latter [] more widely spread, circular pattern of growth was also a result of the development of public transportation, in this case by motor bus."

As Batty *et al.* put it, the relationship between transportation and urban growth "is the typical chicken and egg conundrum of what comes first: better transportation or population growth..." (Batty *et al.* 2003, p.1-2)

2.2 Public Transportation in Europe: *the SCATTER Outlook*

In Europe, all city regions have good public transportation, according to Batty *et al.* (2003, p.9). In addition, urban sprawl² is lesser than in North America due to a "deeper continuity" resulting from an "underlying network of villages and small towns consistent with the past agricultural basis of medieval society" (2003, p.9). Nevertheless, sprawl, congestion and long-distance commutes are becoming common features in all European city regions (Batty *et al.* 2005, p.9; Gayda *et al.* 2005, p.7).

According to Europe's SCATTER³ project, simulations of different policy scenarios based on integrated land-use/transport models in Brussels, Helsinki, and Stuttgart show that "public transport investments [] generate urban sprawl if they extend to the suburban or rural areas." The results also reflect an increase in home-to-work commutes by 8 per cent due to the *Réseau Express Régional* (RER) in Brussels, and 12 per cent according to a scenario for Helsinki where rail services were made 25 per cent faster. Reductions in CO₂ emissions were

² Gayda *et al.* (2005, p.7) define urban sprawl as low density, uncoordinated urban growth, and spatially segregated land uses.

³ SCATTER: research project that addresses urban sprawl in relation to new suburban public transit (Gayda *et al.* 2005, p.7).

evident; by 8 per cent in Brussels, and 2 per cent in Helsinki. However, the study points out that sprawl “[consumes] part of [such] potential benefits of the public transport investments, with regard to the reduction of car mileage and emissions.” (Gayda *et al.* 2005, p.11)

In Madrid, urbanised land increased by 50 per cent in the 1990s, compared to 25 per cent in Spain and 5.4 per cent in the EU. The European Environment Agency (EEA 2006, p.24) identifies increased mobility among the contributing factors to urban decentralisation in the Madrid region, “based on a substantially improved transport network, including new toll motorways, three motorway rings around the city, and new and improved metropolitan and train connections.” Areas that used to be external to Madrid are now important parts of the region, and new peripheral, low-density developments are generating more mobility needs. “[Transport] improvements are a priority.” (2006, p.24)

In the Region of Stuttgart, land-use structure and policy have had a clear influence on population distribution, housing demands, and thus mobility needs. Despite the availability of all transportation modes; walking, cycling, buses, light rail, suburban rail, automobiles, and intermodal transport such as park-and-ride, congestion still causes “serious obstructions in long-distance traffic, as well as high environmental pollution...” (Haag 2007, p.53). An important cause for this travel demand can be attributed to an out-migration pattern to the city’s four surrounding districts since 1992 (2007, p.47). According to Haag (2007, p.47), restrictive development policy in the inner city “corresponds to a transfer of work places and a reorganisation of related commuter flows.” This highlights the impact of land-use policy on population distribution and commuting patterns as a key consideration for regional transportation planning.

Another important consideration that can be drawn from Stuttgart’s transit situation is the level of commuter awareness of the expenses associated with housing versus travel choices.

According to Professor Siedentop (personal communication, August 27, 2008, Institute of Regional Development Planning, University of Stuttgart), Stuttgarters are generally “biased towards commuting costs;” they out-migrate for cheaper land price and underestimate the consequential cost of commuting. Stuttgart has special constraints due to its geography, and the “bottle-neck” structure of its public transportation system that requires six *S-Bahn* lines to pass through *Hauptbahnhof* (main station), which makes it difficult to increase the frequency of *S-Bahn* trains any further. (Junesch and Siedentop, personal communication, August 27, 2008)

Transportation policy (or mobility) is a causal factor in the evolution of a metropolitan region, and thus an integral component of land-use policy (OMAH 2005, p.12). In addition, improved mobility is a probable root-cause of sprawl, decentralisation, and travel demand (Gayda *et al.* 2005). Traffic congestion and subsequent pollution/GHG emissions are therefore associated with both transit and land-use provisions, which highlights a prospective role for TDM in a wide range of policy areas.

3.0 Commuting in Ontario: *Patterns and Forecasts*

Statistics Canada (2006, p.9-12) shows a 1 kilometre rise in commuting distance in Ontario between 1996 and 2006 (7.7 to 8.7 km). In 2006, 79.2 per cent of workers commuted by car, despite a slight decrease of 0.7 per cent to public transit (12.2 to 12.9 per cent) since 1996. Walking and cycling represented only 5.6 and 1.2 per cent of commutes respectively. According to a Metrolinx⁴ publication, the driving trend rose significantly in the GTHA over the past two decades. “The proportion of commuter travel by transit, walking or cycling dropped from 31 per cent to 24 per cent, while vehicle-kilometres driven nearly doubled,” with an inefficient average use of about 1.2 passengers per vehicle (Metrolinx 2008a, p.4). Figure 1

⁴ Metrolinx was created by the Government of Ontario to develop and implement the GTHA transportation plan. It operates within the legislative framework of the *Greater Toronto Transportation Authority Act, 2006*. (Metrolinx 2008b, p.1)

indicates an increase in commutes of 25 km and over in all census metropolitan areas⁵ (CMA) in the GGH, except Guelph and Peterborough, and a decrease in commutes of 5 km or less in all CMAs, except Brantford.

