Report on the workshop of March 25, 2010

Quantifying and Forecasting Greenhouse Gas Emissions from Urban Passenger Transportation

TECHNICAL ANNEX: SLIDE DECKS

Prepared for
Transportation Association of Canada

By
Noxon Associates Limited

January 2011
This Technical Annex reproduces the PowerPoint slide decks used by four invited speakers at the “Quantifying and Forecasting Greenhouse Gas Emissions from Urban Passenger Transportation” workshop hosted by the Transportation Association of Canada (TAC) at the Crowne Plaza Hotel in Ottawa, Ontario on March 25, 2010. Following are the titles and presenters of the four decks.

Planning for transportation greenhouse gas emissions reductions in the Greater Toronto and Hamilton Area
Joshua Engel-Yan – Senior Advisor, Policy and Planning, Metrolinx

Public transit: A key to reducing greenhouse gases – The Montréal case
Catherine Laplante – Head Economist, ADEC Consultants

Visioning and backcasting for transport in Victoria, B.C.
David Crowley – Vice President, Halcrow Consulting
Dr. Robin Hickman – Associate Director, Halcrow and Research Fellow & Lecturer, Transport Studies Unit, University of Oxford

Moving Cooler: An analysis of transportation strategies for reducing greenhouse gas emissions
Joanne Potter – Senior Associate, Cambridge Systems
Planning for Transportation GHG Emission Reductions in the Greater Toronto and Hamilton Area

Joshua Engel-Yan
Senior Advisor, Policy and Planning
Metrolinx

Quantifying and Forecasting GHG Emissions from the Urban Passenger Transportation Sector
Ottawa, ON
March 25, 2010
The Issue

Today, the Intergovernmental Panel on Climate Change says:

- “Warming of the climate system is unequivocal.”
- “Many natural systems are being affected by regional climate changes.”
- “Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations.”
- “Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century.”

Therefore, we must stabilize concentrations of CO$_2$. How fast we act will determine the level, and the impact on the climate.
The Response

Governments are responding

- Kyoto
- EU, country-specific targets
- Federal, provincial, municipal targets – all different
- Some are not sufficient to stabilize concentrations, but all are ambitious
The Response

Ontario’s Go Green Action Plan for Climate Change

• - 6% from 1990 levels by 2014
• - 20% from 1990 levels by 2020
• - 80% from 1990 levels by 2050
Figure 8. Where Emissions Reductions Will Have Been Achieved by 2020:
Based on Current and New Policies

- Coal Phase Out, Renewables & Other Electricity Policies: 29%
- Research and Innovation: 19%
- Additional Current Policies (e.g., Greenbelt): 13%
- Federal Plan for Industrial Reductions: 7%
- Municipal Eco Challenge & Other Actions: 8%
- Homes: 5%
- Freight & Diesel: 6%
- Passenger Vehicles & Transit: 13%
Metrolinx Mission

- Deliver rapid transit improvement
- Make up for lost generation of rapid transit investment
- Lay foundation for long-term sustainable strategy of investment in rapid transit
A Bold Plan
The Big Move Vision (in numbers)

25 Years from now:

- The distance that people drive every day will drop by ONE-THIRD
- We will accommodate 50% MORE PEOPLE in the region with LESS CONGESTION than we have today
- On average, ONE-THIRD of trips to work will be taken by transit and ONE in FIVE will be taken by walking or cycling.
- 60% of all children will walk or cycle to school
- There will be SIX times more bike lanes and trails than today.
- ALL transit vehicles will be accessible.
- Customer satisfaction with the transportation system will exceed 90%.
- A single fare card will be used for ALL transit trips and ALL fares will be integrated.
- By transforming the GTHA’s transportation system, we will help meet the province’s Go Green Action Plan for Climate Change.
- Per person, our emissions from passenger transportation will be HALF what they are today.
The Magnitude of the Challenge

Trends and targets

- Mt CO2e
- Year
- Passenger
- Goods
- Total

- 1990
- 2006
- 2020
The Magnitude of the Challenge in the Greater Toronto and Hamilton Area

- 5.8 million people in 2001...
- 8.6 million in 2031
- 48% more people = 48% more cars, trips, distances travelled and emissions?

*We assume that the GTHA will pull its weight.*
What are 2020 GHG reduction targets for the GTHA?

 Assumes GTHA will aim for reductions proportional to 2006 emissions

- ~50% of provincial emissions for passenger vehicles
- Less than 50% for freight and diesel since a share of goods movement is inter-regional

Reductions from Go Green Business-as-Usual scenario:

- Passenger vehicles and transit: 5-7 Mt CO2e annually
- Freight and diesel: 0.8-2.5 Mt CO2e annually
Potential Strategies

Three types of GHG reduction strategies for transportation:

- **Travel**: Reduce vehicle-kilometres travelled (km)
- **Technology**: Increasing energy efficiency of vehicles (L/km)
- **Fuel Carbon Content**: Decrease carbon content of fuels (kg CO2e/L)
Travel: Reduce vehicle-kilometres travelled

- Land use strategies to reduce auto use (e.g., TOD)
- Initiatives to reduce commuting at peak times
- Investment in public transit
- Road and parking pricing
- Soft TDM measures (e.g., carsharing, ridematching, parking cash out)
Technology: Increase energy efficiency of vehicles

