

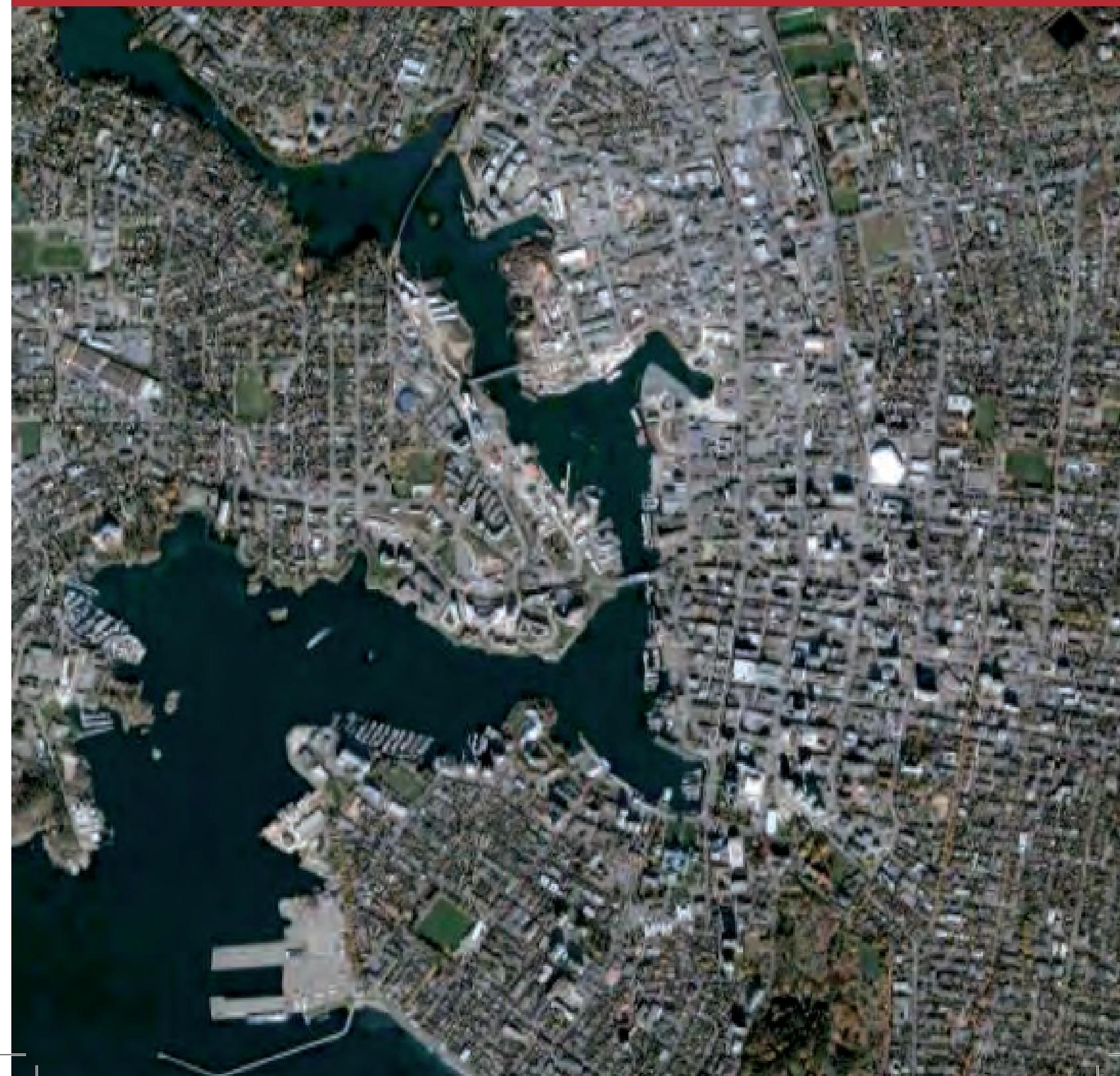
# Visioning and Backcasting for Transport in Victoria (VIBATVICTORIA)

A Pilot Study for the Capital Regional District

Halcrow Consulting Inc.  
for Transport Canada

**FINAL REPORT**  
**September 2009**

**Halcrow**



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## Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
	1.1 <i>Context</i>	1
	1.2 <i>Climate Change and Transport</i>	2
	1.3 <i>The Backcasting Approach</i>	5
	1.4 <i>Study Methodology</i>	6
	1.5 <i>Structure of the Report</i>	7
<b>2</b>	<b>The Victoria CRD Baseline</b>	<b>8</b>
	2.1 <i>CRD Context</i>	8
	2.2 <i>Baseline CO2 Emissions</i>	11
<b>3</b>	<b>Inventory of Existing and Potential Measures</b>	<b>16</b>
	3.1 <i>Introduction</i>	16
	3.2 <i>PP1: Low Emission Vehicles and Alternative Fuels</i>	18
	3.3 <i>PP2: Pricing Mechanisms</i>	21
	3.4 <i>PP3: Transit</i>	22
	3.5 <i>PP4: Walking and Cycling</i>	24
	3.6 <i>PP5: Urban Planning</i>	27
	3.7 <i>PP6: Mobility Management/Traffic Demand Management</i>	28
	3.8 <i>PP7: Ecological Driving and Slower Speeds</i>	29
	3.9 <i>Wider Potential Interventions</i>	30
<b>4</b>	<b>Exploratory Modelling Outputs</b>	<b>31</b>
	4.1 <i>Exploratory Modelling Approach</i>	31
	4.2 <i>Exploratory Modelling Results</i>	32
<b>5</b>	<b>Conclusions and Potential Next Steps</b>	<b>35</b>
	5.1 <i>Initial Findings</i>	35
	5.2 <i>Specification for Potential Further Work</i>	35
	5.3 <i>Examining the Future Strategic Choices</i>	38
	<b>References</b>	<b>39</b>

## Acknowledgements

The VIBAT Victoria study team is grateful to a range of organisations and individuals who contributed to the study.

Many thanks to Transport Canada for funding the pilot study, and the following individuals and organisations for providing data and comments:

Tracy Corbett, Malcolm MacPhail, Chris Robins and Teresa Waddell (Victoria Capital Regional District); Andrea Mercer (Ministry of Environment, Climate Change Branch); Stephen Brydon and Graeme Masterton (BC Transit); Sarah Webb (Office of Campus Planning and Sustainability, University of Victoria); and Todd Litman (Victoria Transport Policy Institute).

Also Professor David Banister (University of Oxford, Transport Studies Unit) for additional comments.

The views expressed in this report are, of course, from the authors and do not necessarily reflect those of Transport Canada, or other governmental organisations in the CRD or B.C.

## List of Figures

Figure 1: The Backcasting Approach	6
Figure 2: Victoria Capital Region District	10
Figure 3: B.C. Sectoral Emissions	12
Figure 4: Canada Baseline and Projective Emissions (Surface Transport)	13
Figure 5: B.C. Baseline and Projective Emissions (Surface Transport)	14
Figure 6: CRD Baseline and Projective Emissions (Surface Transport)	15
Figure 7: Policy Packages to 'Bridge the Gap'	17
Figure 8: Exploratory Results by Level of Application of Package	34
Figure 9: Simulation Modelling (Package Selection)	37
Figure 10: Simulation Modelling (Target Achievement)	37

## List of Tables

Table 1: Global CO <sub>2</sub> and Carbon Emissions	3
Table 2: GHG Emissions in the Transport Sector	11
Table 3: Example Available Vehicles in the Canadian Fleet	19
Table 4: Fuel Price, Consumption and Vehicle Travel	22
Table 5: Exploratory Results by Level of Application of Package	33

# 1 Introduction

## 1.1 Context

Halcrow Consulting Inc. has been commissioned by Transport Canada to undertake a pilot study of the Visioning and Backcasting for Transport (VIBAT) methodology in Canada. The project was supported by Transport Canada to help meet an objective in its Sustainable Development Strategy 2007-09 to implement projects that enhance the decision-making capacity for governments and the transportation sector. The project does so by applying an innovative analytical approach that considers the potential contribution of the transport sector in reducing carbon dioxide (CO<sub>2</sub>) emissions and in illustrating the potential for a simulation capability that can be useful in explaining and discussing strategic policy choices with decision makers and potentially the public. The Capital Regional District (CRD) is used as a case study.

The CRD is a local government administrative district including the southern tip of Vancouver Island, the southern Gulf Islands and a number of smaller islands. On Vancouver Island, the CRD includes the 13 municipalities of Greater Victoria and the Juan de Fuca Electoral Area. The major urban centre is the City of Victoria. The CRD is one of several regional districts in British Columbia (B.C.) and had a population of 345,000 (Canada Census, 2006). It has one of the lowest per capita CO<sub>2</sub> emissions in Canada. The CRD was selected as a case study largely due to the availability of data for modelling purposes.

The aim of this VIBAT Victoria pilot study is to undertake a scoping exercise as to the applicability of scenario testing and backcasting within the Canadian context. The analysis includes a brief review of policy interventions available

within the CRD to reduce transport CO<sub>2</sub> emissions, together with an exploratory modelling run representing a possible future scenario. The aim is not to provide a fully comprehensive review of future options, nor to model impacts in detail, but simply to test the methodology for more thorough and wider applicability in the Canadian context<sup>1</sup>. The CRD is comparable in size to a number of other cities in the Canadian urban hierarchy, including Halifax, Winnipeg and Quebec City.

The efficient movement of people and goods is critical to the economic well being of urban areas and of countries in general. Canada's urban transportation systems provide considerable benefits to individuals and communities. However, Canada's current infrastructure and travel trends are not supportive of greenhouse gas (GHG) emission reduction targets that are being set at the federal, provincial and municipal levels. There is widespread recognition that 'business as usual' implies increased GHG emissions and related environmental problems, as well as increased congestion, longer travel times and earlier and higher infrastructure costs. Given expected increases in congestion, the accessibility to key facilities and services may decline under the BAU scenario. The combination of these challenges has led to the realisation that Canada's urban land use and transportation systems require significant changes if sustainability objectives (environmental, social and economic) are to be achieved.

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<sup>1</sup> Section 4 gives more details on modelling approach and modifications that would be required in a more detailed study.

Investment patterns need to be radically altered to support sustainability in Canada’s urban land uses and transport systems. There are many initiatives being developed to help encourage sustainable transport in cities in Canada. This study is intended to present a scenario-based modelling approach that will help decision-makers and transportation practitioners further understand the scale of change required to meet strategic GHG reduction targets, the policy and program instruments that are available, how these might be packaged and implemented, and what the corresponding economic and social impacts might be.

The data analysis in this report is based on CO<sub>2</sub>e, though the contextual material also refers to GHGs and CO<sub>2</sub> emissions.

## 1.2 Climate Change and Transport

Understanding how the transport sector can contribute to the reduction of CO<sub>2</sub> emissions is now a critical issue for the Federal and Provincial Governments. The difficulty is that the transport sector continues to experience increases in transport emissions under ‘business as usual’ (BAU) projections and is not contributing to any great degree to the achievement of adopted headline targets.

### Climate Change Metrics

Greenhouse gases (GHG) absorb and emit radiation in the atmosphere. The most common GHGs in the Earth's atmosphere include carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphurhexafluoride (SF<sub>6</sub>) (UNFCCC definition)..

CO<sub>2</sub> is the most important gas in terms of its aggregate contribution to climate change. International targets such as Kyoto are defined in terms of GHGs.

Carbon dioxide equivalent (CO<sub>2</sub>e) is also used as a standard of measurement against which the impacts of releasing (or avoiding the release of) different greenhouse gases can be evaluated. This is based on the Global Warming Potential (GWP) - the impact that a particular gas has on 'radiative forcing' (the additional heat/energy which is retained in the Earth's ecosystem through the addition of this gas to the atmosphere).

The GWP varies by type of gas and the time period under consideration. For example, for a 100 year time interval, methane and nitrous oxide are 21 and 310 times more detrimental as GHGs than CO<sub>2</sub>. CO<sub>2</sub>e is ostensibly a weighted measure of the collective GWP of a range of greenhouse gases expressed relative to CO<sub>2</sub>.

The Intergovernmental Panel on Climate Change (IPCC) is recognized as the leading authority on the science of climate change. Established by the United Nations, the role of the IPCC is to assess the scientific evidence relevant to climate change, the potential impacts and options for adaptation and mitigation, and to make recommendations to policy makers. Global GHG emissions have grown since pre-industrial times, with an increase of 70% between 1970 and 2004. The largest growth in emissions during this period has come from the energy supply sector (an increase of 145%), while growth in direct emissions from transport was 120%.

