Transportation Association of Canada

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

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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

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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.

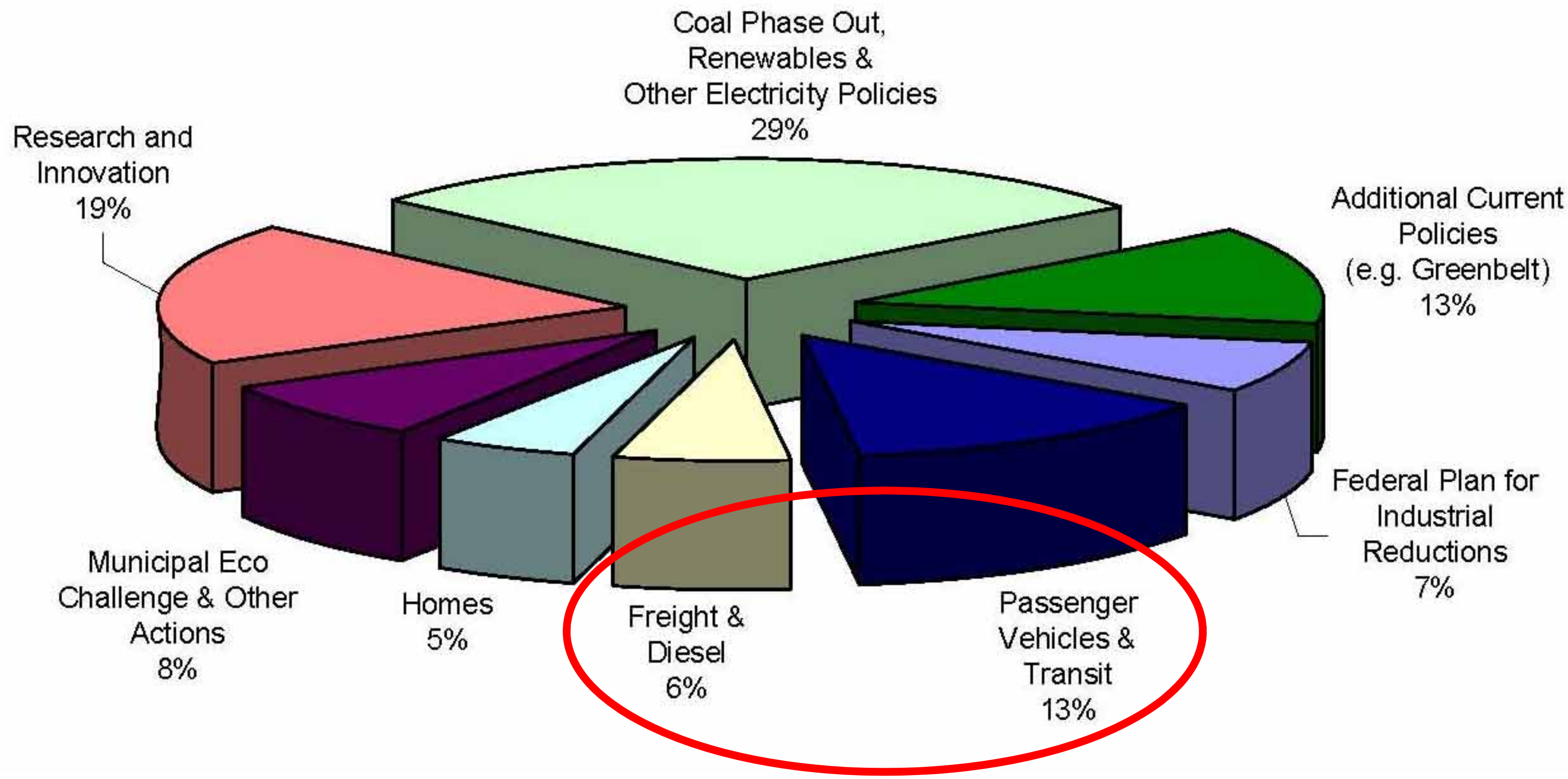
The Response

- 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

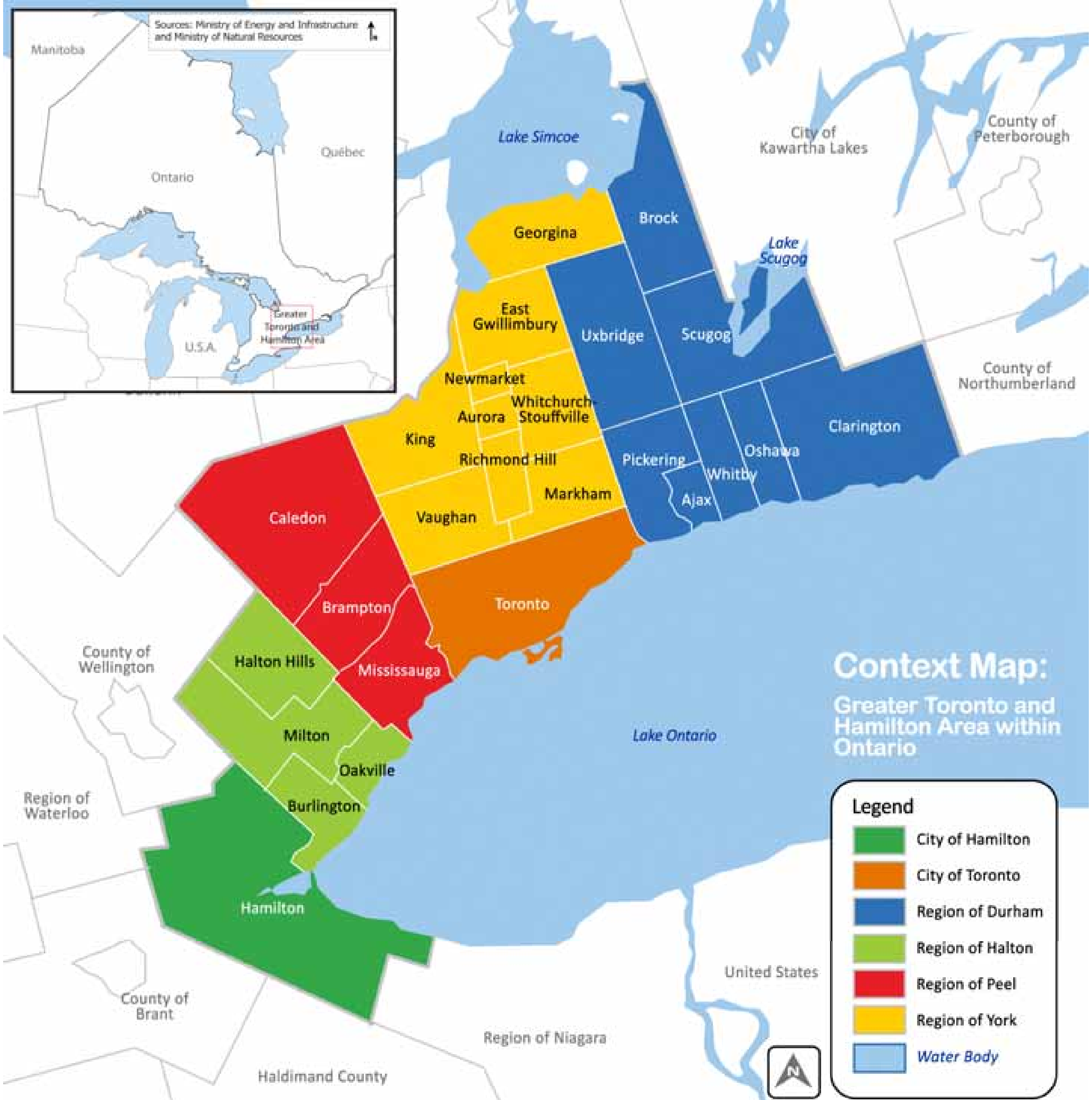
- Ontario's Go Green Action Plan for Climate Change
  - - 6% from 1990 levels by 2014
  - - 20% from 1990 levels by 2020
  - - 80% from 1990 levels by 2050