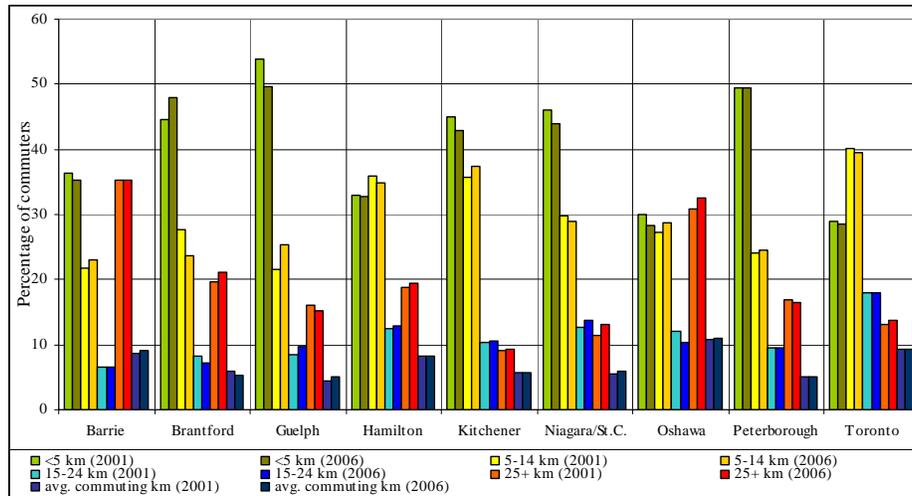


Figure 1: Proportion of median commuting distance and commuting distance of workers in 2001 and 2006 for different metropolitan areas in the Greater Golden Horseshoe (adapted from Statistics Canada 2006, p.24)

Travel demands and commuting patterns are closely related to land-use density. According to Metrolinx, “residents of central, denser communities tend to take transit, walk and cycle more often, and their trips are generally shorter.” It is stated that “one-third of downtown Toronto trips are made by public transit, one-third by walking or cycling, and one-third by car, [and] in peak periods, public transit use exceeds 70 per cent” (Metrolinx 2008a, p.4). This is a stark contrast to the provincial figure (79.2 per cent) for automobile commuters.

The GGH’s general lack of reliable alternative modes of travel (Metrolinx 2008b, p.4) makes it difficult to determine with much certainty what the presented commuting patterns mean in terms of social attitudes towards cycling or public transit. It is possible that social trends would favour these alternative modes as the infrastructure becomes more available. However, it is clear that commuting patterns can be used as indicators of social and cultural

⁵ CMA is an “area consisting of one or more neighbouring municipalities situated around a major urban core. [It] must have a total population of at least 100,000 of which 50,000 or more live in the urban core.” (Statistics Canada 2006, p.41)

behaviour relative to urban structure. For regional planning policy, this relation must be observed in conjunction with foresight of emerging socio-economic concerns.

3.1 Population Growth

Population growth is an incentive for TDM that targets the root causes of travel demand. By 2031, the GGH population is “forecast to grow by an additional 3.7 million (from 2001) to 11.5 million people, accounting for over 80 per cent of Ontario’s population growth” (OPIR 2006, p.12). The GTA alone will account for about 60 per cent of population growth in southern Ontario (Chiotti and Lavender 2007, p.233). If current commuting patterns persist, the growing population could only increase travel demand in the GGH, which would compromise the effectiveness of the government mandate to mitigate congestion, pollution and GHG emissions (section 2.2). In addition, rising travel demand could require additional funds to support public transit infrastructure. As Matrolinx puts it; “it is much cheaper to avoid a trip... than to provide the infrastructure to support it” (2008a, p.6).

3.2 Peak Oil⁶

According to Colin Campbell, Founder of the Association of the Study of Peak Oil and Gas, “important [oil] producers have already passed their peak, suggesting that the world peak of production is now imminent” (2008). In Ontario, oil security may last longer given the large potential of oil production in Canada (Brown 2006, p.22). However, Ontarians may still experience shortages in case of a global oil crisis due to the North American Free Trade Agreement energy provisions that ensure a completely open North American energy market – especially given the United States’ high demand for oil⁷ (Holden 2006; Zakzouk 2008, p.9-11).

⁶ *Peak Oil*: “the maximum rate of the production of oil in any area... recognising that it is a finite natural resource, subject to depletion.” Maximum rate occurs upon the extraction of approximately half the oil in a given reserve. (Campbell 2008).

⁷The U.S. is the biggest oil consumer per capita (Energy Information Administration, 2008a). Canada is currently its top source of foreign supply, providing 1.944 million barrels of crude oil and 2.586 million barrels of petroleum daily (EIA 2008b)

Peak Oil still faces many uncertainties (Campbell 2008) and some scepticism (Lendman 2008) regarding concerns such as the date of peak, the global amount of remaining oil resource base, and prospects of technological advancements. Nevertheless, studies indicate a clear rise in gasoline prices (Finance Canada 2006) and consequential reductions by about 23 per cent in the public's tendency to drive (Federation of Canadian Municipalities, FCM and Canadian Urban Transit Association, CUTA 2008, p.25). More demand for oil is not sustainable and would increase the risks associated with anticipated production shortages and costs of subsequent adaptation (Brown 2006, p.21-40). Reducing reliance on oil-dependant transportation is an important adaptation strategy to rising oil prices.

3.3 Climate Change

3.3.1 Climate Change Mitigation⁸

The Government of Ontario has pledged to reduce provincial emissions by 6% by 2014 and 15% by 2020 below 1990 levels, for a total GHG reduction of 100 million tonnes “against business-as-usual” (Go Green Ontario 2007a, p.2,7). Given that Ontario's transportation sector represents over 30 per cent of total emissions and is the largest and fastest growing source of provincial GHGs (Go Green Ontario 2007b; Zakzouk 2008, p.7), low-emission transportation modes and reductions in travel times and distances are positive measures for GHG mitigation in view of Ontario's commuting trends and in the absence of revolutionary, zero-emission transportation technologies.

3.3.2 Climate Change Adaptation⁹

It is not yet clear what measures are necessary to adapt transportation infrastructure to climate change. During a Transport Canada workshop on the impacts of climate change on

⁸ *Mitigation*: “anthropogenic intervention to reduce the sources or enhance the sinks of [GHG]” (Klein *et al.* 2006, p.750).

⁹ *Adaptation*: “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities” (Klein *et al.* 2006, p.750).

transportation, delegates concluded that “the impacts of climate change on transportation infrastructure in Canada have not been explored in great depth to date.” Representatives of the transportation industries noted that “although infrastructure investments are planned for a fairly long-term horizon, climate change is not yet a significant factor in their planning activities” (Marbek Resource Consultants 2003, p.I-II).