Within Canada, GHG emissions are at 721 MtCO<sub>2</sub>e in 2006, an increase of 20% relative to 1990 emissions. Between 2003-06 emissions decreased by 2.8% - mostly due to reductions in the domestic sector. In B.C., emissions are estimated at 62.3 MtCO<sub>2</sub>, an increase of 27% since 1990 (Environment Canada, 2008); and in Victoria CRD at 811 kTCO<sub>2</sub>e, an

increase of 11% since 1990 (SENES, 2006; and Environment Canada, 2008)<sup>2</sup>.

Canada's Kyoto commitment is for a 6% reduction in six GHGs below 1990 levels over the period 2008-2012. Current Canadian GHG emissions are estimated to be 29% above the Kyoto commitment (Environment Canada, 2008), so the current challenge is much greater.

The current Federal government objective is a 20% reduction over 2006 levels by 2020 and a 60-70% reduction by 2050 (Environment Canada, 2007). In B.C., Premier Gordon Campbell has committed to reducing GHG emissions by at least 33% below current levels by 2020; this is equivalent to a 10% reduction on 1990 levels by 2020 (Office of the Premier, 2008).

Municipalities within B.C. are also attempting to address emissions from their own operations. The Climate Action Charter (introduced at the Union of B.C. Municipalities conference, 2007), commits signatory local governments to developing strategies and taking action to:

- become carbon-neutral in their operations by 2012;
- measure and report on their community's GHG emission profile; and
- create more compact and energy-efficient urban and rural communities.

More than 90 municipalities and regional districts have signed the Charter (as at 2007), including six

Capital Regional District (CRD) member municipalities and the CRD agency itself.

Per capita emissions in Canada remain at a very high level – nearly 20 tonnes per person, similar to per capita emissions in the USA.

Other western industrialised countries are considering an 80% reduction in cross-sectoral CO<sub>2</sub> emissions. The UK, for example, has recently adopted this as a target for 2050, based on 1990 levels. The target assessed in this report is of this scale – whether CRD could achieve an 80% reduction in CO<sub>2</sub> emissions in the transport sector, using a 1990 baseline.

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<sup>2</sup> Note updated data is now available from the National Inventory Report 1990-2007.

Table 1: Global CO<sub>2</sub> and Carbon Emissions

Country	Total CO <sub>2</sub> (million tonnes)	Per Capita CO <sub>2</sub> (tonnes)	Global Ranking
<b>North America</b>			
United States	5,956.98	20.14	1
Canada	631.26	19.24	7
Mexico	398.25	3.75	16
<b>Central and South America</b>			
Brazil	360.57	1.94	18
Venezuela	151.29	5.99	29
Argentina	146.64	3.71	30
<b>Europe</b>			
Germany	844.17	10.24	6
United Kingdom	577.17	9.55	8
Netherlands	269.66	16.44	23
Sweden	58.77	6.53	54
<b>Eurasia</b>			
Russia	1,696.00	11.88	3
Kazakhstan	198.01	13.04	26
<b>Middle East</b>			
Saudi Arabia	412.35	15.61	14
United Arab Emirates	137.82	33.73	31
Bahrain	25.18	36.58	76
<b>Africa</b>			
South Africa	423.81	9.56	12
Uganda	1.62	0.06	152
Malawi	0.86	0.07	169
<b>Asia and Oceania</b>			
China	5,322.69	4.07	2
Japan	1,230.36	9.65	4
India	1,165.72	1.07	5
South Korea	499.63	10.27	9
Australia	406.64	20.24	15
<b>World</b>	28,192.74	4.37	N/A

Source: World Bank/United Nations (2005) as featured in The Guardian Newspaper, UK, 15 December 2007. More recent figures from exploratory research in the Netherlands show that China is now the highest total emitter (but not per capita).

### 1.3 The Backcasting Approach

This scoping study for Transport Canada draws on previous studies developed by Halcrow and the University of Oxford (Transport Studies Unit) on the transport and climate change topic.

The study uses a backcasting methodology. Instead of starting with the present situation and projecting prevailing trends (forecasting), the backcasting approach designs ‘images’ or scenarios of the future, representing desirable solutions to societal problems, and “casts back” to the present. A policy pathway is then developed to achieve this desirable future (Figure 1). This is useful in allowing analysis of trend-break futures.

Backcasting has been developed as a particular niche of futures analysis. There was a particularly strong backcasting debate in Sweden in the 1980s over energy futures. Much of the initial working methodology was developed in this period (Johansson et al., 1983), although there have been some modifications in recent years. The well-known OECD project on Environmentally Sustainable Transport (EST – OECD, 2000) and the EU-POSSUM project (POSSUM, 1997; and Banister et al, 2000) introduced the backcasting methodology to the transport planning field in Europe.

A series of VIBAT studies have been published by Halcrow and the University of Oxford, all using the backcasting methodology<sup>3</sup>. These include VIBAT-UK

(UK Department for Transport, 2005-06), VIBAT-London (UrbanBuzz, Transport for London and Greater London Authority et al, 2007-09), VIBAT India and Delhi (Asian Development Bank, scoping study 2008) and VIBAT-Oxford (Oxfordshire County Council, 2009-10). We have also incorporated some of the carbon wedge mitigation methodology, as developed by Princeton Environmental Institute, into the backcasting approach.

A transport and carbon simulation model (TC-SIM) has been developed for use in London. Within this, users are able to consider a series of potential policy packages and select variable levels of application to help achieve headline CO<sub>2</sub> emission reduction targets. The previous VIBAT studies and TC-SIM model are hosted on [www.vibat.org](http://www.vibat.org).

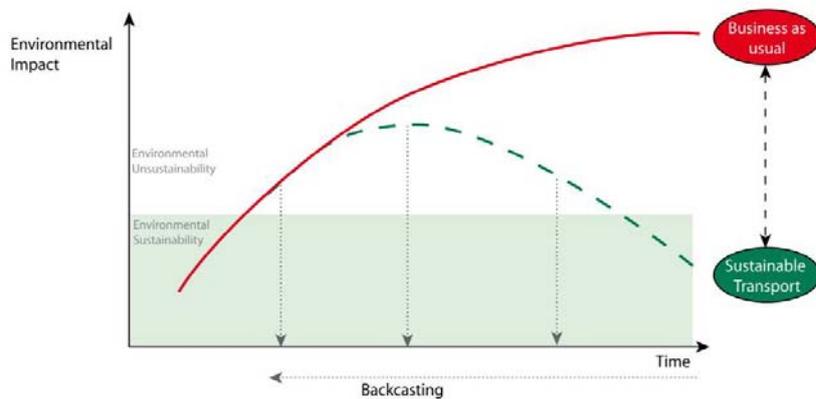
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<sup>3</sup> Again it should be noted that this is a scoping study exploring the potential applicability of the backcasting methodology. There are some potential limitations to using backcasting, i.e. starting conditions are often important and may limit what can be introduced. A more detailed study would factor such issues into

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appropriate policy pathways. “Desirable” futures would also be developed in more detail in a full study, together with the range of interventions, levels of application and quantification of likely impacts/modelling approach (see section 4).

Figure 1: The Backcasting Approach



### 1.4 Study Methodology

This study includes a number of stages:

- **Baseline:** review of backcasting and scenario building methodologies and assess potential for application to CRD. Establish baseline transport CO<sub>2</sub> emissions for CRD, to an agreed future year (2020);
- **Inventory of measures:** an initial review of potential interventions available in the transport/urban planning sector, at the regional scale, that may help reduce CO<sub>2</sub> emissions. These are grouped into policy packages and used to show potential mitigation impacts. The inventory is based on a review of literature and meetings with local officials in the CRD;
- **Exploratory modelling run:** this is developed to illustrate potential CO<sub>2</sub> reduction pathways for a selected cluster of policy packages (a strategy);
- **More detailed working methodology:** a specification for a more detailed study for Transport Canada and other parties.

This would include a more thorough inventory of measures, testing of applicability to the local context (potentially using a stated preference exercise), development of simulation capability (similar to the simulation model developed in London) and cost-benefit analysis. The work could be carried out for a number of jurisdictions.

The study develops an initial transport-carbon policy calculator for CRD, based upon the current available datasets, previous Halcrow modelling tools based on CRD and B.C. and previous Halcrow transport carbon simulation modelling.

Vehicle emission standards reflect observed Canadian and North American transport emission factors. Changes to future vehicle emissions reflect technological and behavioural policy interventions. The transport-carbon-policy calculator simulates the individual and collective impacts of various policy packages at differing levels of application. These include individual policy packages and a combined clustered package of these (a potential strategy). The base year used is 2006, with projections modelled to 2020.

## 1.5 Structure of the Report

This pilot study report is structured as follows:

- Section 2: The Victoria Baseline;
- Section 3: An Inventory of Existing and Potential Measures;
- Section 4: Exploratory Modelling Outputs;
- Section 5: Conclusions and Potential Next Steps.

## 2 The Victoria CRD Baseline

### 2.1 CRD Context

The Victoria CRD is located on the southern end of Vancouver Island in British Columbia, Canada. The Victoria CRD is a federation of 13 municipalities and 3 electoral areas. As an overarching agency, the CRD coordinates regional services and interests for its member municipalities. These municipalities include Central Saanich, Colwood, Esquimalt, Highlands, Langford, Metchosin, North Saanich, Oak Bay, Saanich, Sidney, Sooke, Victoria, View Royal, and the electoral areas of Juan de Fuca, Southern Gulf Islands, and Salt Spring Island. Victoria, Saanich, and Oak Bay are the most urbanized of the CRD members. This study focuses specifically on the area included within the 13 municipal boundaries and excludes the electoral areas (Figure 2).

The B.C. Climate Action Plan (2007) develops a strategy for GHG reduction at the provincial level, including targets for achievement, a range of policy measures and a process for public engagement.

Within this, the CRD and its member municipalities are developing their own policy approach. The CRD and local authorities are currently (April 2009) working to review and update the Regional Growth Strategy (RGS). The RGS was previously adopted in 2003. It is estimated that this process will take 18-24 months to complete. Modest population growth is forecast on Victoria Island – from a 700,000 base in 1996 to 1 million in 2026. The RGS however seeks to focus most of this growth in the downtown core of Victoria. A key strategic objective is to keep the urban settlement compact, based around a strong mixed-use core. New growth is also to be centred on eight major centres, with walkable and transit-

focused communities. Transport mode share targets are adopted (for example transit achieving 10% of trips in the PM peak, region-wide, by 2026, and 40% in the metropolitan core).

The CRD's transport strategy is contained in TravelChoices (CRD, 2005) which combines with the Regional Growth Strategy to present a comprehensive vision for land use, development and the transportation network. TravelChoices aims to significantly increase the proportion of people walking, cycling, using transit, ride-sharing or using other alternatives to single occupancy vehicles (SOV).