Figure 8. Where Emissions Reductions Will Have Been Achieved by 2020:
Based on Current and New Policies



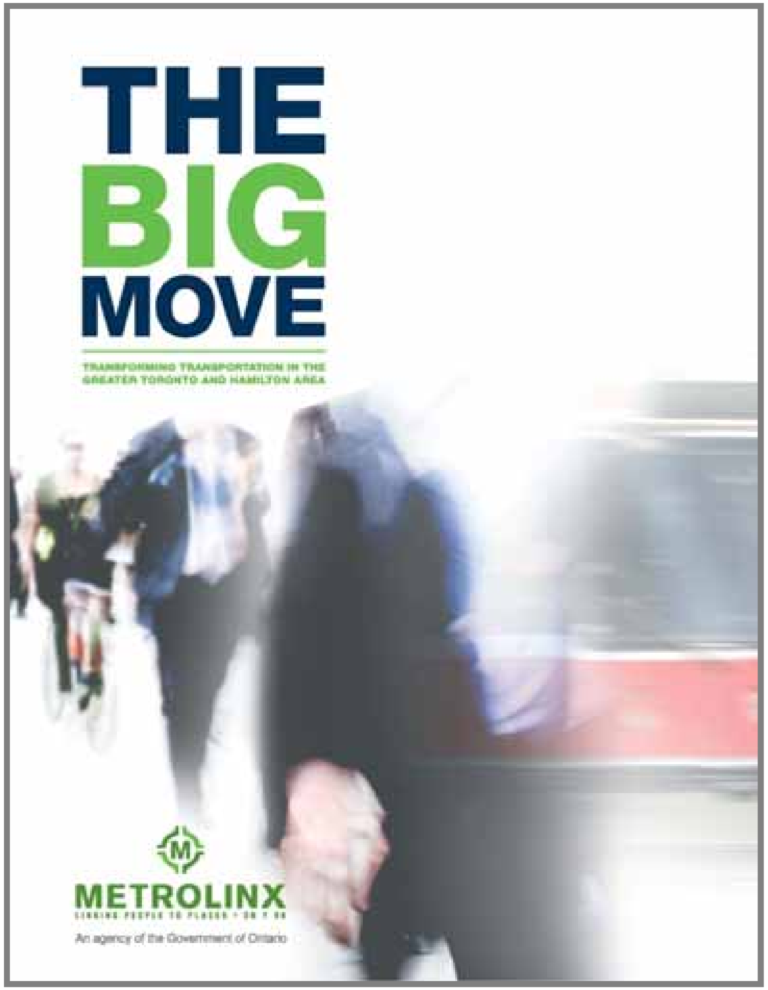
Metrolinx Mission

- 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