- Fuel efficiency standards
- Aerodynamic improvements, speed limiters, and anti-idling devices for trucks
- Policies to encourage purchase of low-emission vehicles (e.g., hybrids) and technologies
Fuel Carbon Content: Decrease carbon content of fuels

- Targets for alternative fuel use
- Support development of distribution network for alternative fuels
- Preferential taxation system for biofuels
- Clean electricity
GHG Emissions Forecasting

Methodology

1. Travel demand forecasts (MTO Greater Golden Horseshoe Model)
   • Peak hour vehicle kilometres travelled (VKT) for 2021 and 2031
   • Peak hour transit passenger kilometres travelled (PKT) for 2021 and 2031

2. TDM related post-processing (adjustments to vehicle occupancy, transit mode split, work from home activity)

3. Convert to vkt&pkt to annual values using expansion factors

4. GHG emissions estimation (Transport Canada Urban Transportation Emissions Calculator)
   • “Well to Wheels”
     ▪ Upstream emissions
     ▪ Operation emissions
Existing Regional Rapid Transit Network
The Region in 25 Years
The Region in 15 Years
Promoting Modal Shift and Reducing Vehicle Travel Demand

- 15-year regional rapid transit network
- Land use measures building on the Growth Plan for the Greater Golden Horseshoe
- Aggressive package of transportation demand management measures (soft and hard measures)

🌟 1.6 Mt CO2e reduction
Promoting Modal Shift and Reducing Vehicle Travel Demand

- Aggressive transit investment, more concentrated land use and aggressive TDM measures are mutually supportive
- Relevant technology is available immediately
- Many TDM measures can be implemented relatively quickly
- Land use changes happen slowly, but intensification is key to success
Improving Fuel Efficiency

- 25% improvement in fuel efficiency of light duty fleet assumed
- California Air Resource Board (CARB): 5.5 L/100km target to 2020 vs. current standard of 9.4 L/100km
- Depends on consumer buying preferences
- Requires major effort by auto manufacturers

2.7 Mt CO2e reduction
Reducing Fuel Carbon Content

- Provincial low carbon fuel standard to reduce the carbon content of fuels by 10% to 2020

1.1 Mt CO2e reduction
GHG Planning, Quantification, and Forecasting Challenges

- Expanding from modelled peak hour VKT & PKT to annual results, particularly for transit modes
- Developing consistent GHG reduction targets between municipal, regional, provincial, federal levels
- Connecting economy-wide targets to passenger transportation targets. Should the passenger transport sector pull its weight?
- Consideration of upstream emissions in the context of GHG reduction targets
Conclusions: Planning for Targeted GHG Reductions

- Aggressive GHG reduction targets are achievable, but will require system-wide changes
- Future conditions will have a large impact on the potential success of individual strategies
- No silver bullet - we need to pursue lots of different strategies at the same time
- Effect of additional enabling measures need to be considered: rising oil prices, carbon pricing/rationing
- New infrastructure, fleet turnover take time – we need to start now
Opportunities

Reducing travel and using less oil are “no-regret” moves

- A “built in” reduced need to travel has long-term effects
- More efficient and resilient companies and households
- Lower costs to individuals – greater equity
- Lower costs to governments – reduced infrastructure needs
- Reduced human and financial costs from traffic injuries and deaths
- Cleaner air, less incidence of cardio-respiratory disease
- More money in the Ontario economy
  - Ontario does not use Canadian oil, imports it from the same “problematic” places as the US, without strategic reserves
- More flexibility to switch to alternate fuels
1. Introduction

- What does the STM do for the environment?
- Why the PQTC green plan?
1.2 1,680 BIO BUS

- All busses run on biodiesel fuel.
- Reduction of 3,500 tones of GHG.

1.3 Environmentally friendly busses

- 8 hybrid busses (biodiesel and electricity).
- Reduction of fuel consumption by 30% and 36 tones of GHG/year per vehicle.

1.4 Articulated Bus

- The increased capacity will eventually allow for a reduction in GHG production: passenger capacity to bus of 1.5 or 33%.

1.5 759 metro cars

1.6 STM’s role

- What can the STM anticipate in terms of GHG reduction with:
  - An increase in services;
  - An increase of the cost of using a car.

2. Methodology

- Scope:
  - Network development program (NDP);
  - Increase in public transit services;
  - Scenarios;

- Methodology and traffic assignments:
  - EMME (auto-volumes);
  - MADITUC - MADIGAS (public transit volumes);

- Factors influencing modal choice:
  - Levels of service (LOS);
  - Economic cost of travel;
2.1 General approach

- Modeling increases in public transit services from 2006 to 2011 for the greater Montreal area;
- Estimate modal shift associated to different economic shocks:
  - Increase in public transit supply (S1)
  - Implement fare by distance to car travel (S2)
  - Assess the impact of simultaneous shocks (S3)

2.1.1 NDP/STM 2008-2011

- Metro:
  1. Extend Line 5 to Pie-IX/Jean-Talon
  2. Increase frequency for Lines 1, 2, 4 and 5
  3. Globally increase vehicle-km by 30%
- Add commuter train to the East of Montreal:
- Rail:
  1. Improve 50 lines: 50% more vehicle-km
  2. LRT on the West towards the down-town
  3. Extend train, Noise from current and the extra loud
  4. Add 4,000 new lines:
  5. Increase bus services in the West Island and to Trudeau international airport