According to Field *et al.*, transportation networks in North America “are sensitive to weather extremes that exceed their safety margins,” with potential high-cost impacts. Chiotti and Lavender (2007, p.254) identify temperature-related damages, snow and ice control, and damages related to heavy rainfalls and other extreme weather events as “the most significant impacts of changing climate on land transportation in the south subregion [of Ontario].” According to the Clean Air Partnership, transportation service disruptions are already frequent in Toronto due to weather-related incidents which contribute to about “10 train derailments, 10 to 15 aircraft accidents, over 100 shipping accidents, and tens of thousands of road collisions every year.” These risks are expected to rise due to climate change (2006, p.23). Conversely, Field *et al.* (2007, p.635) point out that “warmer or less snowy winters will likely reduce relays, improve ground and air transportation reliability, and decrease the need for winter road maintenance.”

The inherent unpredictability of extreme weather events makes it difficult to quantify this argument for policy purposes. However, from a risk management perspective – risk defined as the product of the probability of an event occurring and the consequences of such event¹⁰ (Dr. Brian Baetz 2007, SEP-702 Lecture on Risk Analysis and Decision Trees, McMaster University) – reducing social and economic reliance on transportation infrastructure would advance climate adaptation.

¹⁰ Risk = Probability x Consequence

3.4 Differential Adaptive Capacity

In climate change literature, the term adaptive capacity refers to the “ability or potential of a system to respond successfully to climate variability and change, [which] includes adjustments in both behaviour and in resources and technologies” (Adger *et al.* 2007, p.727). As Field *et al.* point out; climate adaptation incorporates wider socio-economic concerns, since the climate will not be changing in isolation (2007, p.635). Therefore, the study of adaptive capacity is applicable to a wide range of emerging issues and inherently involves socio-economic considerations associated with population growth and Peak Oil.

Adaptive capacity to emerging issues can be increased through reductions in avoidable travel demand for a subsequent reduction in oil use, GHG emissions and weather-related threats (extreme events) to transportation infrastructure. However, adaptive capacity incorporates a wider set of socio-economic concerns including: human/social capital, per capita income, civic resources, health, education, social status, age, class and gender (Adger *et al.* 2007, p.727-731). As Adger *et al.* (2007, p.719) explain, differential capacities exist even in regions, localities, and social groups of nations with high adaptive capacity. According to Chicotti and Lavender (2007, p.267), there are various obstacles to adaptive capacity building in Ontario, most notably due to institutional obstacles such as overlapping jurisdictions, poor consensus building on cross-jurisdictional issues, and uneven distribution of resources. The authors also identify aboriginal populations, rural communities and the urban poor as social groups with “broad disadvantages” in this matter.

As pointed out by Germany’s Federal Office for Building and Regional Planning (*Bundesamt für Bauwesen und Raumordnung*, BBR 2001, p. 23-24), social divisions have a spatial dimension that may manifest as regional disparities in living conditions and economic opportunities. Based on a study of local climate policies across Norwegian municipalities, Aall

et al. (2007) warn that disparities in the fiscal and political capacities of local institutions – particularly surrounding big cities – may result in a situation where “islands of ‘best practice’ are surrounded by a sea of ‘business-as-usual’” (2007, p.99). The spatial dimension of regional inequity could be partly managed through provisions of land-use and transportation by directing population and capital distribution towards a balanced regional structure.

4.0 Policy Frameworks and Proposals: *the Long-term Shift*

In practice, an objective to eliminate all travel needs is neither realistic nor desirable. As Calthorpe and Fulton (2001, p.6) point out, the health of emerging regions depends on the sophistication, vitality and connectivity of their networks, which includes the contribution of transportation-systems to social and economic connectivity. Moreover, an elimination of travel needs is not a realistic objective because the employment-housing structure is influenced by externalities (namely free market forces and individual choice) that are complex and may act against policy objectives. Calthorpe and Fulton argue that regions are becoming “what the city used to be, the nexus of our culture and the armature of our economy.” They are dominated by multifaceted forces; hence their evolution “cannot be a simple return to central city urbanism or Garden City deconcentration.” (2001, p.7)

A wide spectrum of policy measures is necessary in Ontario to implement a dual mandate to improve mobility through transportation infrastructure and services, and at the same time manage travel demand to reduce/eliminate *unnecessary* or *avoidable* commutes. The following policy discussion focuses on the latter by addressing the root-causes of frequent, regional commuting (i.e. frequent travel needs *between* municipalities or urban centres) through a combination of transit and land-use considerations. The aim is to introduce a policy framework that exploits the potential influence of mobility patterns to advance the mutual

objectives of different policy areas, thereby maximising and sustaining the benefits of Ontario's transportation investments. The following objectives are emphasized: 1) reduction/elimination of avoidable travel needs (also a form of climate adaptation); 2) reduction of reliance on oil; 3) gradual shifts in business and public behaviour to support smart growth; 4) municipal empowerment by attracting investment (adaptive capacity building).

The proposals add to existing government policies and/or plans that undertake similar objectives¹¹ (e.g. PPS policy 1.6.5.4: "a land use pattern, density and mix of uses should be promoted that minimize the length and number of vehicle trips...") Many concepts are based on theoretical approaches and existing practices or studies in other jurisdictions. All proposed policies should be read as recommendations for further discussion, research, and consultation with stakeholders along the development life of Ontario's transportation plans.

4.1 Transportation Policy

4.1.1 Raising the Cost of Driving

1st Proposal: Raise the cost of automobile usage in the GGH through parking fees, road tolls, and higher or sustained gasoline tax.

Long-distance commutes could be discouraged through increases in the cost of automobile usage. According to SCATTER simulations in Brussels, Helsinki and Stuttgart, a 50 per cent increase in car cost "clearly leads to concentration of the population in the urban zones," based on the general principle that "households tend to out-migrate towards suburban areas when the travel cost (or times) decreases,... and concentrate around the work places, when the travel cost (or times) increases" (Gayda *et al.* 2005, p.33). The simulations show "a significant decrease in the total car mileage, and consequently, in [] CO₂ [] and pollutant emissions," (2005, p.36) which also implies reduction in traffic congestion and oil demand.