Sources: Ministry of Public Infrastructure Renewal; findtheway.ca

A Bold Plan

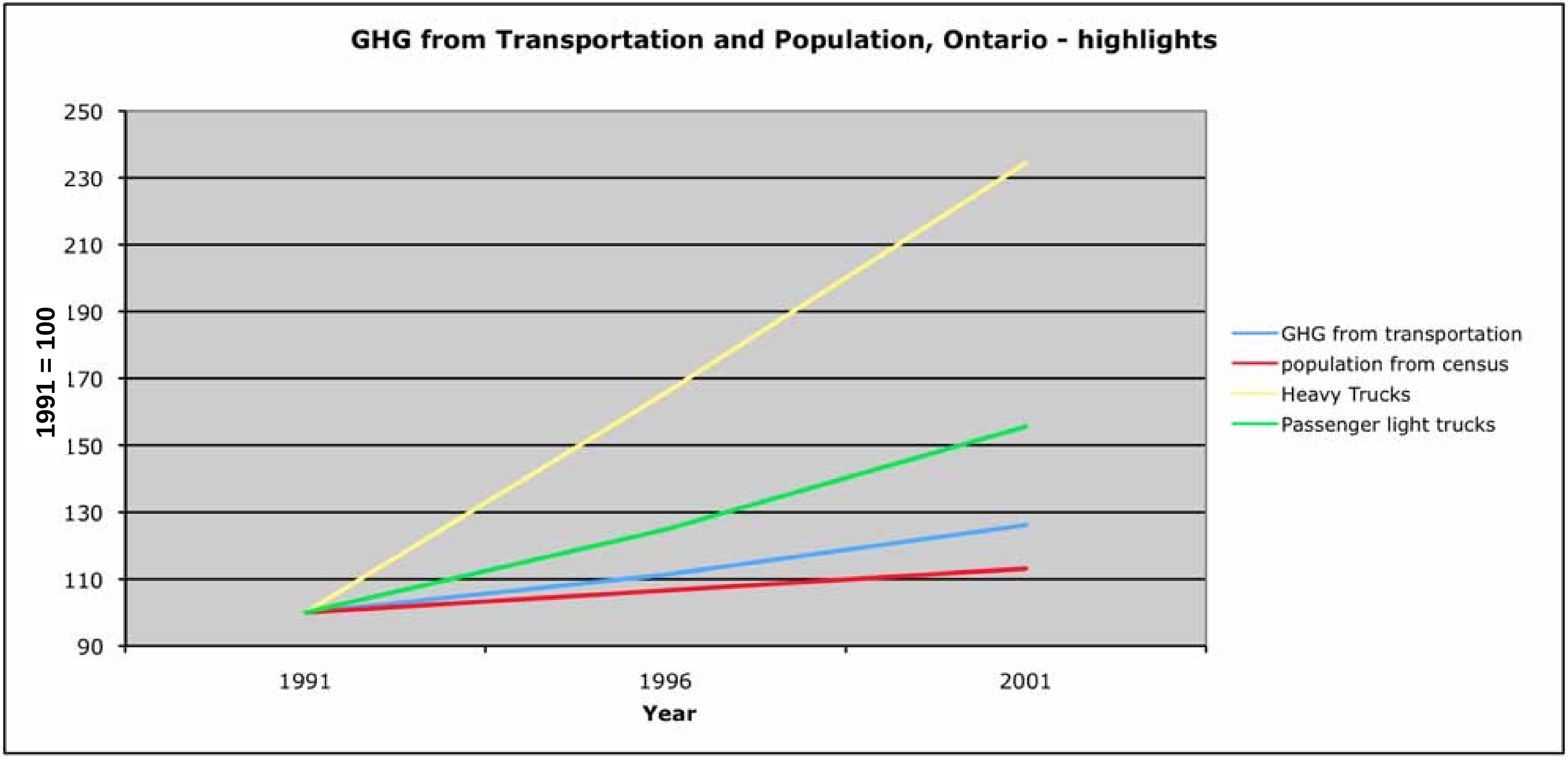

THE
BIG
MOVE
TRANSFORMING TRANSPORTATION IN THE GREATER TORONTO AND HAMILTON AREA
METROLINX
An agency of the Government of Ontario

The Big Move Vision (in numbers)