2.1.2 Scenarios

Scenario 1:
- Network development plan 2006-2011

Scenario 2:
- Implement fare by distance to car travel

Scenario 3:
- Network development plan and fare by distance for car travel

2.2 Methodological elements

- EMME traffic assignments:
  - Morning peak period (PPAM 2003, 2011)
- Modal shift MADITUC-MADIGAS:
  - Improvement in public transit services, TC
  - Impact of fare by distance on cost of transportation
  - Travel purpose:
    - Personal income by SDR
- GHG emissions EMME / Mobile 6C

2.2 Analytical diagram
2.4 Factors of influence in modal share

2.4.1 Elasticity

<table>
<thead>
<tr>
<th>Mode</th>
<th>USA</th>
<th>Melbourne</th>
<th>Adelaide</th>
<th>Brisbane</th>
</tr>
</thead>
<tbody>
<tr>
<td>LRT</td>
<td>0.27 &amp; 0.38</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Train</td>
<td>0.17</td>
<td>0.48</td>
<td>0.09</td>
<td>0.0</td>
</tr>
<tr>
<td>Bus</td>
<td>0.04</td>
<td>0.22</td>
<td>0.21</td>
<td>0.26</td>
</tr>
<tr>
<td>BRT</td>
<td>-</td>
<td>-</td>
<td>0.28</td>
<td>0.0</td>
</tr>
<tr>
<td>All modes combined</td>
<td>0.12</td>
<td>0.22</td>
<td>0.22</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Source: Currie, 2008

2.4.3 Increase in generalized car travel prices

- Calculate the additional cost of car travel following the implementation of fare by distance.
- Based on average fuel consumption of 13.48 L/100 km.
- A 1$/Litre increase equals a 13.48 c per km charge.
- Transformation of additional fuel cost into relative travel time of auto travel.

3. Results

- Passenger volumes.
- Modal shift.
- Emissions
  - Reduction due to modal shift.
  - Increases bus services: STM.
- Economic outcome.
- Elasticity.
3.2 Impact on ridership – 2011

3.3 Environmental impact

### 3.3.1 Reduction in energy consumption

<table>
<thead>
<tr>
<th>Origin</th>
<th>LOS</th>
<th>Fare by distance</th>
<th>LOS and fare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downtown West</td>
<td>76</td>
<td>0.71</td>
<td>109</td>
</tr>
<tr>
<td>Montreal Center</td>
<td>1,159</td>
<td>15.61</td>
<td>3,845</td>
</tr>
<tr>
<td>Laval</td>
<td>1,075</td>
<td>15.61</td>
<td>3,061</td>
</tr>
<tr>
<td>Northshoring</td>
<td>864</td>
<td>12.81</td>
<td>2,676</td>
</tr>
<tr>
<td>South shore</td>
<td>1,494</td>
<td>15.81</td>
<td>4,433</td>
</tr>
<tr>
<td>Total</td>
<td>7,056</td>
<td>100.05</td>
<td>21,905</td>
</tr>
</tbody>
</table>

Source: EMME (MTQ)

3.3.3 Economic benefits of modal shift

### 3.4 Cost related to the increase in bus services

<table>
<thead>
<tr>
<th>Additional bus services</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional bus services</td>
<td>90</td>
<td>121</td>
<td>185</td>
<td>254</td>
</tr>
<tr>
<td>Vehicles Km (Mt)</td>
<td>4,818</td>
<td>5,325</td>
<td>6,063</td>
<td>6,753</td>
</tr>
<tr>
<td>Driver (Mt)</td>
<td>62.00</td>
<td>66.87</td>
<td>73.98</td>
<td>82.92</td>
</tr>
<tr>
<td>Operations (Mt)</td>
<td>486.00</td>
<td>547.46</td>
<td>626.77</td>
<td>715.47</td>
</tr>
<tr>
<td>Fuel (Mt)</td>
<td>1,395</td>
<td>1,461</td>
<td>1,595</td>
<td>1,705</td>
</tr>
<tr>
<td>Total cost</td>
<td>475</td>
<td>541</td>
<td>616</td>
<td>696</td>
</tr>
<tr>
<td>Pollution cost</td>
<td>19.80</td>
<td>21.27</td>
<td>23.61</td>
<td>26.20</td>
</tr>
<tr>
<td>Total ($)</td>
<td>215.3</td>
<td>240.9</td>
<td>271.7</td>
<td>304.7</td>
</tr>
</tbody>
</table>

3.5 Economic outcome

### 3.5.1 Generalized price of transportation related to modal shift 2011 (M$2006)

<table>
<thead>
<tr>
<th>Gains</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time and fuel taxes</td>
<td>4.9</td>
<td>26.2</td>
<td>37.4</td>
</tr>
<tr>
<td>VOC</td>
<td>16.4</td>
<td>40.7</td>
<td>45.5</td>
</tr>
<tr>
<td>Fuel</td>
<td>6.5</td>
<td>16.2</td>
<td>18.1</td>
</tr>
<tr>
<td>Pollution emissions</td>
<td>2.0</td>
<td>5.1</td>
<td>5.7</td>
</tr>
<tr>
<td>Accidents</td>
<td>10.3</td>
<td>25.4</td>
<td>28.5</td>
</tr>
<tr>
<td>Total</td>
<td>40.2</td>
<td>113.6</td>
<td>135.1</td>
</tr>
</tbody>
</table>