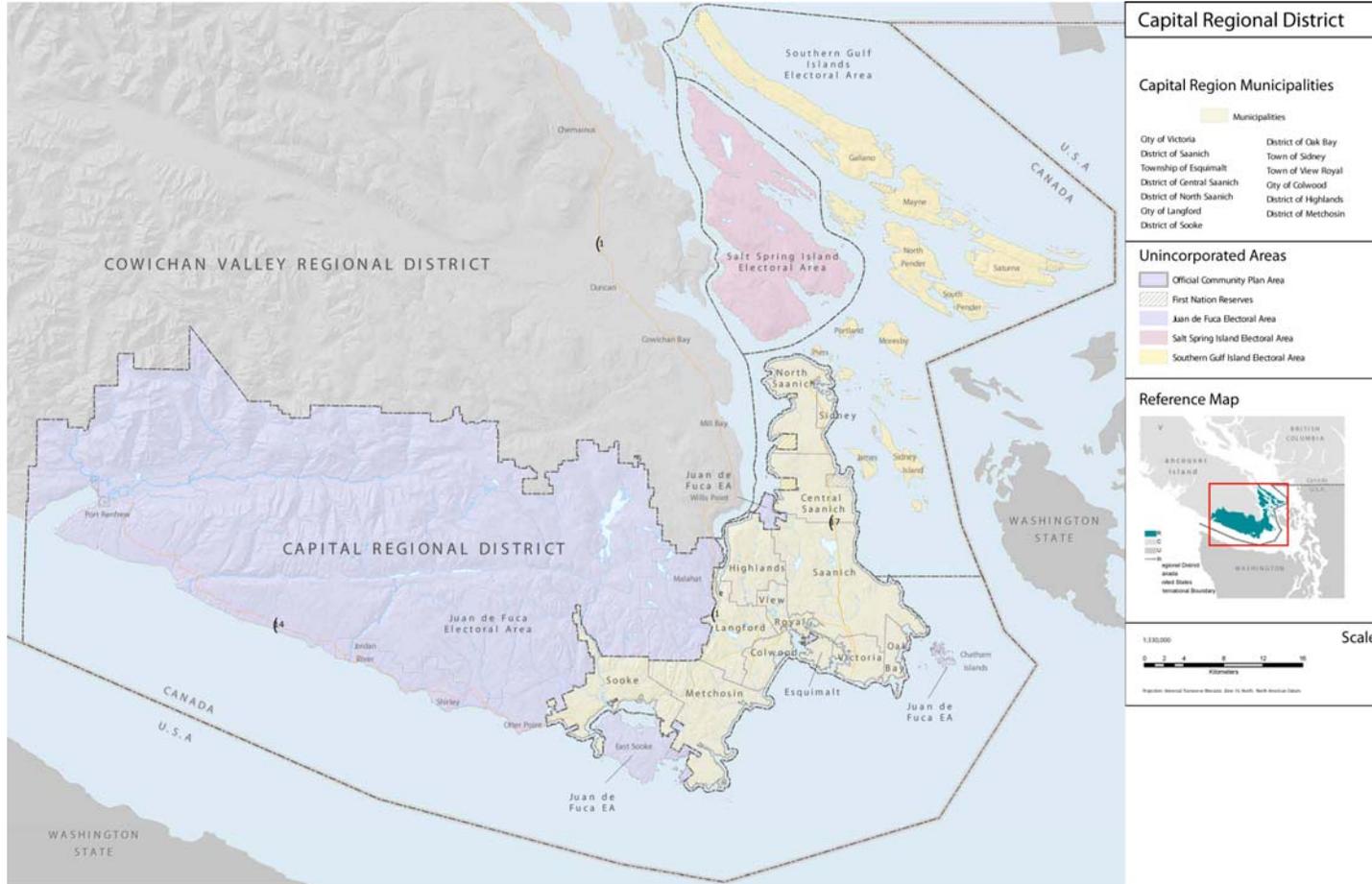
The CRD forecasts that by 2026, regional travel will average 400,000 person-trips per day. The TravelChoices goal is to provide the required facilities and attractive alternatives such that 300,000 of these trips are made via cycling, walking, transit, or ride-sharing, and not via single occupant vehicles (SOVs).

In terms of political jurisdiction, the CRD is charged with coordination and service provision to its member municipalities, but is bound by federal and provincial targets and laws. These set a framework for many policy decisions, including emissions and tailpipe standards, fuel and carbon taxes and other initiatives. Local municipalities control most land use and transportation decisions. However, B.C. Transit, a Provincial Agency, controls transit provision and funding. The recently adopted Bill-27 (Green Communities) was enacted at the provincial level and will be implemented at the municipal level, where activities related to development and permit issuance are handled.

There has been some previous evidence-building research in this area. TSI Consultants and Cansult (2005) developed a major study on the impact of transit improvements and other traffic demand management measures on GHG emissions. This report identifies the

likely impacts of various investment scenarios on emissions within 10 municipalities, including the CRD. Some of the modelling work developed in this study has been reviewed and developed and is used as the main data source for the empirical part of this pilot study. Data from SENES (2006) and the National Inventory Report (Environment Canada, 2008) is also used.

Figure 2: Victoria Capital Region District



## 2.2 Baseline CO<sub>2</sub> Emissions

The National Inventory Report (Environment Canada, 2008) outlines the current GHG emission trends at the national level. Total emissions are at 721 MtCO<sub>2</sub>e (2006), an increase of 20% relative to 1990 emissions. However there has been a recent decline, with emissions decreasing by 2.8% from 2003-06. This is mostly due to reductions in the domestic sector.

Emissions in the transport sector continue to rise (with a minor reduction 2005-06) (Table 2) and BAU projections forecast national transport emissions rising from 166 MtCO<sub>2</sub>e in 2006 to 193 MtCO<sub>2</sub>e in 2020 (Figure 4).

Canada’s allowable cross sectoral (all sector) emissions under the Kyoto

protocol for 2008-2012 are an aggregate 2,815 MtCO<sub>2</sub>e (compared to 3,605 MtCO<sub>2</sub>e at the estimated annual totals in 2006). Verification reports are due in 2010 and 2014.

In B.C. total emissions are estimated at 62.3 MtCO<sub>2</sub>e, an increase of 27% since 1990 (Environment Canada, 2008). BAU projections forecast a reduction in transport emissions, from 19.2 MtCO<sub>2</sub>e in 2006 to 15.6 MtCO<sub>2</sub>e in 2020 (Figure 5).

In Victoria CRD total emissions are at 811 KtCO<sub>2</sub>e, an increase of 11% since 1990 (using data from SENES, 2006; and Environment Canada, 2008). In the transport sector, emissions are projected to rise from 811 KtCO<sub>2</sub>e in 2006 to 934 KtCO<sub>2</sub>e in 2020 (Figure 6).

**Table 2: Baseline GHG Emissions in the Transport Sector**

Scale and Sector	1990	1995	2001	2004	2006		Kyoto 2008***	Kyoto 2012***
<b>Canada</b>								
Transport MtCO <sub>2</sub> e*	132	141	154	162	166		124	124
Total*	592	642	710	743	721		556	556
<b>B.C.</b>								
Transport MtCO <sub>2</sub> e*	14.84	18.59	18.88	20.64	19.17		13.95	13.95
Total*	48.90	57.10	60.80	65.60	62.30		45.97	45.97
<b>CRD</b>								
Population	307,650	328,724	-	349,638	-		-	378,316
Transport kTCO <sub>2</sub> e**	729	882	835	811	811		685	685
Total**	-	1,763	-	1,532	-		-	1,636**

Sources:

\*National Inventory Report, Greenhouse Gas Sources and Sinks in Canada: The Canadian Government’s Submission to the UN Framework Convention on Climate Change, 1990–2006 (2008). Halcrow Consulting Inc (2009)

\*\*Greenhouse Gas and Energy Use Inventory for the Capital Region (2004)

\*\*\*2008/12 - Kyoto protocol equivalent targets as estimated by Halcrow

- Data not available and extrapolation not undertaken

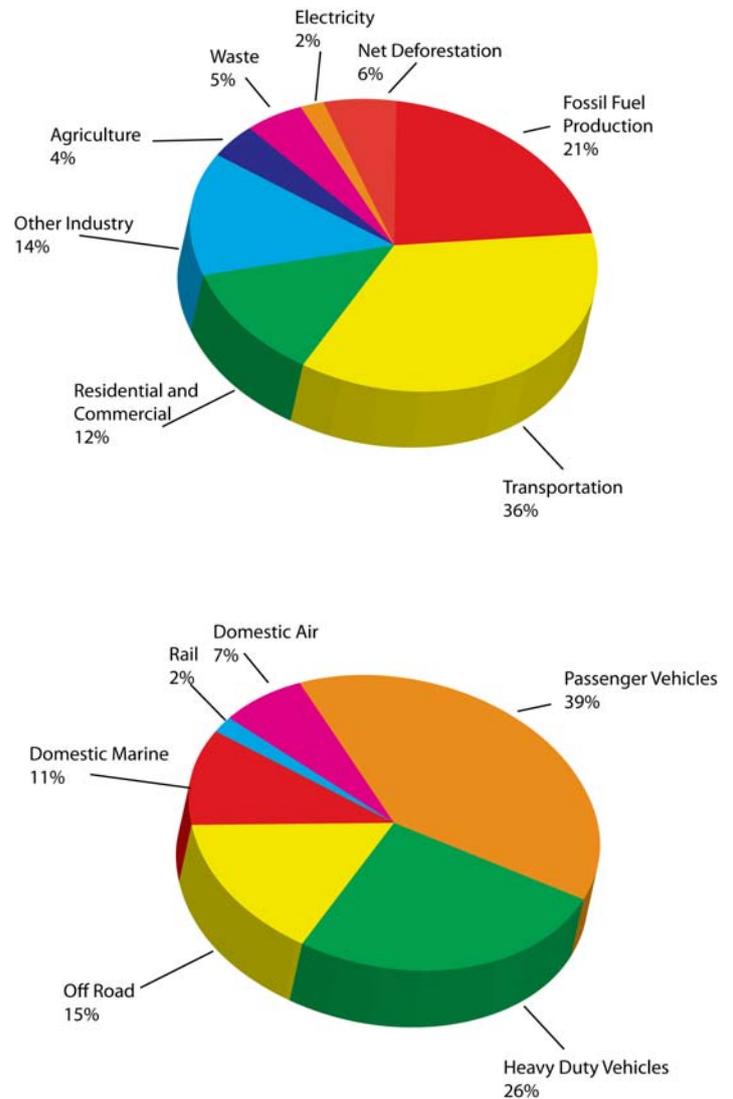
Note. Pipeline transport not included in all estimates. Canada and B.C - transport sector defined as all transport excluding aviation, shipping and pipelines (hence includes rail). CRD - transport sector defined as private and commercial motor vehicles (excludes rail).

The transport sector accounts for an estimated 36% of B.C.'s total GHG emissions and is the single largest source of emissions in the province (Figure 3). This is a very large proportion compared to, for example, the UK (around 25%). While population growth accounts for part of the recent increase in total GHG emissions in B.C., the increase in emissions from the transportation sector exceeds the population growth rate.

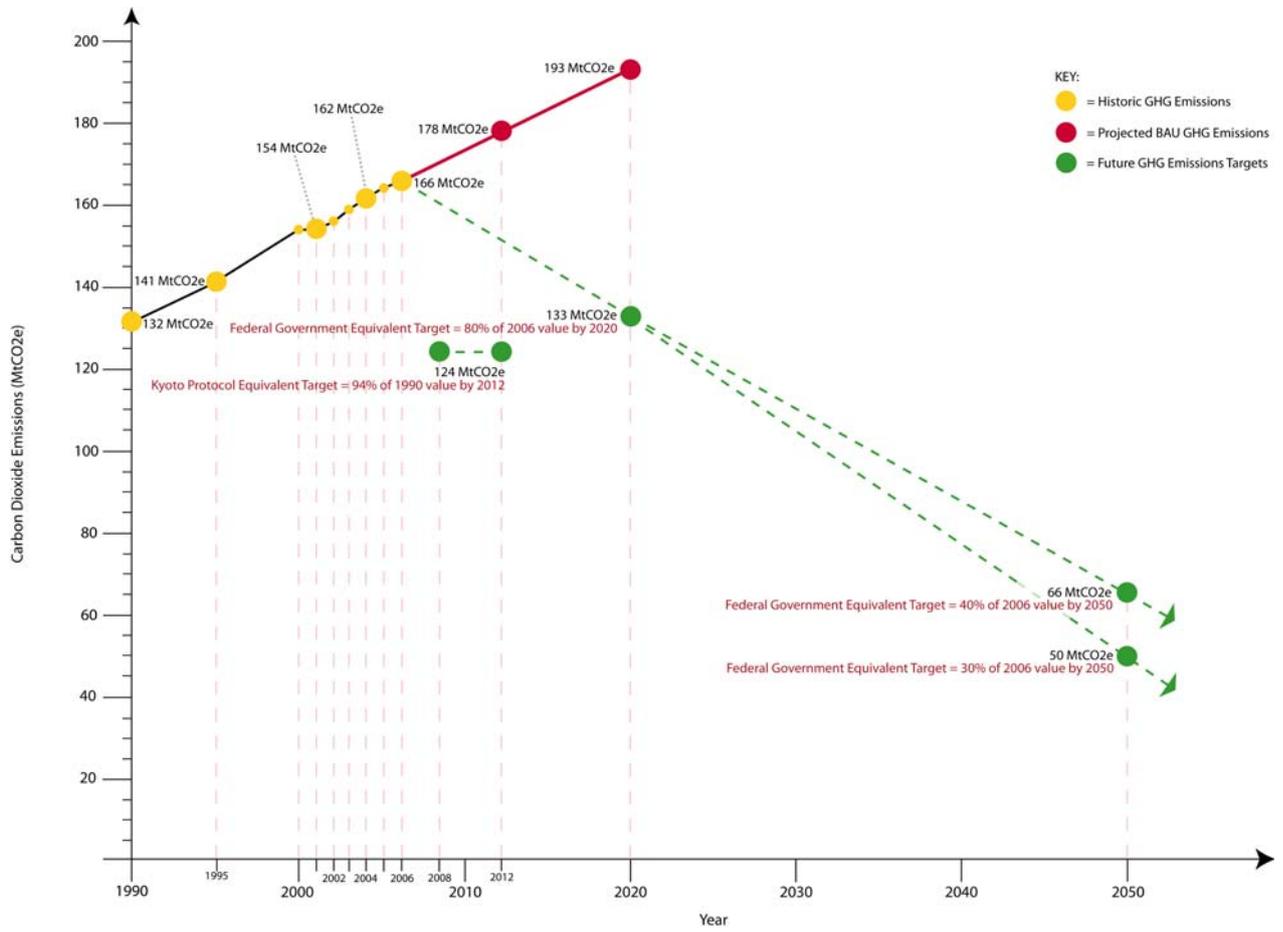
Although B.C. has the second lowest per capita GHG emissions in Canada, primarily due to 90% of B.C.'s energy being derived from clean sources, emissions are growing faster than most other provinces and territories. For B.C. to reduce its GHG emissions, new and innovative strategies within the transportation sector are required, implemented at 'high intensity' levels of application.