¹¹ See Metrolinx 2008a,b; OMAH 2005, p.4-14; and OPIR 2006, p.12-28

Parking fees and tolling are already being considered by Metrolinx (2008a, p.4) as financing instruments for the GTHA transportation plan. However, raising taxation generally has low public and political acceptance despite the fact that Canadian gasoline taxes are among the lowest in industrialized countries (Natural Resources Canada 2008b). Alternatively, the government should sustain existing taxes to allow rising market prices to continue to discourage driving, as evidenced by a study by FCM and CUTA (2008). According to the study, 23 per cent of Canadians are already driving less due to the “new reality” of higher gasoline price (2008, p.24). Jean Perrault, President of the FCM believes this is a “tipping point” for driving behaviour in Canada (2008).

4.1.2 Facilitating Occasional Automobile Usage

2nd Proposal: Facilitate car rental/sharing services.

As an incentive to discourage car ownership, rental/sharing services (e.g. zipcars¹²) could be improved in order to facilitate alternative access to automobiles for occasional use (e.g. moving heavy items, trips to locations not accessible by public transit, etc.). This way drivers could more easily choose to eliminate the fixed costs of car ownership (e.g. purchase, insurance, maintenance, parking, etc.), thereby minimising their frequent reliance on automobiles. Car rental/sharing facilities should be in central locations, accessible by public transit (e.g. mobility hubs), and should be required to provide pick-up and drop-off services for customer convenience. Where possible, fiscal incentives (e.g. tax breaks) should be introduced to reduce renting/sharing costs.

4.1.3 Raising the Cost of Regional Public Transit

3rd Proposal: Raise regional public transit fares through a long-term, system-responsive pricing process¹³.

¹² Zipcar is a car sharing service for occasional automobile usage. See <http://www.zipcar.com/>

¹³ See section 4.5 for more discussion on system-responsive policy frameworks.

This proposal is based on SCATTER's 4th policy recommendation: *Reduction of public transport only in the urban centre*. According to simulations in Brussels, Helsinki and Stuttgart, decreasing the cost of regional public transit (i.e. between the urban centre and suburban areas) generates urban sprawl. On the other hand, "when the accessibility is improved *only* within the urban centres, [the urban centre is made] more attractive both for households and for economic activities." (Gayda *et al.* 2005, p.38)

Until commuting patterns change in the GGH, the current tendency towards long-distance commuting (section 3) would require immediate measures to encourage regional public transit in order to reduce driving and address congestion and GHG emissions. Consequently, the proposed policy may not be immediately desirable in Ontario. The pricing process must follow a system-responsive policy framework so that as travel and housing attitudes change in favour of shorter commutes (section 4.2.3), and as long-distance driving becomes more and more unaffordable, regional public transit should become more expensive. As a general rule, public transit must always be cheaper than driving (i.e. the average cost of gasoline, tolls, parking and other fees combined).

The pricing system could be applied by identifying transit zones corresponding to the urban growth centres outlined in Ontario's growth plan for the GGH. Same-zone travel should have a flat rate, and fare increments should be exponential as the destination zone gets farther. Surveys similar to those examining the relationship between gasoline prices and driving/public transit use (FCM and CUTA 2008) should monitor potential tipping points in public behaviour where regional commuting costs make it worthwhile to relocate closer to work.

Raising the cost of regional travel would have subsequent disadvantages on aspects such as economic activity, social connectivity, tourism, and the delivery of goods and services. A solution to these drawbacks is to diversify fare options according to different travel needs.

4.1.4 Diversifying Fare Options

4thProposal: Introduce different fare options to discourage avoidable daily commutes and encourage other favourable uses of regional public transit.

To distinguish between undesirable commutes and other uses of public transit, table 2 proposes categories based on whether or not commuters should be encouraged to travel between transit zones, and respective types of public transit fare.

Table 2: Commuter categories based on whether or not travel between urban zones should be encouraged

Commuter	Travel	Reason(s)	Proposed Fare/Pass Option(s)
Fixed workplace	NO	Objective of reducing regional-level commutes	<ul style="list-style-type: none"> • <i>Normal Fare</i>: system-responsive pricing ^a.
Non-fixed or mobile workplace	YES	Nature of employment Economic benefits	Valid based on occupation or special work requirements: <ul style="list-style-type: none"> • <i>Employment Mobility Cards</i> ^b: different discount rates; • <i>Monthly Pass for Employees</i>: discounted pass
Goods/services	YES	Economic benefits	<ul style="list-style-type: none"> • <i>Reduced fare</i>
Tourism/ Recreation	YES	Temporary travel Economic benefits	<ul style="list-style-type: none"> • <i>Regional Day Pass</i> • <i>Regional Day Pass for up to 5 Passengers</i> ^c. • <i>Regional Weekend Pass for up to 5 Passengers</i> ^d.
Commute to special-event ^e	YES	One-time event Social benefits	Booking in advance with proof of event and photo ID: <ul style="list-style-type: none"> • <i>Special-Event Pass</i>
Low-income	YES	Social concerns	<ul style="list-style-type: none"> • <i>Reduced fare</i> ^e.
Students	YES	Social concerns	<ul style="list-style-type: none"> • <i>Student Pass</i> (common practice)
Youth/ elderly	YES	Social concerns	<ul style="list-style-type: none"> • <i>Special Pass</i> (common practice)

a. Refer to sections 4.1.2 and 4.5
 b. Based on Deutsche Bahn (DB 2008) *BahnCards* 25, 50 and 100 that provide 25%, 50% and 100% discounts on transit tickets.
 c. Based on DB (2008) *Länder-Tickets*; valid for one day from 9 a.m. to 3 a.m. within a given federal state in Germany.
 d. Based on DB (2008) *Happy-Week-End Ticket* in Germany; valid from Friday midnight until Monday at 3 a.m.
 e. Further research necessary to account for social welfare concerns (out of the scope of this study)

The application of this fare system is realistic given that most instruments are already common practice in Germany and/or Ontario. However, the system's differential attitude toward different occupations may be controversial and difficult to implement. Promotional measures must clarify the long-term benefits of the system and highlight the attractiveness of some of its options (e.g. Special-Event Pass, Weekend Pass, etc.). Another challenge concerns the system-responsive process of determining *Normal Fare* (section 4.5) which is inherently complex and subjective.