### 3.5.2 Generalized transportation cost reduction 2011 (M$2006)

<table>
<thead>
<tr>
<th>Socio-economic gains</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct benefits – fuel reduction</td>
<td>1,395</td>
<td>1,604</td>
<td>1,890</td>
</tr>
<tr>
<td>Additional cost for STM</td>
<td>68.8</td>
<td>68.8</td>
<td>68.8</td>
</tr>
<tr>
<td>Total</td>
<td>79.6</td>
<td>139.4</td>
<td>157.8</td>
</tr>
</tbody>
</table>
3.6 Elasticity

- Elasticity of demand/prix du transport as a result of an increase in services.

3.6.1 Demand elasticity TC / LOS by trip purpose and revenue class

3.6.2 Elasticity of travel demand TC / Generalized price of transportation

Conclusion

- Impacts:
  - Increased cross elasticity for lower-income clientele.
  - Students and other travelers are more sensitive to LOS.
  - Derived elasticity varies between 0.17 and 0.90.
  - From an economic point of view, a combined solution allows for greater gains.

Conclusion

- Model limitations:
  - Congestion and modal shift only measured during morning peak period.
  - Does not take into account subtle improvements such as comfort and prolonged increase in service during morning peak period.
  - New behaviors and alternative transportation modes: ride-sharing, biking, Bixi, etc.

Post conclusion: OD-2008

- [Graph showing changes in transportation modes]
The team!

- **ADEC:**
  - Catherine Laplante
  - Gilles Joubert
  - Alain Doyon

- **MTQ:**
  - Louis Gourvil
  - Martin... (rest of the name not visible)
  - André Robin

- **STM:**
  - Jocelyn Grondines
  - Jean-Pr... (rest of the name not visible)
  - Michel Bourbonnais
  - Robert... (rest of the name not visible)
Visioning and Backcasting for Transport (VIBAT-Victoria)

Greenhouse Gas Emission Quantification and Forecasting Workshop

Dr Robin Hickman
Dave Crowley
Outline

- Context
- VIBAT-Victoria (CRD)
- Transport and CO2 calculators
- Wider multi-criteria assessment
- Conclusions
Global Emissions

North America
- USA: 5,957 MtCO₂ (20.14 Tpp)
- Mexico: 398.25 MtCO₂ (13.1 Tpp)

Central & South America
- Brazil: 369.57 MtCO₂ (8.3 Tpp)

Europe
- Russia: 1,696 MtCO₂ (11.88 Tpp)
- China: 5,323 MtCO₂ (4.07 Tpp)

Middle East
- Iran: 151.29 MtCO₂

Africa
- South Africa: 105.38 MtCO₂ (2.17 Tpp)

Asia & Oceania
- Australia: 400.64 MtCO₂ (20.24 Tpp)

Global Total
Scenario Testing and Backcasting

- Baseline and projection
- Alternative image(s) of the future
- Policy measures and packages available
- Appraisal, costing, optimum pathways
VIBAT-Victoria Methodology

Systematic packaging of interventions/sifting, and scenario testing/optioneering:

- Consider likely policy interventions (OCC remit and beyond)
- Group interventions into packages
- Model impacts against CO2
- [Potential for wider multi-criteria (WebTAG): local environment, economy, accessibility and safety]
- Cluster policy packages, at various levels of application, into scenarios
- Systematically assess strategic policy choices and priorities
- Discuss and prioritise most likely strategies
CRD Baseline GHG Emissions and Projection
Policy Packages Considered

- PP1: Low Emission Vehicles and Alternative Fuels;
- PP2: Pricing Mechanisms;
- PP3: Transit;
- PP4: Walking and Cycling;
- PP5: Urban Planning;
- PP6: Mobility Management/Traffic Demand Management (TDM);
- PP7: Ecological Driving and Slower Speeds/Idling.
## Modelling Assumptions

### PP3: Transit

<table>
<thead>
<tr>
<th>GHG Emissions Reduction (KtCO2e)</th>
<th>GHG Emissions Reduction (%) of 2020 BAU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current</strong></td>
<td>Large investment plans via the C.C. Transit Plan, but much of the focus on Vancouver rather than Victoria.</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>'Low level' of further network investment</td>
</tr>
<tr>
<td><strong>Medium</strong></td>
<td>'Medium level' of further network investment and marketing initiatives</td>
</tr>
<tr>
<td><strong>High</strong></td>
<td>'High level' of further network investment and incentives for use</td>
</tr>
</tbody>
</table>

*Modelling based largely on mode share changes. Different levels of policy package application illustrative, and not exhaustive.*