Simpson and Jaccard (2007) and Jaccard and Natural Resources Canada (2006) have been critical of the historical achievement levels in reducing CO<sub>2</sub> emissions. For example they plot rising [cross sectoral] emissions against timescale and the release of various strategy documents. The work illustrates the huge difficulties experienced in reducing emissions.

**Figure 3: B.C. Sectoral Emissions (Cross Sectoral and within Transport)**

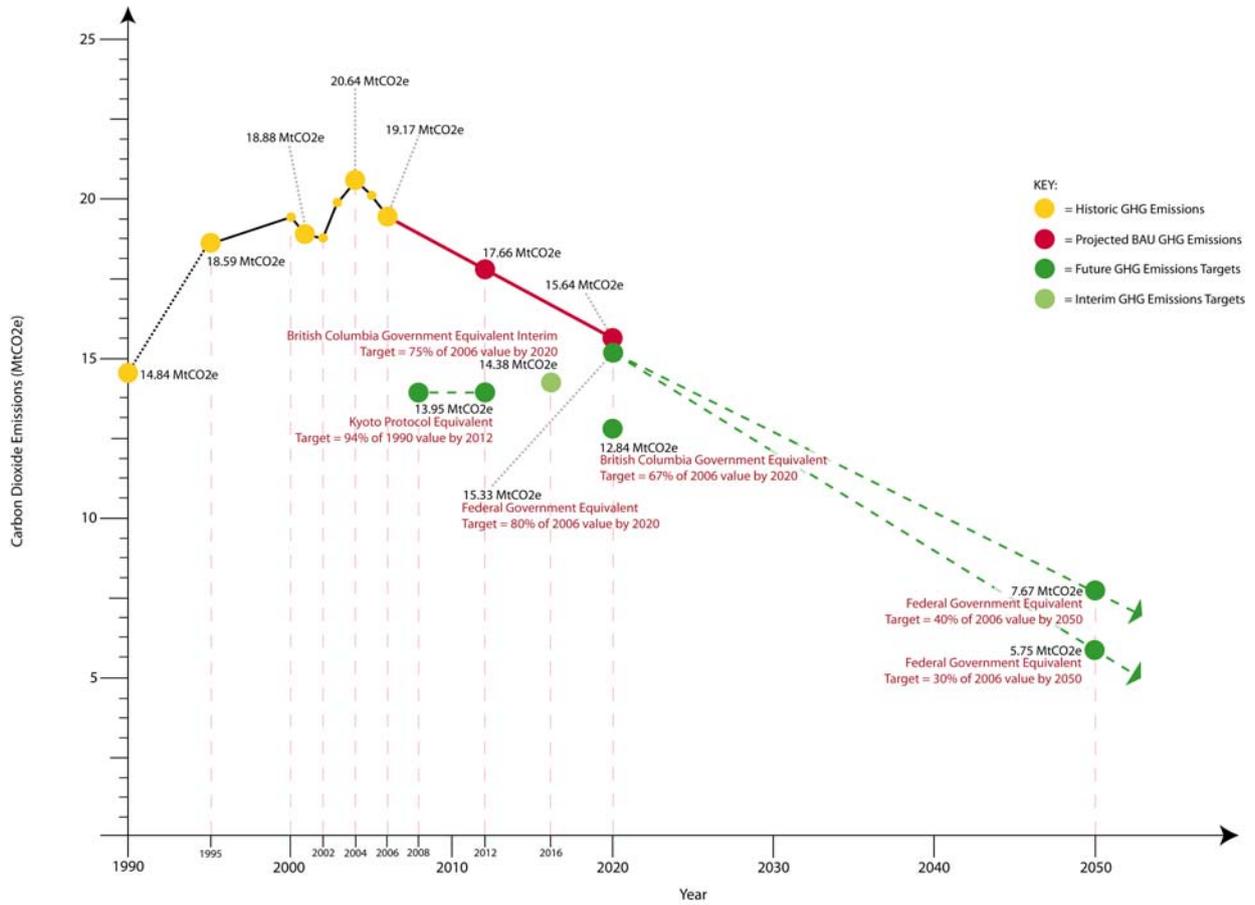


**Figure 4: Canada Baseline and Projective Emissions (Surface Transport)**



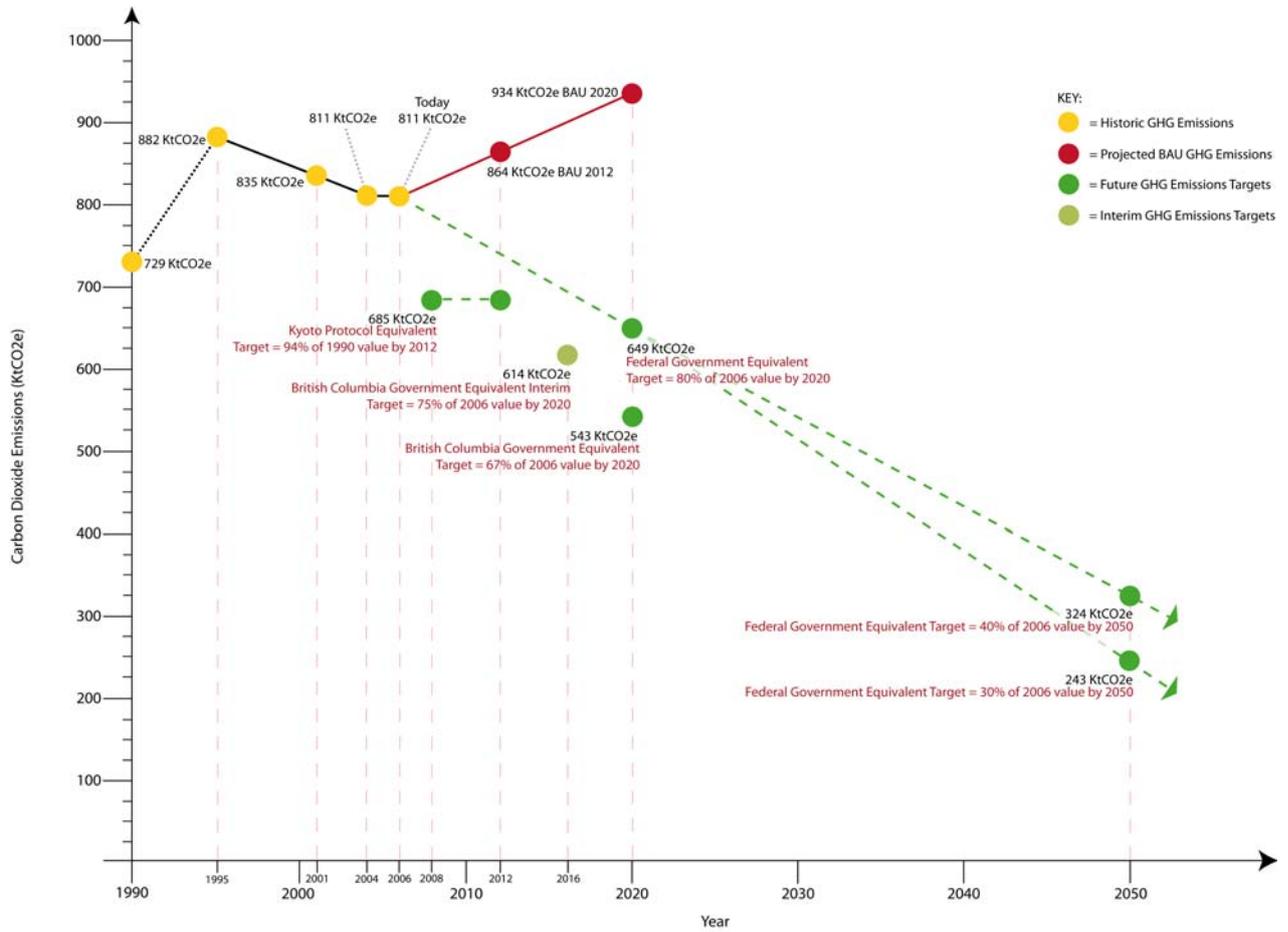
Sources: National Inventory Report, Greenhouse Gas Sources and Sinks in Canada: The Canadian Government's Submission to the UN Framework Convention on Climate Change, 1990–2006 (2008).

**Figure 5: B.C. Baseline and Projective Emissions (Surface Transport)**



Sources: National Inventory Report, Greenhouse Gas Sources and Sinks in Canada: The Canadian Government's Submission to the UN Framework Convention on Climate Change, 1990–2006 (2008).

**Figure 6: CRD Baseline and Projective Emissions (Surface Transport)**



Sources: Greenhouse Gas and Energy Use Inventory for the Capital Region (2004)  
 National Inventory Report, Greenhouse Gas Sources and Sinks in Canada: The Canadian Government's Submission to the UN Framework Convention on Climate Change, 1990–2006 (2008).

Note. BAU projected increase to 2020 based on SENES data trend 2004-2012 (this may need to be updated).

## 3 Inventory of Existing and Potential Measures

### 3.1 Introduction

There is a very wide range of measures available to help achieve more sustainable, carbon-efficient travel behaviour in the CRD. A number of interventions are discussed below, grouped into policy packages (PP) of complementary measures. Individual interventions rarely have a significant impact on the aggregate of level of CO<sub>2</sub> emissions, but when grouped into packages and strategies, can be shown to be very important depending on the level or ‘intensity’ of application.

A large amount of previous analysis has been carried out on the likely impacts of policy interventions. Some good databases are available – such as the VTPI TDM encyclopaedia ([www.vtpi.org/tdm/index.php](http://www.vtpi.org/tdm/index.php)), the Leeds ITS Konsult database ([www.konsult.leeds.ac.uk](http://www.konsult.leeds.ac.uk)) and Oxford University IMPACT database ([www.impact-ukerc.org](http://www.impact-ukerc.org)). The previous VIBAT studies have involved international reviews of policy interventions and application in various contexts. TSI and Cansult (2005) reviewed a range of interventions, with a particular focus on Canadian application. The context, of course, is all important here – the impact of interventions differs markedly by location.

The modelling work in this pilot study draws on all of these sources, and discussions with local officers in B.C. and CRD, Todd Litman at VTPI, and develops a range of policy packages that may have carbon reduction potential in

the CRD. The following packages are identified:

- 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.

The interventions and packages are not intended to be exhaustive, but to give an indication of likely potential in reducing transport CO<sub>2</sub> emissions. They allow an exploratory modelling run to be developed as part of this pilot study. The working concept is that each policy package gives a level of carbon reduction against the headline target. Together, a range of interventions can make a significant change (Figure 7).