4.2 Land Use and Housing Policy

4.2.1 Impact Fees on Low-Density Development

5th Proposal: Impose an “impact fee” on all development outside urban growth centres, and reduce taxation on development within urban growth centres.

The proposal is based on SCATTER’s proposal to tax suburban development in order to “internalise a part of the external costs generated by [] new housings [] equipments and infrastructures... [as] an application of the “polluter pays” principle” (Gayda et al. 2005, p.31). Similarly, “polluter pays” applies in compensation for the long-term impacts of increasing mobility needs through urban decentralization. SCATTER performed simulations of this policy in Brussels, Helsinki and Stuttgart with tax reductions calculated to impose no net cost on the authorities. The results prove the policy “efficient to concentrate the population in the urban zones... [with a tendency] to concentrate the induced employment¹⁴ in urban areas.” (Gayda *et al.* 2005, p.31).

This policy is among the recommendations of the European Conference of Ministers of Transport, has been used in the United States for over thirty years (Gayda *et al.* 2005, p.31), and is consistent with *Places to Grow Growth Plan*, section 2.2.2 which states that “population and employment growth will be accompanied by... directing development to *settlement areas*...[and] prohibiting the establishment of new *settlement areas*¹⁵” (OPIR 2006, p.14).

4.2.2 Decentral Economic Concentration through Industrial Ecology

6th Proposal: Establish provisions for decentral concentration in the GGH economy through principles of industrial ecology.

To provide an equitable mix of housing and employment, and mitigate differential adaptive capacity across the GGH, the regional economy must be distributed evenly across

¹⁴ Induced employment is defined as a product of “local demand” (Gayda *et al.* 2005, p.31).

¹⁵ *Settlement areas*: urban/rural settlements with concentrated development and mixed land uses, where “lands have been designated in an official plan for development over the long term planning horizon provided for in [PPS].” (OPIR 2006, p.46)

urban growth centres. This concept is similar to Germany's federal economic structure which is characterised by its *decentral concentration* – a relatively even distribution of population and employment in contrast to other European states that are “economically and culturally dominated by one big (capital) city” (BBR 2001, p.7). Decentral concentration has had advantages in terms of economic efficiency, accessibility and provisions of goods and services, and remains an “important objective of German spatial planning policy” (2001, p.7).

In setting up a regional economic structure, principles of *industrial ecology* (IE) – which is “the study of the physical, chemical, and biological interactions and interrelationships both within and between industrial and ecological systems” (Garner and Keoleian 1995, p.2) – should be considered and applied where possible. As explained by the University of Washington Mesoscale Ensemble (UWME 2008), IE “[manages] eco-efficient industrial systems that take advantage of the cyclic patterns of materials and energy flow found in natural ecosystems.” It differs from traditional industrial models in that “the flow [] and stock of materials and energy is optimized in Industrial Ecosystems such that emphasis is placed on efficiency, waste recovery and exchange, and the minimization of adverse environmental impact.” IE benefits industry by providing “opportunity to decrease production costs through increased materials and energy efficiency waste recycling, and the elimination of practices that incur regulatory penalty;” it benefits the environment by “[restoring] damaged ecosystems, [reducing] sources of pollution and waste, [and decreasing] demand for natural resources...;” and it benefits society by “[enhancing] economic performance and development and [reducing] solid waste streams leading to reductions in demands on municipal infrastructure and budgets” (UWME 2008).

The application of this policy requires a holistic, long-term vision involving various disciplines, appropriate technologies, and policy/legislative changes (Garner and Keoleian

1995, p.10). This could have many complications in practice, but is worthwhile to advance sustainable economic development in Ontario. It is also consistent with PPS *Employment Areas* policy 1.3.1 (OMAH 2005, p.8) instructing planning authorities to “[provide] for an appropriate mix and range of employment... to meet *long-term needs*” (emphasis added).

4.2.3 Subsidising Residence in Employment Zones

7th Proposal: Introduce fiscal housing incentives for employees to live in the same urban zone as their place of employment.

To manage the relationship between housing and commuting tradeoffs, housing policy should make it more attractive for employees to live/relocate in the same urban centre as their place of employment. People residing outside their urban zone of employment would be taxed to subsidize relocation closer to work. For those people who already live and work in the same urban centre, the policy would act as an incentive for them not to move away.

A critical challenge to this proposal, as pointed out by Dr. Junesch (personal communication, August 27, 2008), concerns couples working in different municipalities. One way to address this concern is to introduce different levels of subsidies relative to the number of employees per household that work outside their residence zone. Households with two or more residents working outside their residence zone would be taxed, households with at least one resident working in their residence zone would be partially subsidized, and households with two or more residents (or all employed residents) working in their residence zone would be fully subsidized. Taxation would be relative to the length of home-to-work commutes. Gradually, *Places to Grow* provisions and improved employment opportunities (section 4.2.2) would increase the chances of couples finding employment in their residence zone.

4.2.4 Building Attractive Communities

8th Proposal: Provide diverse housing options to accommodate different social demands. In particular, introduce intermediate designs between collective and single-family housing.

This policy proposal is based on SCATTER's 6th recommendation: *Intermediate housing/urban design, or how to combine household social aspiration and density*. The aim is to improve the attractiveness of compact urban growth centres by supplying the single-family housing commonly sought in low-density suburbs. SCATTER refers to the French PUCA research centre as an example of such initiatives (Gayda *et al.* 2005, p.43). More research in Ontario is necessary to develop housing designs that address cultural demands within the GGH.

4.2.5 Advancing Tourism Opportunities

9th Proposal: Identify and preserve cultural heritage buildings and sites in order to boost the attractiveness and financial status of municipalities across the GGH.

4.3 System-Responsive Policy Frameworks

10th Proposal: Establish monitoring and stakeholder participation instruments to inform system-responsive policy measures in a self-organising system.