### PP5: Urban Planning

<table>
<thead>
<tr>
<th>GHG Emissions Reduction (KtCO2e)</th>
<th>GHG Emissions Reduction (%) of 2020 BAU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current</strong></td>
<td>Some efforts to improve densities and develop around the public transit network</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>'Low level' of further intensity of application – thickening of densities along key public transport corridors</td>
</tr>
<tr>
<td><strong>Medium</strong></td>
<td>'Medium level' of further intensity of application – polycentric concentration efforts in suburbs</td>
</tr>
<tr>
<td><strong>High</strong></td>
<td>'High level' of further intensity – urban structure index used to integrate urban and transport planning effectively in centres and suburbs (density, location of work, school, etc.)</td>
</tr>
</tbody>
</table>

*Modelling based largely on reduction in car distance. Different levels of policy package application illustrative, and not exhaustive.*
## Exploratory Results

<table>
<thead>
<tr>
<th>Policy Package Description</th>
<th>Implementation Level</th>
<th>GHG Emissions Reduction (KtCO2e)</th>
<th>GHG Emissions Reduction (%) of 2020 BAU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PP1</strong> Low Emission Vehicles and Alternative Fuels</td>
<td>Low</td>
<td>28</td>
<td>3.0%</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>94</td>
<td>10.1%</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>160</td>
<td>17.1%</td>
</tr>
<tr>
<td><strong>PP2</strong> Pricing Mechanisms</td>
<td>Low</td>
<td>17</td>
<td>1.9%</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>38</td>
<td>4.1%</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>76</td>
<td>8.1%</td>
</tr>
<tr>
<td><strong>PP3</strong> Transit</td>
<td>Low</td>
<td>11</td>
<td>1.2%</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>23</td>
<td>2.5%</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>46</td>
<td>4.9%</td>
</tr>
<tr>
<td><strong>PP4</strong> Walking and Cycling</td>
<td>Low</td>
<td>6</td>
<td>0.6%</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>17</td>
<td>1.8%</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>34</td>
<td>3.6%</td>
</tr>
<tr>
<td><strong>PP5</strong> Urban Planning</td>
<td>Low</td>
<td>8</td>
<td>0.8%</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>19</td>
<td>2.1%</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>38</td>
<td>4.1%</td>
</tr>
<tr>
<td><strong>PP6</strong> Mobility Management</td>
<td>Low</td>
<td>8</td>
<td>0.8%</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>23</td>
<td>2.5%</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>38</td>
<td>4.1%</td>
</tr>
<tr>
<td><strong>PP7</strong> Ecological Driving and Slower Speeds</td>
<td>Low</td>
<td>19</td>
<td>2.0%</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>47</td>
<td>5.0%</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>93</td>
<td>10.0%</td>
</tr>
</tbody>
</table>
Modelling Approach

- A road-based transport and carbon simulation spreadsheet model
- Use of Canadian version of US EPA MOBIL emission model (v. 6.2C) *estimates emission factors from motor vehicles and VKT*

- Input road traffic and transit data from CRD Emme/2 model (Halcrow)
- Use of CRD 2004 GHG inventory (SENES, 2006)
- 2006-2020, pm peak
Exploratory Results

28% CO2 reduction, assuming ‘medium level’ application across PPs
VIBAT series of studies

What does the future hold for travel and city life? Our travel behaviour and lifestyles are likely to change beyond all recognition up to 2030 or 2050.

Achieving a carbon efficient transport system, whilst still improving wider sustainability and quality of life objectives, is likely to be no easy task. The VIBAT series of projects seek to explore these difficult issues. They explore a range of very different contexts - including national and city-based case studies - and demonstrate the potential policy pathways towards demanding strategic carbon reduction targets.

A number of empirical methodologies are used, including forecasting, scenario testing and backcasting. All of the projects demonstrate the considerable efforts needed to achieve carbon efficiency in transport, including markedly changed investment patterns and the development of new incentives and mechanisms for delivery. The most difficult emerging area is in engaging decision makers and the public in defining and ‘owning’ new pathways towards substantial lifestyle change.
The Projection and Mitigation Pathway

Backcasting (the programme from 2025)
The CO2/Multi-Criteria Analysis Methodology
TC-SIM London

Local Version 03  C:\tcsim\tcsim_version_02\tcsim_65\vibat.html
Web Version 03  www.vibat.org/vibat_ldn/tcsim3/tcsim.html

tcsim; topgear
‘Optimising’ the strategy
INTRA-SIM Oxfordshire

Local Version 03
C:\Documents and Settings\hickmanro\My Documents\oxfordshire intra-sim\bin\intrasim.html

Web Version 03
http://www.vibat.org/intrasim_ox/intrasim.html
intrasim
halcrow
Conclusions

- VIBAT-Victoria - an initial, exploratory study for TC
- Builds on methodology developed in other international studies from Halcrow/University of Oxford
- More detailed analysis useful – with series of case studies
- Perhaps with simulation capability to enhance discussion and ‘ownership’ of future decision-making
- Perhaps MCA-based, including CO2 impacts
A typical study methodology
(VIBAT Canada / Vancouver / Toronto etc)

1. Baseline: quantification of existing transport, technology and carbon policy approaches
2. Evidence base: derivation of local or organisation carbon reduction potential (technology/behavioural), possibly including SP analysis
3. Simulation framework design & development; model design, algorithm development
4. Alternative image(s) of the future
5. Development of simulation model
6. Policy packaging and scenario development
7. Appraisal of packages
8. Dissemination.
Visioning and Backcasting for Transport (VIBAT-Victoria)