25 Years from now:

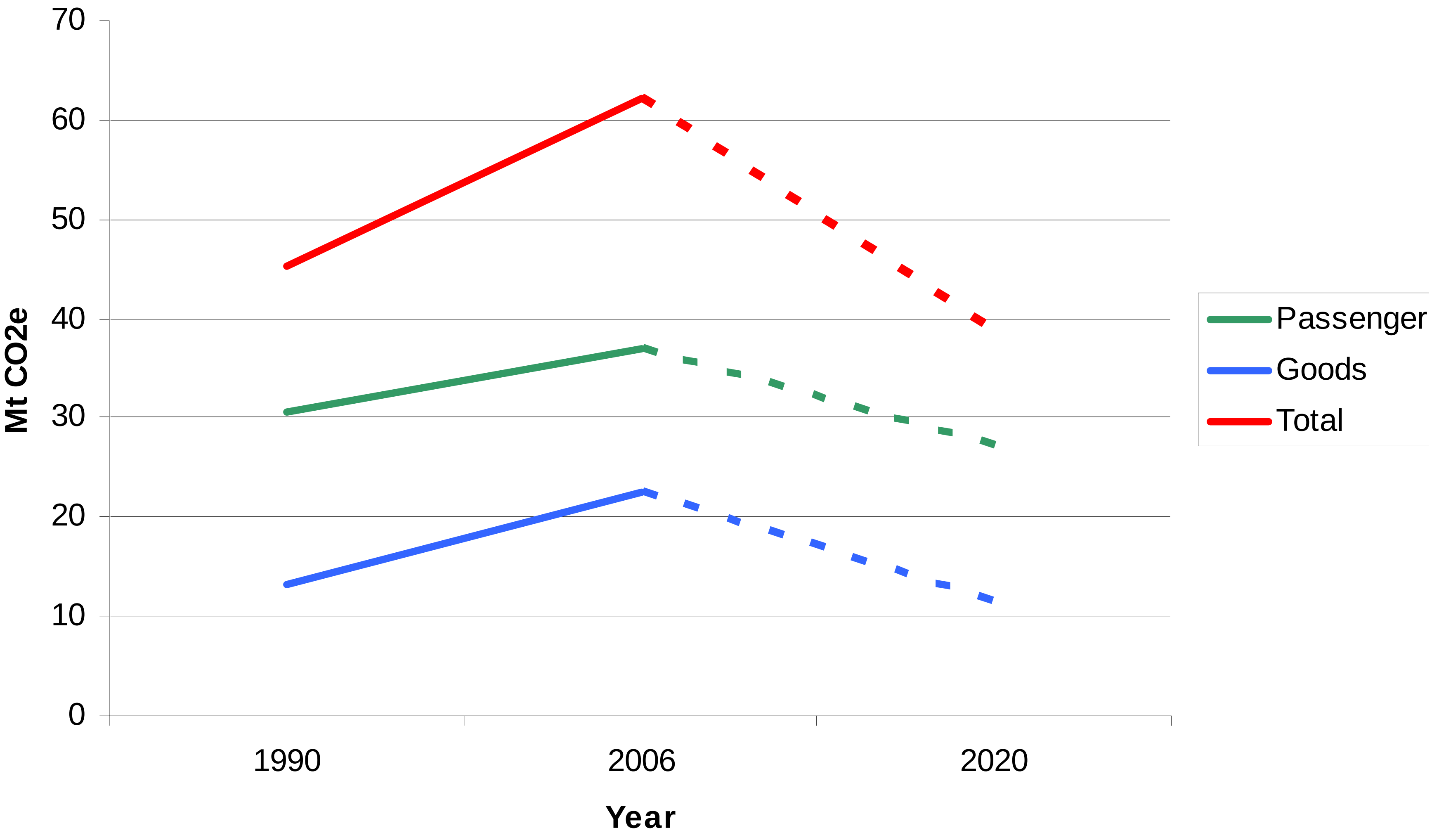
- The distance that people drive every day will drop by **ONE-THIRD**
- We will accommodate **50% MORE PEOPLE** in the region with **LESS CONGESTION** than we have today
- On average, **ONE-THIRD** of trips to work will be taken by transit and **ONE in FIVE** will be taken by walking or cycling.
- **60%** 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



Source: National Inventory Report 1990–2004, Greenhouse Gas Sources and Sinks in Canada

Trends and targets



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?