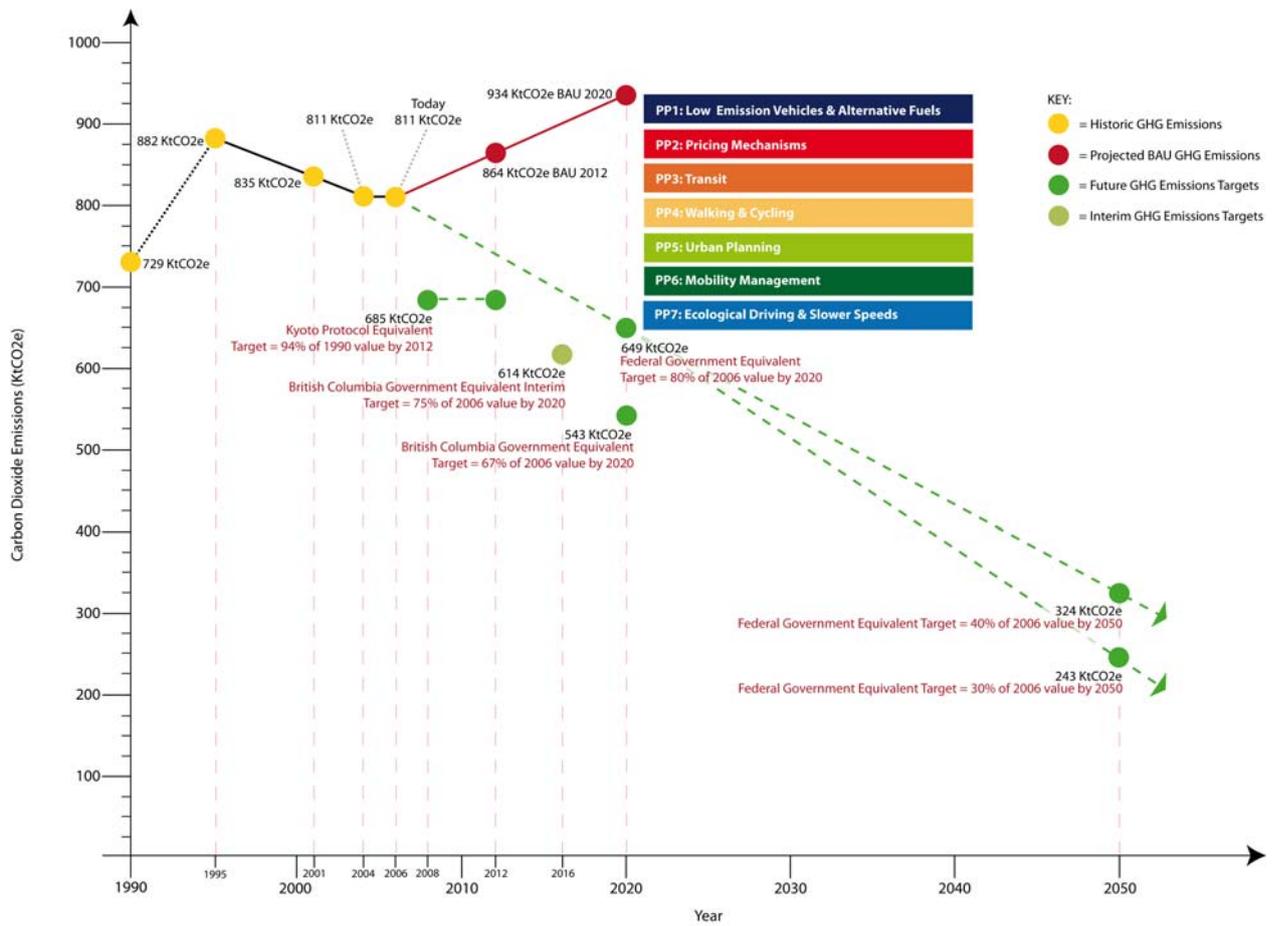
A key area for future research is to develop an exhaustive inventory of policy measures available to practitioners, with an indication of current best practice, likely travel and CO<sub>2</sub> emission reduction impacts. Assessments can also be made of contextuality (different impacts by location), where the evidence is available. This inventory could be web-based and updated over time. This would then be useable for more exhaustive modelling work.

Each of the following policy packages is presented as follows:

- A brief description of the package elements;
- An overview of programmes already in place;

- An estimate of package contribution to reduced transport CO<sub>2</sub> emissions, at different levels of application (low, medium and high).

Figure 7: Policy Packages to 'Bridge the Gap'



### 3.2 PP1: Low Emission Vehicles and Alternative Fuels

Low emission vehicles are those which achieve reduced fuel consumption through innovative engine design, including technologies such as hybrid petrol vehicles, advanced diesel and electric engines. Alternative fuel sources can also be used, including biofuels, compressed natural gas, liquid petroleum gas, plug-in electricity (ideally sourced from hydropower) and, potentially in the long term, hydrogen fuel cells. The take up of low emission vehicles is being encouraged as follows.

#### Tailpipe Emissions Standards

The Canadian Government intends to regulate the fuel consumption of cars and light trucks sold in Canada under the Canadian Environmental Protection Act. This will replace the Memorandum of Understanding (MoU) between the industry and Government, which has not led to the intended reductions in vehicle CO<sub>2</sub> emissions. The standard will be benchmarked against the Californian regulations (Environment Canada, 2007).

The B.C. provincial government is developing a similar approach. The new tailpipe emissions standards will apply to new vehicles and be phased in between 2009 and 2016. The standards employ a fleet-average approach, such that manufacturers may sell higher-emitting vehicles as long as they counterbalance the emissions levels with a sufficient number of low-emissions vehicles. In addition, B.C. has the authority to mandate larger manufacturers to include a percentage of zero-emissions vehicles in their fleets each year.

The government estimates that, under this initiative, GHG emissions from personal vehicles will decrease by 30% over 2005 models.

A number of programs are running at the national level. The EcoENERGY for Personal Vehicles Initiative is investing \$21m over 4 years to provide information to consumers on fuel consumption, including vehicle labelling, to encourage more fuel efficient purchasing patterns, driving and maintenance. The ecoENERGY for Fleets initiative targets operators and managers of commercial and institutional road vehicle fleets. The ecoTECHNOLOGY for Vehicles program tests the safety and environmental performance of a range of emerging vehicles for use in light duty vehicles in Canada. Similarly, the ecoFREIGHT program tests emerging technologies in the freight sector and helps remove financial barriers to adoption.

Further incentives are available locally for the purchase of hybrids/fuel efficient cars. B.C. has waived the Provincial Sales Tax on hybrid vehicles since 2002, saving buyers up to \$2,000. A similar sales tax exemption is now also in place for alternative-fuel vehicles, saving buyers up to \$2,000. All vehicles that qualify for the federal government's Eco-Auto Rebate were also GST exempt (until the end of 2008). The PST exemption has also been extended to include other environmentally friendly forms of transportation, including electric-assisted bicycles, scooters, and electric motorcycles.

**Table 3: Example Available Vehicles in the Canadian Fleet**

Manufacturer/Model	l/100 km (City)	CO2 Emissions/Year (20,000km)
Toyota Prius Hybrid, 1.5l	4.0	1,968
Honda Civic Hybrid, 1.3l	4.7	2,160
Mini Cooper, 1.6l	7.1	3,024
Ford Focus, 2.0l	8.5	3,456
Chrysler Sebring, 2.4l	9.7	3,984
Volkswagen Golf, 2.0l	9.8	4,128
Audi A3, 2l	9.4	3,984
BMW 323i, 2.5l	11.2	4,416
Bentley Arnage, 6.8l	13.9	5,040
BMW X6 35i, 3.0l	14.4	5,952
Hummer H3T	16.4	7,056
Aston Martin DB9, 5.9l	18.9	7,536
Ferrari Scaglietti 612	22.8	8,784

From [www.etc-cte.ec.gc.ca/databases/carpollution/default.aspx](http://www.etc-cte.ec.gc.ca/databases/carpollution/default.aspx)

### Vehicle Scrapping Programs

A range of incentives are provided to ‘scrap’ older cars and replace with newer (presumably more fuel efficient) vehicles. Many of these are branded under the LiveSmart B.C. program. In total individuals can receive up to \$6,000 for carbon efficient lifestyle changes.

The BC government’s ‘Scrap-It’ Program employs a tiered approach, where owners of pre-1995 vehicles can receive between \$750-\$2,250, depending upon the model year and emissions level of the vehicle. The program has been expanded province-wide from the Lower Mainland, meaning CRD residents now qualify to participate. According to B.C. Transit, the program to-date has scrapped 6,510 vehicles and provided 5,951 incentives of which 2,920 were for transit passes, 2,060 were for new vehicles and 641 for used vehicles. In addition, 330 incentives were claimed for bicycles, West Coast Express, car sharing or van pooling. Between 2008 and 2011, B.C. Transit estimates predicted 10,000-20,000 vehicles would be taken off the road.

### Alternative Fuels

The Canadian Government intends to develop a regulation requiring fuel producers and importers to have an average annual renewable fuel content of at least 5% of the volume of gasoline that they produce or import, commencing in 2010 (Environment Canada, 2007). The province also intends to adopt a 5% renewable fuel standard for diesel by 2010 (B5) as well as to support the federal efforts. It is estimated this will reduce passenger vehicle carbon emissions by 10% by 2020.

Currently, there are many biodiesel suppliers in B.C. but only two located in the CRD. However, with sufficient volume, commitments, or demand, local production would likely become feasible with a lower cost of a B5 or B20 blend. If biodiesel were cost neutral, there would be a real opportunity to impact emissions, not only from the CRD fleet, but also from all diesel engines in the region.

The B.C. government currently has 584 hybrid vehicles in its fleet – the largest fleet in Canada. B.C. Transit, as part of its \$14 billion B.C. Transit plan (more detail in under PP3 Transit, section 3.4), is looking to add to its fleet of fuel-efficient vehicles, and has designated \$1.6 billion towards the procurement of 1,500 clean energy buses. The technologies that may be considered include:

- Hydrogen
- Hybrid
- Electric
- Natural Gas
- Low emissions diesel

As part of its efforts to ensure the 2010 Winter Olympics at Whistler are sustainable, B.C. Transit will be operating a fleet of 20 hydrogen fuel cell

buses. This pilot initiative will provide the opportunity to validate and establish an 'implementation pathway'. B.C. Transit is hoping that the fuel cell bus will, ultimately, be used in a large proportion of the fleet. Half of this operates within the Victoria CRD area. The current Victoria fleet consists of clean diesel, a few diesel-electric hybrids, and also double-decker buses. Victoria was the first in North America with double-decker buses and first city in Canada with hybrid vehicles.

The fuel cell bus project is part of the larger 'Hydrogen Highway Initiative', which will connect California, Oregon, Washington, Victoria, Vancouver, and Whistler with hydrogen infrastructure. B.C. has invested over \$3m in hydrogen and fuel cell technology development since 2002. At present, there is one hydrogen fuelling station in the Victoria CRD, located on B.C. Transit property. As part of the intention to expand the infrastructure, and strategies to enable private sector use, hydrogen fuelling is also being considered for expansion beyond the public transit system.

Both the CRD and the City of Victoria are working to make their respective government fleets as clean as possible. As part of its efforts to reach 'carbon neutrality' by 2012, the CRD is pursuing a number of actions to reduce its fleet emissions, including auditing the fleet vehicles, reducing fuel consumption, downsizing and replacing vehicles, switching to greener fuels, including diesel vehicles, biodiesel, and hybrids. The CRD acquired a Toyota Prius as part of its LEED rating certification in 2004, however it has been found not to be as cost effective as might be desired given the relatively small mileage fleet cars are driven each year. Much of the CRD fleet is comprised of medium and heavy-duty vehicles. CRD will consider deploying more hybrid models when they become cheaper, mass market vehicles.

Similar to the CRD, the City of Victoria has a municipal Fleet Operations Climate Protection Program. Since 1998, the City of Victoria has sought to decrease its fleet size and has moved towards more fuel efficient vehicles. 72 of its engineering department's light duty vehicles now run on high pressure natural gas. Fleet initiatives are not limited to the public; a number of taxis are now hybrid.

Electric vehicles are also expected to see increased rates of adoption. In 2007, the B.C. Government passed legislation allowing the use of electric, zero emission vehicles on public roads with speed limits up to 40 km per hour (there is a caveat in the law, which allows local municipalities to decide to allow the use of electric vehicles on streets with speed limits up to 50km per hour, which is a more common speed in the municipalities throughout the CRD, aside from Oak Bay, which is limited to 40 km per hour). Vehicles may range in size from small, golf-cart like vehicles to larger mid-sized cars and mini-vans. Such vehicles plug-in to charge, and in B.C. where much of the electricity is produced from hydropower, the electricity source pollution is lower than in other locations where plug-ins are used (and where hydropower is not so frequently used). Relative to fuel cells or other alternative fuels, infrastructure requirements are not hugely intensive for plug-ins, hence there is even potential to incorporate plug-in points to parking meters. Such ubiquitous technology may help apply the vehicles at the mass market scale. The great problem with alternative fuel and low emission vehicle application has been in moving beyond the niche market.