Greenhouse Gas Emission Quantification and Forecasting Workshop

Dr Robin Hickman
Dave Crowley
Halcrow provides:

- Expertise in transport planning, policy and strategy, futures research, accessibility planning, transport modelling and economics and traffic engineering;
- Urban planning, environment and sustainability, including regional and sub-regional development, urban strategy, urban design and masterplanning, environmental assessment and ecology, consultation and institutional strengthening and capacity building;
- Expertise in station and interchange design, PTOD, urban metros, public transport operations, road pricing and tolled highways;
- Support for the group’s engineering teams, taking projects through to implementation;
- Project management expertise, managing complex multi-disciplinary commissions, and providing assurance of timely and appropriate project outputs.
Halcrow Consulting Inc.

- Established multi-disciplinary firm with 2 Canadian (Toronto and Vancouver) and 61 international offices
- International research leaders in the field of sustainable transport planning, incl. carbon emissions, able to draw on global expertise
- Diverse team of transport planners, urban planners, and policy experts, with significant international experience

- VIBAT Victoria scoping study
- VIBAT UK/London/Delhi/India/Auckland – impact of carbon reduction policies (using backcasting methodologies)
- INTRA-SIM Oxfordshire, Swindon, Corridor 10 (UK LA and DfT studies)
- The Impact of transit improvements on GHG emissions (Canada)
- Carbon emission impacts of major transport projects (ADB Asia)
Quantifying and Forecasting GHG Emissions from Urban Passenger Transportation
Transportation Association of Canada
March 25, 2010

presented by
Joanne R. Potter
Cambridge Systematics, Inc.
Transportation’s Contribution to U.S. GHGs

Analytic Team – Cambridge Systematics, Inc.

Multiple partners on Steering Committee

- U.S. Environmental Protection Agency
- U.S. Federal Highway Administration
- U.S. Federal Transit Administration
- American Public Transportation Association
- Environmental Defense
- Urban Land Institute

- ITS America
- Shell Oil
- Natural Resources Defense Council
- Foundation Sponsors
  - Kresge Foundation
  - Surdna Foundation
  - Rockefeller Brothers Fund
  - Rockefeller Foundation
Objectives

- Fill a gap left by McKinsey and others who analyzed future technologies and fuels but not travel behavior

- Goal of consistent analysis across strategy types

- Multiple parameters
  - Effectiveness in reducing GHGs
  - Cost
  - Externalities/co-benefits
  - Equity
Focus of Analysis

- Estimates GHG effectiveness and direct implementation costs

- Not a full cost-benefit analysis – therefore not a complete basis for decisions
  - GHG benefits only
  - Direct agency monetary implementation costs
  - Vehicle operating costs (savings) – fuel, ownership, maintenance, insurance

- Allows comparison to McKinsey Report findings on fuels and technology

- Political feasibility not assessed
Wide Range of Strategies Examined

- Pricing, tolls, Pay As You Drive (PAYD) insurance, VMT fees, carbon/fuel taxes
- Land use and smart growth
- Nonmotorized transportation
- Public transportation improvements
- Regional ride-sharing, commute measures
- Regulatory measures
- Operational/ITS strategies
- Capacity/bottleneck relief
- Freight sector strategies
Levels of Implementation Vary
Example – Pricing Strategies

Federal
- VMT Fees
- Motor Fuel Tax or Carbon Price

State
- Intercity Tolls
- PAYD Insurance

Regional
- Parking Pricing
- Congestion Pricing

Local
- Parking Pricing
- Cordon Pricing
Analytic Approach

1. Establish baseline

2. Select strategies and define parameters

3. Estimate the GHG reduction of each individual strategy

4. “Bundle” the strategies and examine the combined impacts
Analytic Approach

1. Establish baseline
   • Consider sensitivity analyses

2. Select strategies and define parameters

3. Estimate the GHG reduction of each individual strategy

4. “Bundle” the strategies and examine the combined impacts
Assumptions for Baseline

Travel continues to grow
- Vehicle miles traveled (VMT) growth of 1.4% per year
- Transit ridership growth 2.4%/year

Fuel prices increase
- 1.2% per year, beginning at $3.70/gallon in 2009*

Fuel economy improves steadily
- Light-duty vehicles at 1.91% annually
- Heavy-duty vehicles at 0.61% annually

*AEO high fuel price scenario.
Moving Cooler Baseline to 2050

Note: This figure displays National On-Road GHG emissions as estimated in the Moving Cooler baseline, compared with GHG emission estimates based on President Obama’s May 19, 2009, national fuel efficiency standard proposal of 35.5 mpg in 2016. Both emission forecasts assume an annual VMT growth rate of 1.4 percent. The American Clean Energy and Security Act (H.R. 2454) identifies GHG reduction targets in 2012, 2020, 2030, and 2050. The 2020 and 2050 targets applied to the on-road mobile transportation sector are shown here.
Moving Cooler Sensitivity Tests to 2050

- **High Fuel Price/Low VMT**: Fuel prices increase dramatically, resulting in lower VMT and improved vehicle technology.
- **Low Fuel Price/High VMT**: Lower fuel prices drive higher VMT growth and less investment in improved technology.
- **High-technology/High VMT**: Technology progresses rapidly, leading to decreased driving cost and higher VMT.
Analytic Approach