Land use and transportation planning are particularly complicated because they require long-term policy application that depends on individual participation within society (i.e. *choosing* where to live, locate a business, or how to commute). This entails cultural and psychological barriers that extend beyond the influence of public policy. In his book *Strategic Management and Organisational Dynamics: the Challenge of Complexity*, Stacey (2003) argues that the behavioural patterns of an organization (i.e. a society) are impossible to predict, and hence fully control or adapt, due to the complex interactions between individual actors. He highlights the position taken by the complex responsive processes perspective that “individuals and groups form and are formed by each other simultaneously” (2003, p. 411) in an *emerging* system of intentions and strategies based on “the ongoing conversational life of an organisation and...ongoing conversations between people in different organisations” (2003, p.423).

All prescribed plans are thus endangered by the inherent complexity and unpredictability of cultural change. Long-term executive choices (or public policy) could be

seen as “gestures in an ongoing conversation of gestures out of which the evolution of organizations emerges,” and strategic management could be defined as “the process of actively participating in the conversations around important emerging issues” (2003, p.423). Policy measures must adapt to socio-economic changes, and incorporate sufficient monitoring and stakeholder participation instruments to observe, understand, evaluate and respond to such changes. In Stacey’s words, it is necessary that decision making “[shifts from] focusing on how to make a choice to focusing on the quality of participation in self-organising conversations from which such choices and the responses to them emerge” (2003, p.417).

To improve the “conversational” quality of policy making both policy makers and the public require a constant exchange of information regarding the emerging relationship between transportation and land-use. The public should be made aware of the overall vision behind all policy decisions (e.g. benefits of reducing travel demand through housing and transit policy), as well as the specific purpose of each policy initiative (e.g. allocation of parking fees). According to a study by Brathen and Odeck (2008, p.92) on social attitudes towards road tolls in Norway, increasing public awareness tends to diminish negative attitudes towards public policy.

On the other hand, policy makers must engage in extensive research to understand the general state of public attitude regarding commuting, housing, and employment. The *Bürgerbefragung* program in Stuttgart which consists of annual interviews investigating a wide-range of social attitudes and opinions (e.g. life objectives, happiness, consumer habits, etc.) has improved the understanding of re-urbanisation constraints upon discovering that societal demand for city-centre living is much higher than the actual supply (Junesch and Siedentop, personal communication, August 27, 2008). Similar initiatives in the GGH could reveal social tendencies that may be counted on to advance changes to the *status quo*.

Policy makers must also understand the link between social attitude and reaction towards a proposed policy (Brathen and Odeck 2008, p.91). According to Brathen and Odeck (2008, p.91), “attitudes are expressions of feelings, which are not necessarily converted to actions,” while reactions affect the actual participation of individuals towards a given policy, provided they have a choice to react (2008, p.91). The latter could be determined through *elasticity*, which “measures the responsiveness of demand to changes in factors determining the level of demand” (2008, p.80). One of the most frequently used approximations, according to the authors, is the *arc elasticity*:

$$e_{x_i}^{arc} = \frac{\ln y_2 - \ln y_1}{\ln x_{i2} - \ln x_{i1}} = \frac{\Delta \ln y}{\Delta \ln x_i}$$

where y_1 and y_2 represent initial and final demand quantities in response to a change from x_{i1} to x_{i2} (2008, p.80).

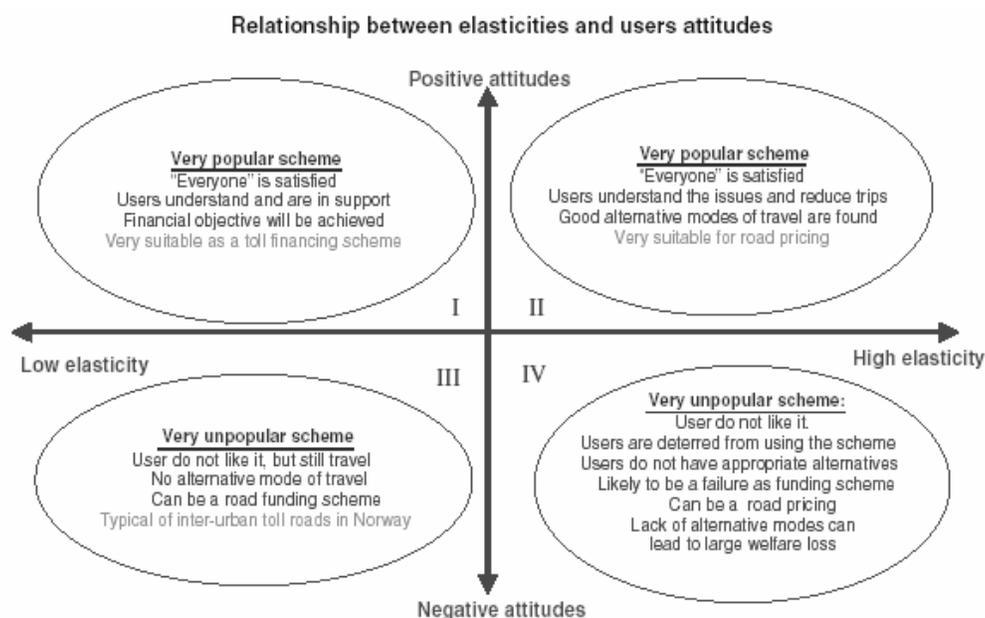


Figure 2: The link between elasticity and user attitude (source: Brathen and Odeck 2008, p.91)

Figure 2 was prepared by Brathen and Odeck (2008, p.91) to analyze travel demand elasticity and user attitude towards toll projects in Norway in particular, and to serve as a guide to policy makers in general. According to the authors, policy falling in quadrant IV should be avoided due to both negative attitude and high elasticity (i.e. reaction against policy). Policy in

quadrant III is unpopular but has low elasticity, for example due to lack of alternatives or insignificant demands from the public (e.g. low tolls). Policy in both quadrants I and II reflect positive user attitude, and could be used for different policy applications. In quadrant II, elasticity is high because users understand the benefits of the policy to alter public behaviour – in this case, abstain from toll payment and abandon driving, which makes the policy suitable to reduce congestion/GHG. On the other hand, quadrant I has low elasticity, meaning that users did not change their behaviour – in this case, pay toll and continue driving, which makes the policy a suitable financing scheme. The nature of public participation is therefore a critical determinant of the outcome and use of a given policy. (2008, p.91-92)

Considering the diverse effects that commuter mobility patterns have on different policy areas, policy objectives must be prioritized differently along the lifetime of the transportation system. This is particularly important in cases of conflicting objectives (e.g. an immediate goal to reduce congestion/GHG and encourage regional public transit usage versus the more long-term goal of discouraging frequent, regional public transit commutes by raising fares).