PP1: Low Emission Vehicles and Alternative Fuels		GHG Emissions Reduction (KtCO <sub>2</sub> e)	GHG Emissions Reduction (%) of 2020 BAU
Current total vehicle fleet average	9.8 litres/100km 28.8 miles per gallon (208 gCO <sub>2</sub> /km)		
Low	9.4 l/100km 30.0 mi/gal 200 gCO <sub>2</sub> /km	28	3.0%
Medium	8.3 l/100km 34.3 mi/gal 175 gCO <sub>2</sub> /km	94	10.1%
High	7.1 l/100km 40.0 mi/gal 150 gCO <sub>2</sub> /km	160	17.1%

\*Modelling based largely on average vehicle fleet efficiency changes. Different levels of policy package application illustrative, and not exhaustive.

### 3.3 PP2: Pricing Mechanisms

There is a range of pricing policy instruments available to help influence travel patterns and CO<sub>2</sub> emissions. In theory these include road user charging schemes (usually distance, cordon, area or emissions based); private and public parking charges; vehicle ownership taxes; and fuel taxes. The funds raised can also be used to subsidize or reinvest (this is known as hypothecation) in alternative means of transport such as transit or walking and cycling. Graham and Glaister (2002), Litman (2008), amongst others, have reviewed likely income and price elasticities relative to road traffic demand, including parking prices. These studies indicate that the elasticity of vehicle trips with regard to parking prices is typically in the -0.1 to -0.3 range, but with significant variation depending on demographic, geographic, travel choice and trip characteristics. Area congestion pricing schemes have been developed in cities such as London, Stockholm and Trondheim, though none, as yet, in Canada. B.C and

the CRD are focusing on carbon and fuel tax and parking regimes in terms of fiscal mechanisms.

#### Carbon and Fuel Tax and Level of Fuel Price

Litman (2008) reviews carbon tax rates for various fuels in Canada (Table 3) and B.C. (Table 4). Motorists in low fuel price countries tend to travel further distance per capita and use more transport energy use. B.C. introduced the first carbon tax in North America in 2008. Litman (2008) provides an evaluation. The carbon tax is revenue neutral (no increase in total government income), starts at \$10 per tonne of CO<sub>2</sub>eq and increases \$5 per tonne annually for the next four years. Revenues are returned to individuals and businesses through various tax cuts and rebates, including a \$100 per resident Climate Action Dividend and special rebate for low income households. The carbon tax is relatively small – representing 1.6% and rising to 4.7% of total fuel prices. A cap and trade system is also been developed under the Western Climate Initiative.

#### Parking Management and Pricing

Parking management and pricing regimes can have a variety of impacts on travel, affecting the number of trips, destination, route, mode, travel time, type of vehicle, etc. Motorists tend to be particularly sensitive to parking price because it is such a direct charge (Litman, 2008). Compared with other out-of-pocket expenses, parking fees are found to have a greater effect on vehicle trips, typically by a factor of 1.5 to 2.0 (USEPA, 1998). For example, a \$1.00 per trip parking charge is likely to cause the same reduction in vehicle travel as a fuel price increase averaging \$1.50 to \$2.00 per trip. The City of Victoria Parking Strategy (2007) seeks to support sustainable transportation. This includes considering reduced rates for van/car pools and enhanced cycle storage.

**Table 4: Fuel Price, Consumption and Vehicle Travel**

Country	Fuel Price (\$US per liter)		Annual Transport Energy Use (Petrol equivalent tonnes per capita)		Annual Vehicle Travel (Km per capita)	
		(Relative to US)		(Relative to US)		(Relative to US)
Australia	\$0.85	+57%	1.47	-33%	-	-
Canada	\$0.68	+26%	1.72	-21%	15,169	-34%
UK	\$1.56	+189%	0.90	-59%	11,614	-50%
US	\$0.54	0%	2.18	0%	23,095	0%

(Based on VTPI, 2007)

PP2: Pricing Mechanisms		GHG Emissions Reduction (KtCO <sub>2</sub> eq)	GHG Emissions Reduction (%) of 2020 BAU
Current	Reliance on current carbon tax to increase relative cost of motor car usage, from a low level. No area pricing initiative		
Low	'Low intensity 'carbon tax	17	1.9%
Medium	Additional parking charging	38	4.1%
High	Additional emissions-based charging scheme	76	8.1%

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

### 3.4 PP3: Transit

B.C. is making substantial investments in transit. The province has committed \$14 billion in its Transit Plan to 2020 (see later - transit network investments).

B.C. Transit seeks to increase ridership by 400 million trips a year, and to reduce GHG emissions from cars by 4.7 million cumulative tonnes by 2020. For the Victoria region, these targets correspond to an addition 5% transit market share of person-trips by 2030 (an additional 2.5% by 2020).

The CRD has itself established targets for increasing the transit mode share as part of its TravelChoices and Regional Growth Strategies. The 2006 Household Origin-Destination Survey highlights that automobile trips, and the share of trips, outside the urban core have continued to

grow at rates outpacing population growth. Strategies for increasing transit use will need to be aggressively implemented if mode share targets are to be met.

As of 2006, 42% of PM trips to, from, or within the central business district utilize non-auto modes. Compared with other Canadian CMAs of similar size (populations between 250,000 and 500,000), Victoria has the highest mode share of transit, walking and cycling with a 19.8% walking and cycling mode share and a 19.4% transit share.

The CRD's State of the Region report shows the overall number of weekday person-trips increased from 1.12 million to 1.24 million between 2001 and 2006, and the transit mode share for the region remained essentially constant, around 6.3%.

The CRD has set general performance targets for 2026, including:

- Achieving a minimum PM peak period region-wide transit mode share of 10% of trips;
- Achieving a minimum PM peak period mode share by non-auto modes of 40% for trips to, from and within the Metropolitan Core;
- Achieving a minimum region-wide transit mode share of 15% of journey to work trips.

### Transit Network Investments

The B.C. Transit Plan includes large investment in transit options to 2020. While the majority of the funds will go towards the Vancouver Metro Region’s SkyTrain expansion (four new and updated lines – the Canada line, the Evergreen line, the UBC line and the Expo line), there are plans to improve the Victoria CRD region’s transit system with technology upgrades and service improvements. \$1.2 billion of Transit Plan is committed to Rapid Bus B.C. lines, which will introduce new vehicles on major routes in high growth centres, including Victoria. \$1.6 billion will fund new clean technology buses and increase the provincial fleet to provide more frequent transit service. \$50m has been announced for the purchase of new cleaner transit buses, and over \$10m for clean energy school buses.

B.C. Transit is currently in the preliminary stages of a 25-year transportation master plan. This plan is looking at the results of the 2006 household origin-destination study and identifying what the future system will require, in terms of where to best introduce rapid transit routes, and how large a fleet will be required to handle the forecast number of rides.

Originally, a rapid transit route had been proposed from Douglas Street in downtown Victoria to Langford on the West Shore. However, given the results

of the O-D surveys, alternative routes are being explored, including routes that connect the western communities to the University of Victoria.

There are unofficial proposals (from a local politician and other) for an LRT route with the downtown, similar to the Portland LRT.

### Direct Incentives

Incentive programs are also being introduced, including UPASS for the University of Victoria community. 18,000 students have the pass – the university takes money through the student fee and supplements this with \$170,000. ProPass is a similar employee program, encouraging employees to purchase a pass for a year, and deducted straight from the payroll. This has proved to be a relatively expensive system – costing as much for 350 employees as for 18,000 students. The employee system has no direct financial mechanism, i.e. employees are only encouraged to participate.

PP3: Transit		GHG Emissions Reduction (KtCO2e)	GHG Emissions Reduction (%) of 2020 BAU
Current	Large investment plans via the C.C. Transit Plan, but much of the focus on Vancouver rather than Victoria.		
Low	‘Low level’ of further network investment	11	1.2%
Medium	‘Medium level’ of further network investment and marketing initiatives	23	2.5%
High	‘High level’ of further network investment and incentives for use	46	4.9%

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

### 3.5 PP4: Walking and Cycling

The Province of B.C. has a \$40m LocalMotion fund which is used to accelerate the development of capital projects that make communities greener and healthier. This match funds local government investments in projects that encourage active, healthy and environmentally friendly living. The fund has invested in a range of projects including pedestrian facilities, cycle and mountain bike trails and an indoor running track.

As part of its RGS, the CRD is looking to significantly increase the mode shares of walking and cycling. According to the RGS monitoring report, between 2001-2006, cycling saw an increase in mode share, growing from 2.4% to 3.2% of person-trips. However, walking decreased from 11.9% in 2001 to 10% in 2006. Given the shorter nature of cycling and walking trips, the CRD's ability to promote denser building and strong urban centres with safe and convenient neighbourhood connections will be a key factor. Urban planning is considered later (3.6: PP5 Urban Planning).

#### Cycling

The CRD's target in the RGS and TravelChoices for bicycle use is to attain at least a 10% cycling mode share of journey-to-work trips within the Victoria Census Metropolitan Area, by 2026, and 15% of trips within the more urbanized Victoria, Oak Bay and Esquimalt areas, and urban Saanich. In addition, the number of trips would double to 56,000 daily trips, or an overall mode share of 3.5%.

Key links include:

- Routes leading to downtown Victoria, from urban areas such as Esquimalt, Oak Bay, and Saanich;
- Routes connecting the eight regional activity centres, with connections to surrounding

neighbourhoods and activity centres;

- Direct connections to the major education centres, including the University of Victoria and Camosun College.

The CRD recognizes that this target will be challenging to meet, and will require investment above the current 1% share of annual funding.

At present, the CRD does have one of the highest cycling rates of any metropolitan area in Canada. There are around 28,000 bicycle trips made daily, and during peak periods, the total mode share can reach 3.5%. During the afternoon peak, bicycle trips capture 6.2% of journeys to work and post-secondary trips. Finally, bicycle trips account for 3.7% of all trips ranging between 1 and 5 km in length, whereas walking captures 13% and transit 7.4%.

The major bicycle corridors are near the University of Victoria and Camosun College campuses and extending towards Oak Bay, southeast Saanich, and northeast Victoria, where 35% of all bicycle trips take place. Trips between the campuses and downtown Victoria account for another 16% of all bicycle trips.

The CRD currently offers cyclists around 200 km of bicycle routes which include on-street and off-street routes. These include the off-street Galloping Goose and Lochside trails, bicycle lanes on arterial and collector roads throughout Victoria and Saanich, and bicycle lanes incorporated along paved shoulders of highways or local roads. The CRD is looking to further expand the bicycle network. This will involve:

- Building a continuous network of bicycle routes in the region, including routes serving major employment centres such as business parks, hospitals, the airport and commercial centres.

The proposed Westside Trail is an off-street multi-use pathway, similar to the Galloping Goose and Lochside Trails, and would connect downtown Victoria with View Royal via Esquimalt.

- Improving safety at intersections and crossings where bicycle routes intersect major roads;
- Providing more secure bicycle parking.

Currently secure bicycle parking is available to the public in downtown Victoria, at the McTavish park-and-ride on the peninsula and at the Juan de Fuca park-and-ride in the Western Communities. In addition, secured parking is provided for employees at several workplaces in downtown Victoria and elsewhere in the region, including the Ministry of Health and Ministry of Transportation offices in downtown Victoria. Secure parking is also provided for students and employees at the University of Victoria.

Funding for municipalities to implement programs, e.g. bike lanes, infrastructure, etc., is available through the B.C. provincial program called Local Motion.

### Walking

The TravelChoices and RGS targets also call for increased walking mode share. The CRD walking strategy is closely related to urban planning, with high densities, mixed uses and walkable communities supportive of efforts to improve walking facilities. The RGS strategy calls for residential development within the urban containment boundary and within walkable and transit-focused communities.

To date, success with this strategy has varied. The RGS monitoring report found that the percentage of residential units located in the GMPA within walking distance from such services had decreased from 29% to 25% as retail and land use patterns shifted, whereas in the West Shore communities, the percentage increased from 10% to 13%.