1. Establish baseline

2. Select strategies and define parameters
   - 3 levels of intensity of implementation

3. Estimate the GHG reduction of each individual strategy

4. “Bundle” the strategies and examine the combined impacts
Deployment Levels

- Expanded Best Practices
- Aggressive
- Maximum

- Geography
- Timeframe
- Intensity
### 3 Deployment Levels per Strategy

**Example – Pricing Strategies Sample Parameters**

<table>
<thead>
<tr>
<th></th>
<th>Expanded Current Practice</th>
<th>More Aggressive</th>
<th>Maximum Effort</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geographic Scope</strong></td>
<td>Large Urban Areas</td>
<td>Large and Medium Urban Areas</td>
<td>Large, Medium, and Small Urban Areas</td>
</tr>
<tr>
<td><strong>Intensity</strong></td>
<td>Peak Hour at $0.45/Mile</td>
<td>Peak Hour at $0.69/Mile</td>
<td>Peak Hour at $0.69/Mile</td>
</tr>
<tr>
<td><strong>Timeframe</strong></td>
<td>Complete in 15 years</td>
<td>Complete in 10 years</td>
<td>Complete in 10 years</td>
</tr>
</tbody>
</table>
Analytic Approach

1. Establish baseline

2. Select strategies and define parameters

3. Estimate the GHG reduction of each individual strategy
   - Cumulative reduction through 2030 and through 2050
   - Annual reductions in critical target years

4. “Bundle” the strategies and examine the combined impacts
Findings
Individual Strategies

- Individual strategies achieve varying levels of GHG reductions
  - <0.5% to over 4.0% cumulatively to 2050
## Example Findings

### Individual Strategies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Cumulative Percent GHG Reduction from Baseline (2050)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMT Fees</td>
<td>0.4-4.9%</td>
</tr>
<tr>
<td>Speed Limit Reductions</td>
<td>1.7-3.5%</td>
</tr>
<tr>
<td>PAYD Insurance</td>
<td>1.1-3.2%</td>
</tr>
<tr>
<td>Congestion Pricing</td>
<td>0.8-1.8%</td>
</tr>
<tr>
<td>Eco-Driving</td>
<td>1.0-2.6%</td>
</tr>
<tr>
<td>Land Use/Smart Growth</td>
<td>0.2-2.0%</td>
</tr>
<tr>
<td>Urban Public Transit LOS/Expansion</td>
<td>0.3-1.1%</td>
</tr>
<tr>
<td>Employer-Based Commute/Parking Pricing</td>
<td>0.4-1.7%</td>
</tr>
<tr>
<td>Operational and ITS Improvements</td>
<td>0.3-0.7%</td>
</tr>
</tbody>
</table>
Analytic Approach

1. Establish baseline
2. Select strategies and define parameters
3. Estimate the GHG reduction of each individual strategy
4. “Bundle” the strategies and examine combined impacts
   - Effectiveness
   - Interactions, synergies, antagonistic effects
   - Cost
   - Other societal impacts/co-benefits/externalities
   - Equity effects
Strategy Bundles
Illustrative Analysis

- Low Cost
- Near-Term/Early Results
- Long-Term/Maximum Results
- Land Use/Nonmotorized/Public Transportation
- Facility Pricing
- System and Driver Efficiency

Moving Cooler
Example: System and Driver Efficiency Bundle

- Combination of strategies to enhance the efficiency of transportation networks
  - Congestion pricing, transit LOS, HOV lanes, car sharing, speed limits, system operations and management, multimodal freight strategies
  - Improve travel speeds, reduce congestion and idling, create viable alternatives to driving alone

* Projections for on-road surface transportation GHG emissions
Findings
Strategy Bundles

- Combinations of transportation strategies can achieve GHG reductions from transportation
  - 4% to 18% GHG reduction from baseline* in 2050 (aggressive deployment, without economy-wide pricing)
  - Up to 24% GHG reduction from baseline* in 2050 (maximum deployment, without economy-wide pricing)

- These strategies complement the important reductions anticipated from fuel and technology advancements

* Projections for on-road surface transportation GHG emissions.
Range of Annual GHG Reductions of Six Strategy Bundles
Aggressive and Maximum Deployment

Note: This figure displays the GHG emission range across the six bundles for the aggressive and maximum deployment scenarios. The percent reductions are on an annual basis from the Study Baseline. The 1990 and 2005 baseline are included for reference.
Economy-Wide Pricing

- Mechanisms – Carbon pricing, VMT fee, and/or PAYD insurance

- Strong economy-wide pricing measures added to bundles achieve additional GHG reductions
  - Aggressive deployment – additional fee (in current dollars) starting at the equivalent of $0.60 per gallon in 2015 and increasing to $1.25 per gallon in 2050 could result in an additional 17% reduction in GHG emissions in 2050

- Two factors would drive this increased reduction
  - Reduction in vehicle-miles traveled (VMT)
  - More rapid technology advances
Economy-Wide Pricing

Total Surface Transportation Sector GHG Emissions (mmt)