4.4 Provincial TDM Provisions

11th Proposal: Enforce minimum requirements for regional TDM provisions.

Section 3.2.2 of *Places to Grow Growth Plan* states that “Municipalities will develop and implement [TDM] policies in official plans or other planning documents, to reduce trip distance and time, and increase the *modal share* of alternatives to the automobile” (OPIR 2006, p.25). The province must also enforce minimum TDM provisions on a regional level to ensure that strong municipalities do not take advantage of their fiscal and political power to attract businesses and/or residential development, thereby avoiding a situation where “islands of best practice” would be surrounded by “sea of business-as-usual” (Aall *et al.* 2007, p.99).

5.0 Concluding Remarks

By examining superior transportation practices in other jurisdictions, Ontario could seek models to help advance its mandate to improve transportation infrastructure and services across the GGH. The experiences of other jurisdictions are as much guides to successful practices as they are warnings of common setbacks and indicators of areas where transportation planning should divert from traditional approaches.

Regional transportation planning must account for the long-term impacts of improved mobility on social behaviour, commuting patterns and land-use structure. A distinction must be made between desirable generators of travel demand/needs that should be encouraged (e.g. economic activity, social connectivity, tourism, etc.) and undesirable generators that should be avoided – namely the need to commute long-distance to a fixed work location. The root problem of Ontario’s transportation crisis must be defined as an issue of high travel demand generated by a variety of root causes that should be managed in keeping with different regional interests. Accordingly, congestion, pollution and GHG emissions could be appropriately understood as *consequential* problems that indicate *delay* in Ontario’s response to the regional transportation crisis, rather than root problems or primary justifications triggering this repose.

TDM in Ontario must attempt a structural shift in social and economic activity towards conservative travel behaviour. It must take on a central role in both transportation and land-use policy areas, and take part of regional economic planning, education, and adaptation strategies to the emerging socio-economic and environmental challenges of the 21st century. The degree to which this shift will be successful depends on a variety of factors including the applicability of potential policy measures and the specific nature of Ontario’s emerging situation, among other challenges and externalities. Further research and stakeholder consultation is necessary to refine the findings of this study for practical application.

Acknowledgments

I would like to thank Professor Stefan Siedentop, Dr. Gail Krantzberg, and Dr. Richard Junesch for their guidance, input and support throughout the different stages of this study, Mr. Stefan Fina for his advice and research assistance, and Mr. Peter Kindl for his help with research and technical material. I would also like to thank the Ontario/Baden-Württemberg Exchange Program for providing me with the scholarship and opportunity to conduct my research in Stuttgart, and the McMaster Graduate Student Association for contributing to travel expenses. Special thanks to Alexander Liedke for his invaluable help with virtually all aspects of my research term in Germany, which includes the development and review stages of this study.

References

- Aall C, Groven K, Lindseth G. (2007). "The Scope of Action for Local Climate Policy: The Case of Norway," *Global Environmental Politics* 7(2), pp 83-99, <http://scholarsportal.info.libaccess.lib.mcmaster.ca/cgibin/sciserv.pl?collection=journals&journal=15360091>
- Adger, W. N., Agrawala S, *et al.* (2007). "Assessment of adaptation practices, options, constraints and capacity," in *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, pp 717-743, <http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter17.pdf>
- Batty M, Besussi E, Chin N. (2003). "Traffic, Urban Growth and Suburban Sprawl," UCL Centre for Advanced Spatial Analysis, <http://eprints.ucl.ac.uk/216/1/paper70.pdf>
- Brathen S, Odeck J. (2008). "Travel demand elasticities and users attitudes: A case study of Norwegian toll projects," *Transportation Research Part A* (42), pp 77-94, www.sciencedirect.com
- Brown, L. R. (2006). *Plan B2.0, Rescuing a Planet Under Stress and a Civilization in Trouble*, First Edition, W.W. Norton & Company Ltd, New York
- Bundesamt für Bauwesen und Raumordnung, BBR. (2001). *Spatial Development and Spatial Planning in Germany*, Federal Office for Building and Regional Planning, http://www.bbr.bund.de/nm_146998/EN/Publications/Berichte/2000_2007/DL_Berichte7_templateId=raw,property=publicationFile.pdf/DL_Berichte7.pdf
- Calthorpe P, Fulton W. (2001). *The Regional City*, 1st edition. Island Press.
- Campbell, C. J. (2008). "Understanding Peak Oil," ASPO International – The Association for the Study of Peak Oil and Gas, <http://www.peakoil.net/about-peak-oil>