<b>PP4: Walking and Cycling</b>		<b>GHG Emissions Reduction (KtCO<sub>2</sub>e)</b>	<b>GHG Emissions Reduction (%) of 2020 BAU</b>
Current	Relatively low share of funding invested in walking and cycling facilities		
Low	'Low level' of further investment – more extensive walking and cycling networks	6	0.6%
Medium	'Medium level' of further investment - additional public realm improvements and cycle hire scheme	17	1.8%
High	'High level' of further investment – state of the art “Netherlands-style” cycling network and facilities and marketing initiatives	34	3.6%

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

### 3.6 PP5: Urban Planning

Urban planning interventions to support sustainable transport can be made at strategic (the strategic location of new development) and local scales (local masterplanning). The RGS promotes the development of more complete and compact communities by increasing the proportion of apartments, row houses and other associated housing types in the region’s housing stock. Urban growth is encouraged within the Regional Urban Containment and Servicing Area – at least 90% of new dwelling units will be located here. The Local Government (Green Communities) Statutes Amendment Act, 2008 supports and encourages the development of compact communities that help reduce energy use, reduce the costs of servicing, increase opportunities to walk and cycle to work, and minimize GHG emissions. A number of pedestrian/ transit-oriented development masterplans are being developed in the CRD. Development fees can be used to improve sustainable transport provision.

In 2006, estimates for people living and working within the same area, indicating a shorter commuting distance, were 79% in urban core Victoria, 32% in the Peninsula and 49% in the West Shore. Between 2001-2006 average home to work distance has decreased slightly, from 8.7km to 8.4km. In 2006, of the approximate 152,000 dwelling units in Victoria CMA, 85% were within 400m of a transit stop (note this is a measure of proximity rather than quality of service). Further initiatives could be developed, including improved streetscapes/shared space designs, and also financial incentives to encourage development in certain locations. For example, in an ‘efficient’ market, developers may pay less to build in easier-to-access locations, e.g. school-bus services, utility fees, etc. Areas with poorer transit accessibility would be more costly (Litman, 2008).

PP5: Urban Planning		GHG Emissions Reduction (KtCO2e)	GHG Emissions Reduction (%) of 2020 BAU
Current	Some efforts to improve densities and develop around the public transit network		
Low	‘Low level’ of further intensity of application – thickening of densities along key public transport corridors	8	0.8%
Medium	‘Medium level’ of further intensity of application – polycentric concentration efforts in suburbs	19	2.1%
High	‘High level’ of further intensity – urban structure index used to integrate urban and transport planning effectively in centres and suburbs (density, location of development, accessibility planning, mixed use, etc.)	38	4.1%

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

### 3.7 PP6: Mobility Management/Traffic Demand Management

A range of traffic demand management interventions can be used to ‘manage mobility’ and support the growth of sustainable transport behaviours. Litman (2008), for example, draws together a number of policy levers within his TDM encyclopaedia. In their widest sense, these can include improved transport options, alternative modes, parking and land use management, policy and institutional reform. For the purpose of defining the interventions in this policy package, we use a slightly narrower definition for mobility management (other areas are covered in wider PPs). This uses the UK definition of ‘smarter choice’ behavioural measures, including travel plans (workplace, school, residential), personalised travel plans, car clubs and car sharing schemes, home shopping and marketing and information campaigns (Cairns et al, 2004).

The ecoMOBILITY initiative is investing \$10m over four years to work with municipalities across Canada to help develop programs and services to increase the use of public transit, car pooling and other sustainable transport options.

A Regional TDM strategy is being developed with the creation of a toolkit for member municipalities. There are currently few financial or other incentives available, such as preferred parking, cash dividends etc.

PP6: Mobility Management/TDM		GHG Emissions Reduction (KtCO <sub>2e</sub> )	GHG Emissions Reduction (%) of 2020 BAU
Current	Some efforts made to develop mobility management strategies		
Low	Low level of further investment – increased passive encouragement of sustainable travel choices	8	0.8%
Medium	Medium level of further investment – more active involvement with greater incentives, personalised travel planning ‘scaled up’	23	2.5%
High	High level of further investment – high intensity application and investment in mobility management	38	4.1%

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

### 3.8 PP7: Ecological Driving and Slower Speeds

Much of the conventional thinking in transport is designed to speed traffic up, as congestion and delay are seen as ‘wasted’ time, resulting in time that could be productively used on other activities. Lower speeds, however, sometimes have positive impacts in certain circumstances. Potter et al (2001) advise that drivers of vehicles could typically save between 5-10% on their fuel economy by adopting more fuel efficient driving styles.

The UK Department for Transport encourage fuel efficient driving styles ([www.dft.gov.uk/ActOnCO2](http://www.dft.gov.uk/ActOnCO2)). Innovative driving programmes in the Netherlands and Germany also promote driving styles that fit better with emissions reduction, whilst not impacting on final driving times. The driving techniques include:

- Driving at moderate speeds
- Avoiding excessive acceleration and harsh breaking
- Observing speed limits
- Starting the engine without using the accelerator
- Changing gears at low revolutions
- Keeping tyres inflated to correct pressures
- Avoiding unnecessary idling time
- Avoiding carrying heavy loads if not necessary

Limited efforts appear to be being pursued in the Canadian context concerning these types of interventions. Natural Resources Canada and Transport Canada (2009) encourage fuel efficient driving styles in their fuel consumption guide. Vehicle anti-idling regulations are gradually being introduced – in the public sector fleet in B.C. in 2009, and potentially to the wider community by

2012. The No. 03-12 bylaw of the City of Victoria prohibits:

- The operation of any automobile, truck, motorcycle, bus or other motorized vehicle which by reason of disrepair, the use of a muffler that fails to cool and expel exhaust gases from the engine without excessive noise, mode of operation of the vehicle (squealing of tires except during emergency braking to avoid accidents, over-revving of engine or excessive acceleration of vehicle) or any other cause, create noise or sound which disturbs or tends to disturb the quiet, peace, rest, enjoyment, comfort or convenience of individuals or the public.
- The idling or other continuous running of the engine of a truck or bus for more than three minutes at the same location, except where the truck or bus is located within a garage or depot intended to be used for the long term parking of that vehicle.

PP7: Ecological Driving/Slower Speeds		GHG Emissions Reduction (KtCO2e)	GHG Emissions Reduction (% of 2020 BAU)
Current	Limited current programmes		
Low	Low level of further application – increased awareness and idling programmes	19	2.0%
Medium	Medium level of further application – ecological driving campaign and slower speeds in residential areas	47	5.0%
High	High level of further application – intensive ecological driving take up with enforcement mechanisms, potentially technology-based	93	10.0%

\*Modelling based largely on vehicle efficiency changes. Different levels of policy package application illustrative, and not exhaustive.

### 3.9 Wider Potential Interventions

This pilot report has developed only a limited literature review of interventions that may reduce CO<sub>2</sub> emissions in the transport sector. A much more thorough review is suggested in order to detail the evidence building in this field. A whole host of additional potential measures are available – our VIBAT London work, for example, reviewed over 150 policy interventions available to reduce transport CO<sub>2</sub> emissions. This Victoria study has also ignored the freight and international (air and shipping) sectors. Again more detailed work can examine issues within these sectors.

## 4 Exploratory Modelling Outputs

### 4.1 Exploratory Modelling Approach

A transport carbon emission simulation model has been developed to test the likely impact of the various policy packages available. This is based on the CRD administrative area, including the 13 municipalities and unincorporated areas detailed within Figure 2.

The road transport based transport-carbon simulator spreadsheet has utilised the Canadian version of the US Environmental Protection Agency (EPA) MOBIL Emission Model (version 6.2C). The US EPA model produces estimates of atmospheric emission factors arising from motor vehicles within a region and utilises as key inputs estimates of the total VKT annually within the region.

Input road traffic and transit data for the CRD administrative area has been derived from a series of EMME/2 road based transportation simulation models for 2003 and 2026, PM peak hour.

The transport base year and forecast year model runs have been converted into geographical information system (GIS) compatible data formats and road based travel by CRD municipality. This helps to support the validation of the transport-carbon simulator tool's estimates of GHG emissions for a number of key CRD sub-regions such as the Greater Victoria area.

The 2003 EMME/2 model of the CRD administrative region has been used as a 2005 model input to the transport-carbon simulator spreadsheet tool and to ascertain the extent to which the tool outputs, transport GHG emission estimates, match the 2004 and 2012

estimates published in the 2004 'Greenhouse Gas and Energy Use Inventory for the Capital Region'. The latter estimates form the basis for the CRD baseline and projections presented in Figure 6. This baseline/projection underpins the transport-carbon policy/scheme simulation exercise undertaken as part of this scoping study.

The factored<sup>4</sup> 2026 EMME/2 model forecasts for the CRD region were utilised in conjunction within the transport-carbon GHG simulation tool to provide estimates of GHG emissions for the following forms of road based travel:

- Light Duty Gasoline Vehicles (LDGV)

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Some adjustments were made to the Halcrow modelled vehicle distance to replicate earlier factored data and account for under reporting of links. The 2004 CRD GHG inventory was factored, by 20%, to account for the US EPA MOBILE derived fuel consumption rates underestimating the actual recorded fuel consumption figures. The recorded figures are based on fuel purchase tax receipts (previously provided by the British Columbia Government during the development of the 2004 CRD GHG inventory). The CRD data also is based on non-availability of road traffic and transit model simulation results for Saltspring Island and the Southern Gulf Islands.

Accordingly the Halcrow transport-carbon simulator results for 2005 are factored by 32% to correspond with the published 2004 CRD GHG inventory, and the 2020 model is factored by 19% to correspond with 2020 values derived from the CRD GHG inventory 2012 forecast.

- Light Duty Gasoline Trucks1 (LDGT1)
- Light Duty Gasoline Trucks2 (LDGT2)
- Gasoline Buses (GB)
- Diesel Buses (DB)
- Electric Trolley Buses (ETB)

The transport-carbon simulation tool provides estimates of GHG reduction potential for the following seven policy packages previously detailed within section 3:

- PP1: Low Emission Vehicles and Alternative Fuels
- PP2: Pricing Mechanisms
- PP3: Transit
- PP4: Walking & Cycling
- PP5: Urban Planning
- PP6: Mobility Management
- PP7: Ecological Driving and Slower Speeds

These policy packages are modelled at four levels of intensity of implementation:

- BAU
- Low
- Medium
- High

The simulation process draws upon the findings of the policy and literature review summarised within section 3 and models the reduction in GHG emissions arising from various policy and scheme interventions which deliver reductions in GHG emissions through a combination of changes in:

- Vehicle efficiency
- Reduction in trips

- Modal shift
- Reduction in trip length

The simulation process produces estimates of GHG emissions in units of CO<sub>2</sub>e, taking into account the collective weighted influence of carbon dioxide, methane and nitrous oxide greenhouse gases.

#### 4.2 Exploratory Modelling Results

An exploratory modelling run is provided to show a combined application of the policy packages, at varying levels of intensity - low, medium and high - to 2020 (Table 5).

A further strategic scenario is also modelled assuming that the seven policy packages have been implemented at a 'medium' level of intensity. The segment chart (Figure 8) reveals that, for the CRD administrative area, the seven policy packages collectively deliver a 27.9% reduction in GHG emissions within the CRD administrative area by 2020 (percentage computed relative to the 2020 BAU projection of 934 ktCO<sub>2</sub> eq).