- **1990 & 2005 GHG Emissions** – Combination of DOE AEO data and EPA GHG Inventory data
- **Study Baseline** – Annual 1.4% VMT growth combined with 1.9% growth in fuel economy
- **Aggressive** – GHG emissions from bundle deployed at aggressive level without economy-wide pricing measures

- **Economy-Wide Pricing**
  - 18%
  - 35%
  - 12%
  - 30%
  - 7%
  - 19%

Legend:
- **Study Baseline**
- **Aggressive**
- **Economy-Wide Pricing**
Direct Vehicle Costs and Costs of Implementing Strategy Bundles

2008 Dollars (in Billions)

Vehicle Cost Savings

Implementation Costs

Note: This figure displays estimated annual implementation costs (capital, maintenance, operations, and administrative) and annual vehicle cost savings [reduction in the costs of owning and operating a vehicle from reduced vehicle-miles traveled (VMT) and delay. Vehicle cost savings DO NOT include other costs and benefits that could be experienced as a consequence of implementing each bundle, such as changes in travel time, safety, user fees, environmental quality, and public health.
Near-Term and Long-Range Strategies

- Some strategies are effective in achieving near-term reductions, reducing the cumulative GHG challenge in later years.

- Investments in land use and improved travel options involved longer timeframes but would have enduring benefits.
Scale of Implementation

- Both national level and state/regional/local strategies are important
- GHG reductions should be viewed relative to the scale of potential implementation
  - While effect on national emissions may be modest, some strategies may be more beneficial at regional scales
Other Societal Goals

- Many strategies contribute to other social, economic and environmental goals while reducing GHGs

- Some strategies have significant equity implications that should be examined and addressed
Outcomes from Moving Cooler
Three Critical Foundations

**Framework**
Inventory and typology of transportation activity strategies

**Specification**
Baseline assumptions and sensitivity scenarios
Strategy specification – parameters, units of measurements, ranges based on regional and national experience

**Evaluation of Individual and Bundled Strategies**
Appropriate short- and long-term analytic methods for individual strategies
Evaluate bundles and interactions between strategies
Next Steps - Research and Analysis

- Further analyses of individual strategies/bundles
  - Sensitivity to various parameters
  - Vehicle conditions / traffic flow modeling
  - Synergies and interactive effects
  - Interactions with pricing
  - Quantifying co-benefits
  - Induced demand

- Interactions with fuel and vehicle technology pathways

- Sub-national analyses

- Pilot regional assessments

- Cross-sector comparisons
Next Steps – Policy and Practice

- Regionally-tailored strategy packages
- Climate action planning and implementation
- Performance tracking and adaptive management of action plans
Maryland DOT Climate Action Implementation Plan
Preliminary GHG Emissions Modeling Results

mmt CO₂e

25% Reduction Goal

25.15

2006

2020

Target Shortfall
3.86 – 2.32 mmt

37.77 Base 2020 forecast

-3.76 National CAFE Standard

-1.00 Maryland Clean Car

-0.28 Renewable Fuels Standard

-1.38 Funded Plans and Programs

-0.73 Funded TERMS

-1.62 TLU Policy Options
(range of strategies)

-3.16
For More Information…

http://movingcooler.info

http://www.uli.org/Books

jpotter@camsys.com
Levels of Implementation Vary
Example – Operational/ITS Strategies

Federal
- Investments/Incentives
- Performance Requirements

State
- Eco-Driving Training
- Variable Message Signage
- Traveler Information (511)
- Vehicle Infrastructure Integration (VII)

Regional
- Eco-Driving Training
- Variable Message Signage
- Road Weather Management
- Vehicle Infrastructure Integration (VII)

Local
- Ramp Metering
- Incident Management
- Active Traffic Management
- Integrated Corridor Management
- Road Weather Management
- Arterial Management
Example: System and Driver Efficiency Bundle

- Combination of strategies to enhance the efficiency of transportation networks
  - Congestion pricing, transit LOS, HOV lanes, car sharing, speed limits, system operations and management, multimodal freight strategies
  - Improve travel speeds, reduce congestion and idling, create viable alternatives to driving alone

* Projections for on-road surface transportation GHG emissions
## Strategy Parameters
### 7 Area Types

<table>
<thead>
<tr>
<th>Density/Level of Transit</th>
<th>Large Urban</th>
<th>Medium Urban</th>
<th>Small Urban</th>
<th>Nonurban</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hi</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

*Nonurban*
Land Use
Key Assumptions

- 43-90% of new urban development occurs in “compact neighborhoods”
  - >4,000 persons per square mile
  - Walkable, mixed-use neighborhood centers

- VMT/capita 35% lower in compact versus “sprawl” neighborhoods; 60% lower for highest-density versus lowest-density census tracts

- Turnover rates – residential 6%/decade, commercial 20%/decade
VMT Per Capita by Population Density

Source: S. Polzin, et al. VMT forecasting model, Center for Urban Transportation Research at University of South Florida, based on 2001 National Household Travel Survey & 2000 Census.
Tract Density Ranges

- Concord, MA: 500-2,000 ppsm
- Watertown, MA: 4,000-10,000 ppsm
- Lexington, MA: 2,000-4,000 ppsm
- Somerville, MA: >10,000 ppsm

Image source: TeleAtlas and Google Earth.