- Carroll B. W, Jones R.J.E. (2000) “The Road to Innovation, Convergence or Inertia: Devolution in Housing Policy in Canada,” *Canadian Public Policy – Analyse de Politiques* XXVI (3), pp 277-293
- Chin, N. (2002). “Unearthing the Roots of Urban Sprawl: A Critical Analysis of Form, Function and Methodology,” UCL Centre for Advanced Spatial Analysis, http://www.casa.ucl.ac.uk/working_papers/paper47.pdf
- Chiotti Q, Lavender B. (2008). “Ontario; *in* From Impacts to Adaptation: Canada in a Changing Climate 2007,” Natural Resources Canada, http://adaptation.nrcan.gc.ca/assess/2007/on/index_e.php
- Choocharukul K, Van T. H, Fujii S. (2008). “Psychological effects of travel behavior on preference of residential location choice,” *Transportation Research Part A* 42, pp 116-124, www.sciencedirect.com
- Clean Air Partnership. (2006). “A Scan of Climate Change Impacts on Toronto,” Clean Air Partnership, http://www.cleanairpartnership.org/pdf/climate_change_scan.pdf
- DeutscheBahn, DB. (2008). “Prices&Offers,” www.bahn.de/international/view/en/prices/prices.shtml
- European Environment Agency, EEA. (2006). “Urban Sprawl in Europe: the Ignored Challenge,” European Environment Agency, Report no. 10, Luxembourg: Office for Official Publications of the European Communities
- Federation of Canadian Municipalities, FCM; Canadian Urban Transit Association, CUTA. (2008). “Canadian Perceptions Toward the “New Realities of High Gas Prices,” Implications for Public Transit and Environment Policy,” <http://www.fcm.ca/english/View.asp?mp=1&x=955>
- Field, C.B, Mortsch L.D, Brklacich M, Forbes D.L, Kovacs P, Patz J.A, Running S.W, Scott M.J. (2007). “North America,” *in* *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, <http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter14.pdf>
- Finance Canada. (2006). “Backgrounder: Oil and Gas Prices, Taxes and Consumers,” Finance Canada, http://www.fin.gc.ca/toce/2006/gas_tax-e.html
- Garner A, Keoleian G.A. (1995). “Industrial Ecology: An Introduction,” National Pollution Prevention Centre for Higher Education, University of Michigan, <http://www.umich.edu/~nppcpub/resources/compendia/INDEpdfs/INDEintro.pdf>
- Gayda S, Haag G, Besussi E, Lautso K, Noël C, Martino A, Moilanen P, Dormois R. (2005). “SCATTER: Sprawling Cities and Transport: from Evaluation to Recommendations,” UCL Centre for Advanced Spatial Analysis, <http://www.casa.ucl.ac.uk/scatter/>

- Go Green Ontario. (2007a) "Ontario Greenhouse Gas Emissions Target: Technical Brief," Government of Ontario, <http://www.gogreenontario.ca/docs/061807-TechnicalBrief.pdf>
- Go Green Ontario. (2007b). "What You Can Do." Government of Ontario, <http://www.gogreenontario.ca/you-more.php>
- Haag G. (2007). *Sprawling Cities in Germany*, FrancoAngeli: Milano, pp 30-92.
- Holden M. (2006). "Canadian Oil Exports to the United States under NAFTA," Library of Parliament – Parliamentary Information and Research Service, <http://www.parl.gc.ca/information/library/PRBpubs/prb0633-e.htm>
- International Society for Industrial Ecology, ISIE. (2008). "A History of Industrial Ecology," International Society for Industrial Ecology, <http://www.is4ie.org/history.html>
- Klein R.J.T, Huq S, Denton F, Downing T.E, Richels R.G, Robinson J.B, Toth F.L. (2007). "Inter-Relationships between Adaptation and Mitigation," in *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, <http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter18.pdf>
- Land Use Consultants, Oxford Brookes University, CAG Consultants, *et al.* (2006). "Adapting to Climate Change Impacts - a Good Practice Guide for Sustainable Communities," London: defra.
- Lendman S. (2008). "Peak Oil – True or False," Centre for Research on Globalisation, <http://www.globalresearch.ca/index.php?context=va&aid=8260>
- Marbek Resource Consultants, MRC. (2003). "Impacts of Climate Change on Transportation in Canada," prepared for Transport Canada *National Workshop on Impacts of Climate Change on Transportation*, <http://www.tc.gc.ca/programs/environment/nwicct/docs/FullWorkshopReport/Full%20Workshop%20Report.pdf>
- Metrolinx. (2008a). "Sustainable Transportation: an Overview: Development of a Regional Transportation Plan for the Greater Toronto and Hamilton Area," Metrolinx, <http://www.metrolinx.com/en/regionalTransportationPlan.aspx>
- Metrolinx. (2008b). "Vision, Goals and Objectives: Development of a Regional Transportation Plan for the Greater Toronto and Hamilton Area," Metrolinx, <http://www.metrolinx.com/en/regionalTransportationPlan.aspx>
- Natural Resources Canada. (2008a). "Climate Change Impacts and Adaptation," Natural Resources Canada, http://adaptation.nrcan.gc.ca/index_e.php
- Natural Resources Canada. (2008b). "World Average Retail Gasoline Prices," Natural Resources Canada http://www.fuelfocus.nrcan.gc.ca/issues/2008-03-14/supplement_e.cfm

- Natural Resources Canada. (2008c). "Average Retail Prices for Regular Gasoline," Natural Resources Canada, http://www.fuelfocus.nrcan.gc.ca/prices_bycity_e.cfm
- Office of the Premier. (2007). "Mover Ontario 2020," Premier of Ontario, <http://www.premier.gov.on.ca/news/Product.asp?ProductID=1384>
- Ontario Ministry of Municipal Affairs and Housing, OMAH. (2005). "Provincial Policy Statement, 2005," Ministry of Public Infrastructure Renewal, <http://www.mah.gov.on.ca/Page1485.aspx>
- Ontario Ministry of Public Infrastructure Renewal, OPIR. (2006) "Growth Plan for Greater Golden Horseshoe, 2006," Ministry of Public Infrastructure Renewal, <http://www.placestogrow.ca/images/pdfs/FPLAN-ENG-WEB-ALL.pdf>
- Stacey, R. D. (2007). *Strategic Management and Organisational Dynamics-The Challenge of Complexity*, 5th edition, Harlow: Pearson Education Limited
- Statistics Canada. (2006). "Commuting Patterns and Places of Work of Canadians, 2006 Census," Statistics Canada, Catalogue no. 97-561-X, www.statcan.ca
- Transportation Association of Canada. (2005). "Urban Transportation Indicators Survey," Transportation Association of Canada, <http://www.tac-atc.ca/English/pdf/utip-brief-e.pdf>
- University of Washington Mesoscale Ensemble, UWME. (2008). "Industrial Ecology," University of Washington College of Engineering, http://faculty.washington.edu/cooperjs/Definitions/industrial_ecology.htm
- Zakzouk M. (2008). "Ontario Crossroad into the Future: Emerging Issues in the Automotive Sector," Final Project Paper for SEP-709, Engineering and Public Policy, McMaster University, http://msepmcmaster.ca/epp_publications.html