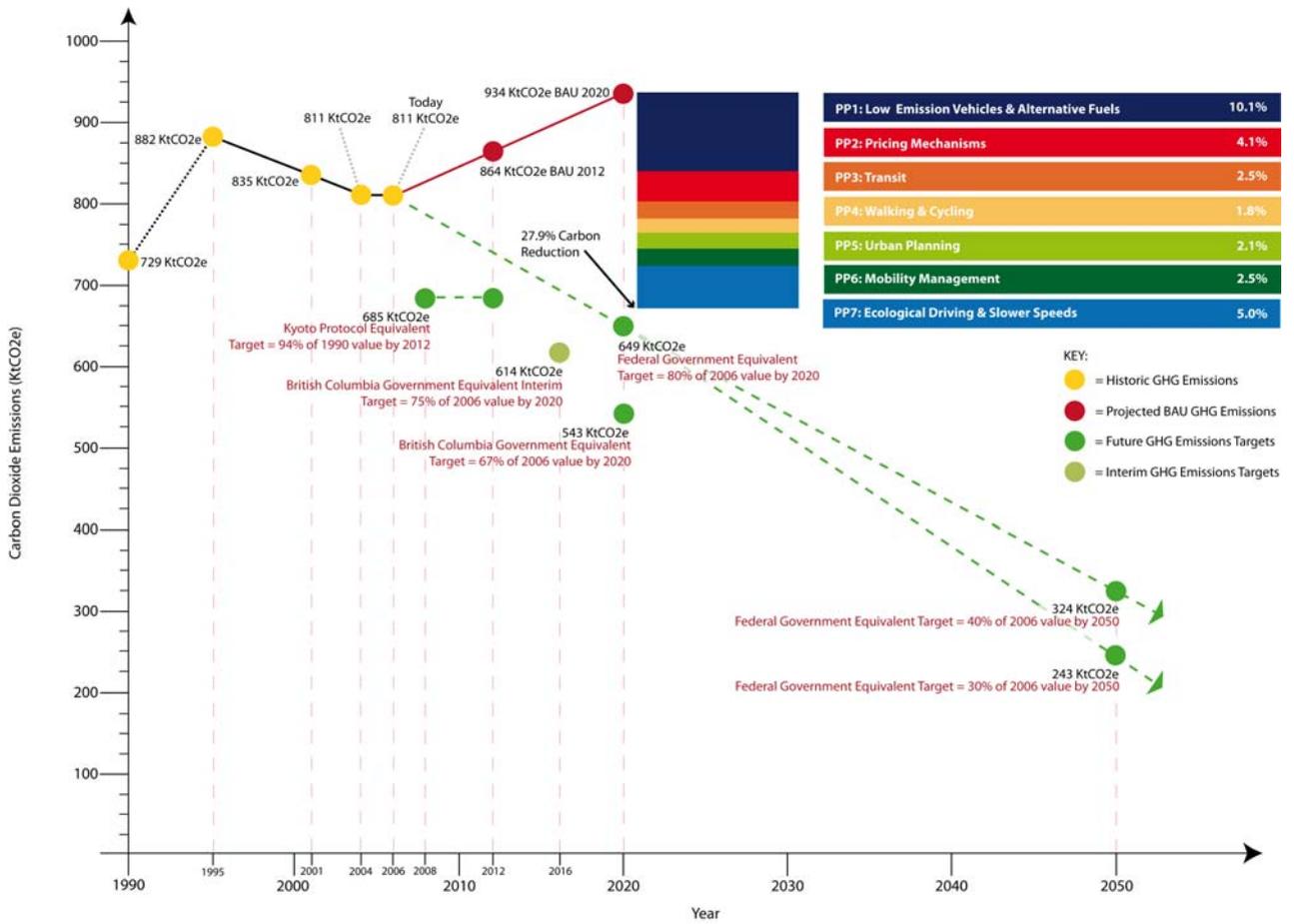
This package of policy measures delivers approximately 91.5% of the Federal Government equivalent target of a 20% reduction in GHG emissions by 2020. The package of policy interventions can also be shown to deliver approximately 66.7% of the British Columbia Government equivalent target of a 33% reduction in GHG emissions by 2020 (Figure 8).

**Table 5: Exploratory Results by Level of Application of Package (CRD Surface Transport)**

Policy Package Description		Implementation Level	GHG Emissions Reduction (KtCO <sub>2</sub> e)	GHG Emissions Reduction (%) of 2020 BAU
PP1	Low Emission Vehicles and Alternative Fuels	Low	28	3.0%
		Medium	94	10.1%
		High	160	17.1%
PP2	Pricing Mechanisms	Low	17	1.9%
		Medium	38	4.1%
		High	76	8.1%
PP3	Transit	Low	11	1.2%
		Medium	23	2.5%
		High	46	4.9%
PP4	Walking and Cycling	Low	6	0.6%
		Medium	17	1.8%
		High	34	3.6%
PP5	Urban Planning	Low	8	0.8%
		Medium	19	2.1%
		High	38	4.1%
PP6	Mobility Management	Low	8	0.8%
		Medium	23	2.5%
		High	38	4.1%
PP7	Ecological Driving and Slower Speeds	Low	19	2.0%
		Medium	47	5.0%
		High	93	10.0%

Using data from the Victoria CRD transport and carbon simulation model, Halcrow Inc. 2009.

Figure 8: Exploratory Results by Level of Application of Package (CRD Surface Transport)



## 5 Conclusions and Potential Next Steps

### 5.1 Initial Findings

This has been an initial, exploratory pilot study for the Victoria CRD, building on the methodology developed by the study team in other international studies. It has drawn upon previous work in the CRD and B.C., a limited further literature review of potential interventions, and a number of discussions with individuals at the CRD and B.C. authorities.

It has demonstrated the utility of the scenario testing and backcasting approach to the Canadian context – where different levels of application of policy interventions, and packages of interventions, can be assessed against strategic targets.

A more detailed study would, of course, be extremely useful in the development of an evidence base for strategic and local policy-making, and in developing the ‘strategic conversation’ required on this issue.

### 5.2 Specification for Potential Further Work

The scoping study has revealed that the quality of the datasets, policy and scheme interventions available within Canada, at a Federal, Provincial, City and municipality level, are sufficiently detailed and robust to develop analysis of this type. A series of more detailed studies and transport-carbon policy and scheme simulation studies can usefully be introduced. These could be developed for a number of case studies – at the city/regional and even national level – demonstrating the range of policy responses available and the potential differential solutions by context. Assessment could move beyond CO<sub>2</sub>

reduction impacts, to also include economic, social, cost and implementability issues. This wider impact analysis is being carried out by the study authors in the current VIBAT-Oxford study (Oxfordshire County Council, 2009-2010) and allows assessment of intervention impacts against different, and often competing, objectives.

A simulation capability is also extremely useful in developing the ‘strategic conversation’ required concerning policy priorities, and ultimately could help widen participation in the decision-making process to the public.

In order to develop a detailed transport-carbon policy/scheme simulation model and decision tool at a Federal, Provincial, City and municipality level the following datasets are required:

- Transport-carbon, and greenhouse gas mitigation policy and strategy documents at a Federal, Provincial, City and municipality level;
- Inventory of policy, scheme and other interventions at a Federal, Provincial, City and municipality level;
- Baseline travel,-carbon and GHG emissions, and wider economic/social data at Federal, Provincial, City and municipality level;
- Ideally multi-modal transport modelling for the jurisdictions studied.

A multi-criteria assessment and simulation, against a range of interventions, can then be developed.

It is, for example, considered to be a relatively simple procedure to develop a web-based transport carbon policy simulator (TC-SIM), operating at a Federal, Provincial, City and municipality

level, drawing upon elements of Transport Canada's web-based Urban Transportation Emissions Calculator (UTEC) ([www.apps.tc.gc.ca/Prog/2/UTEC%2DCE%2DTU](http://www.apps.tc.gc.ca/Prog/2/UTEC%2DCE%2DTU)). This, in many respects, operates in a similar conceptual and methodological manner to the transport-carbon simulator developed during this pilot study.

A more detailed Transport-Carbon Simulator Policy simulator (TC-SIM) is proposed, similar to the TC-SIM London model developed in the VIBAT London study ([www.vibat.org](http://www.vibat.org)) (see screenshots in Figures 9 and 10). A copy is also available via the web at:

[www.vibat.org/vibat\\_ldn/tcsim3/tcsim.html](http://www.vibat.org/vibat_ldn/tcsim3/tcsim.html)

**username: tcsim**  
**password: topgear**

TC-SIM is a web-based scenario testing tool, usable in large urban areas at a range of spatial scales, which forecasts the impact on transport related GHG emissions resulting from a broad range of policy and scheme interventions.

TC-SIM provides a flexible and configurable system architecture comprising of a user friendly Adobe Flash® based graphical user interface, with an XML information feed defining parameters, options and labels, together with a CSV data feed detailing the related Transport-Carbon Calculator (TC-CALC) results. The inherent flexibility of the TC-SIM system architecture means that the simulation framework can support data input in many formats and, for example, can be easily integrated with the UTEC.

The development and integration of such tools help to develop and strengthen local capacity in transport-carbon analysis, evaluation and mitigation as well as helping to ensure

consistency across the country in the methodologies and techniques utilised during transport-carbon mitigation, policy and scheme development and implementation. The methodology can also be broadened to consider wider economic, cost-benefit, social and implementability impacts as a multi-criteria assessment tool.

A number of features could also be developed in any further work:

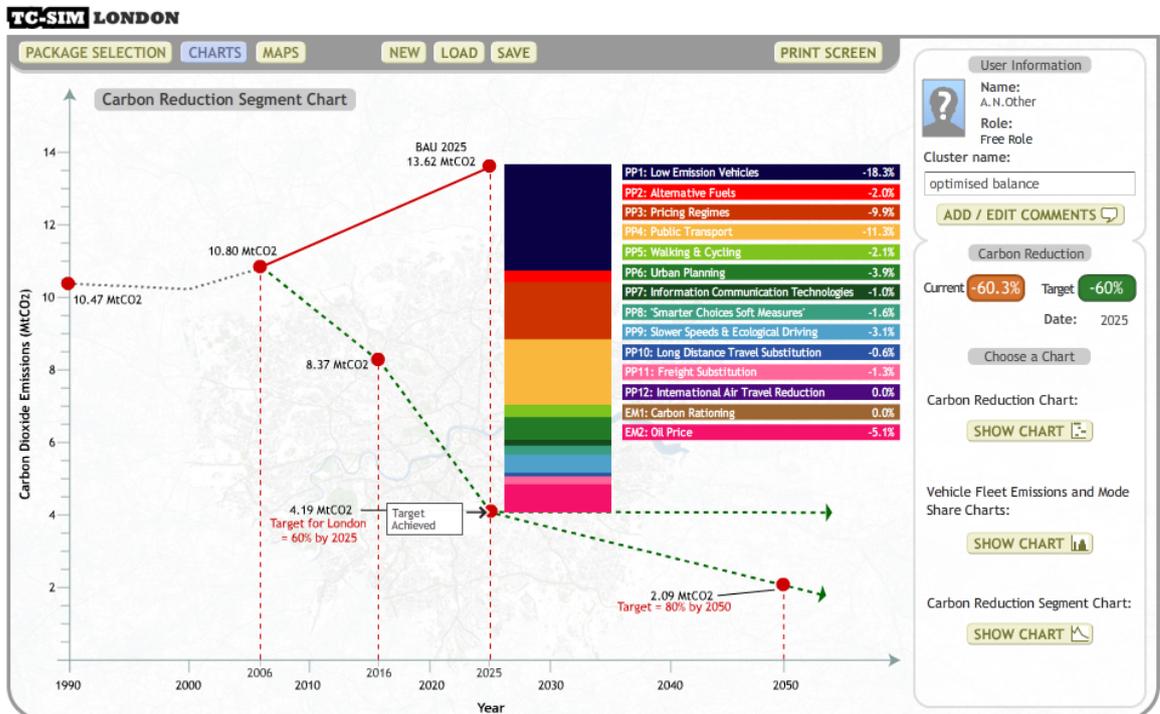
- Modelling of a wider range of interventions, potentially with stated preference analysis underpinning the understanding of context-specific impacts.
- Carbon budget analysis – “the area under the line”. This would replicate work being carried out in the UK for the Climate Change Committee. Carbon budgets appear useful alongside ‘end state’ targets and analysis, ensuring interventions at an earlier timescale.
- Multi-criteria analysis with weighted, wide ranging, sustainability criteria.
- Assessment of potential additionality and synergetic effects; cost-benefit and marginal abatement cost curve analysis;
- More detailed backcasting and pathway mapping – illustrating the potential and likely policy trajectories over time (and backcasting to the present day from future years).

For the CRD administrative area it is recommended that the 2004 GHG inventory be updated and new forecasts developed in light of policy, scheme and technological interventions which have been introduced in the past four years as well as those that are in the pipeline (the team has some concerns as to the accuracy of the 2004 inventory).

Figure 9: Simulation Modelling (Package Selection)



Figure 10: Simulation Modelling (Target Achievement)



### 5.3 Examining the Future Strategic Choices

The severity of the climate change challenge necessitates that the transport sector plays an important role in reducing GHG emissions. Around the world this is proving to be very demanding. There are a range of [theoretical] policy pathways towards substantial improvements in carbon efficiency in the transport sector. All represent significant breaks against current trends and are likely to be very difficult to implement.

Excellent progress is being made in certain cities, such as London and Vancouver. The public, however, needs to radically change their purchasing patterns and behaviour to be more carbon efficient. The means of knowledge dissemination, communication, participation in decision-making and marketing of policy options and futures all need to be considerably enhanced. The backcasting approach offers a way forward to this future policy [and lifestyle] dilemma. Tools such as TC-SIM, applied to different contexts, could play an important role in testing and discussing the different (including innovative and politically difficult) strategic choices with a range of different users.

The huge challenge now is to map out and discuss a variety of policy pathways to carbon efficiency in the transport sector, consistent with wider sustainability objectives. An extensive evidence base is required as to likely policy options and impacts, differential by context. The next step can then be tackled - to enable a consensus for change and *achieve* a level of consumer and behavioural change consistent with strategic aspiration.

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