- Assume 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

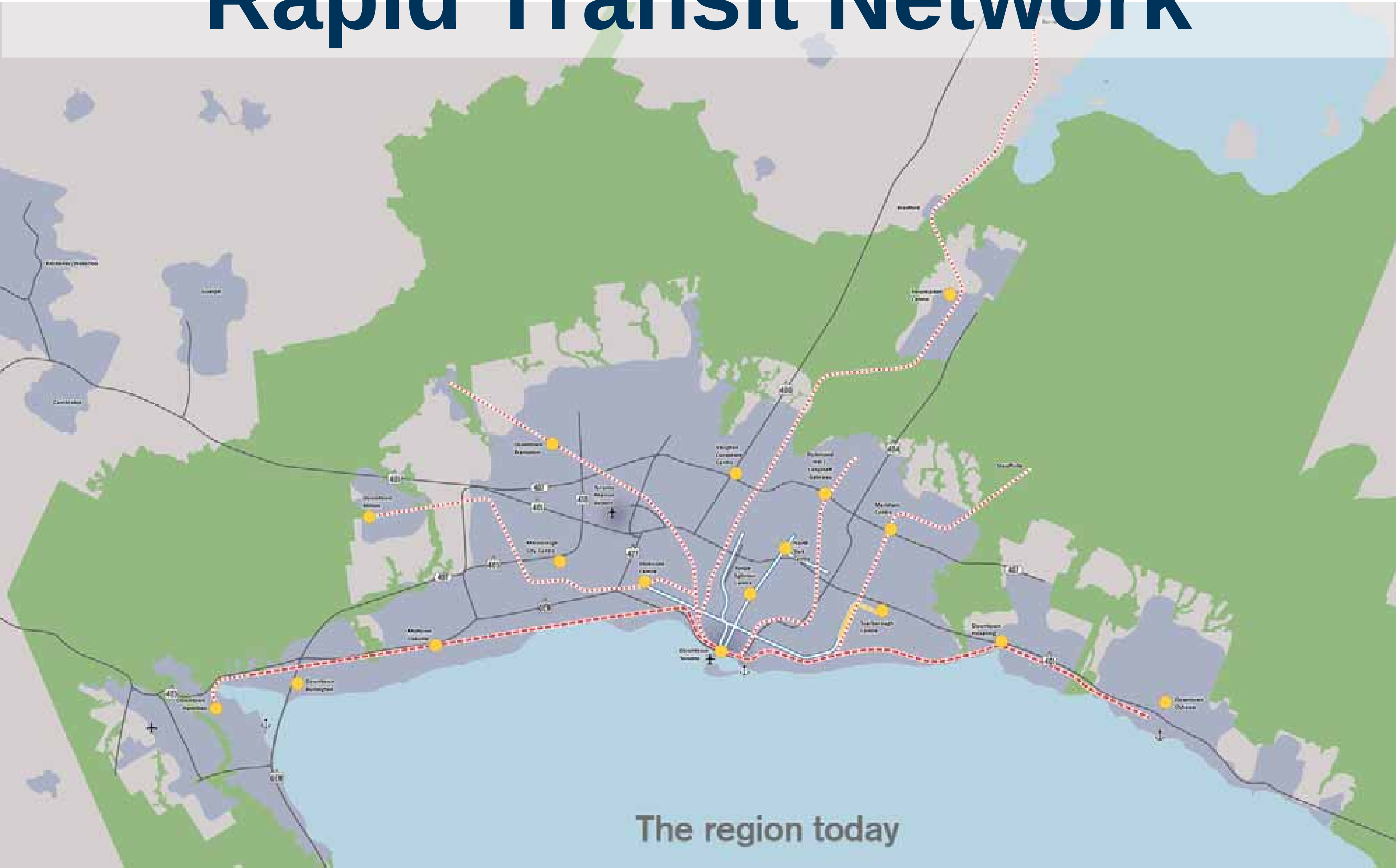
Fuel Carbon Content: Decrease carbon content of fuels

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

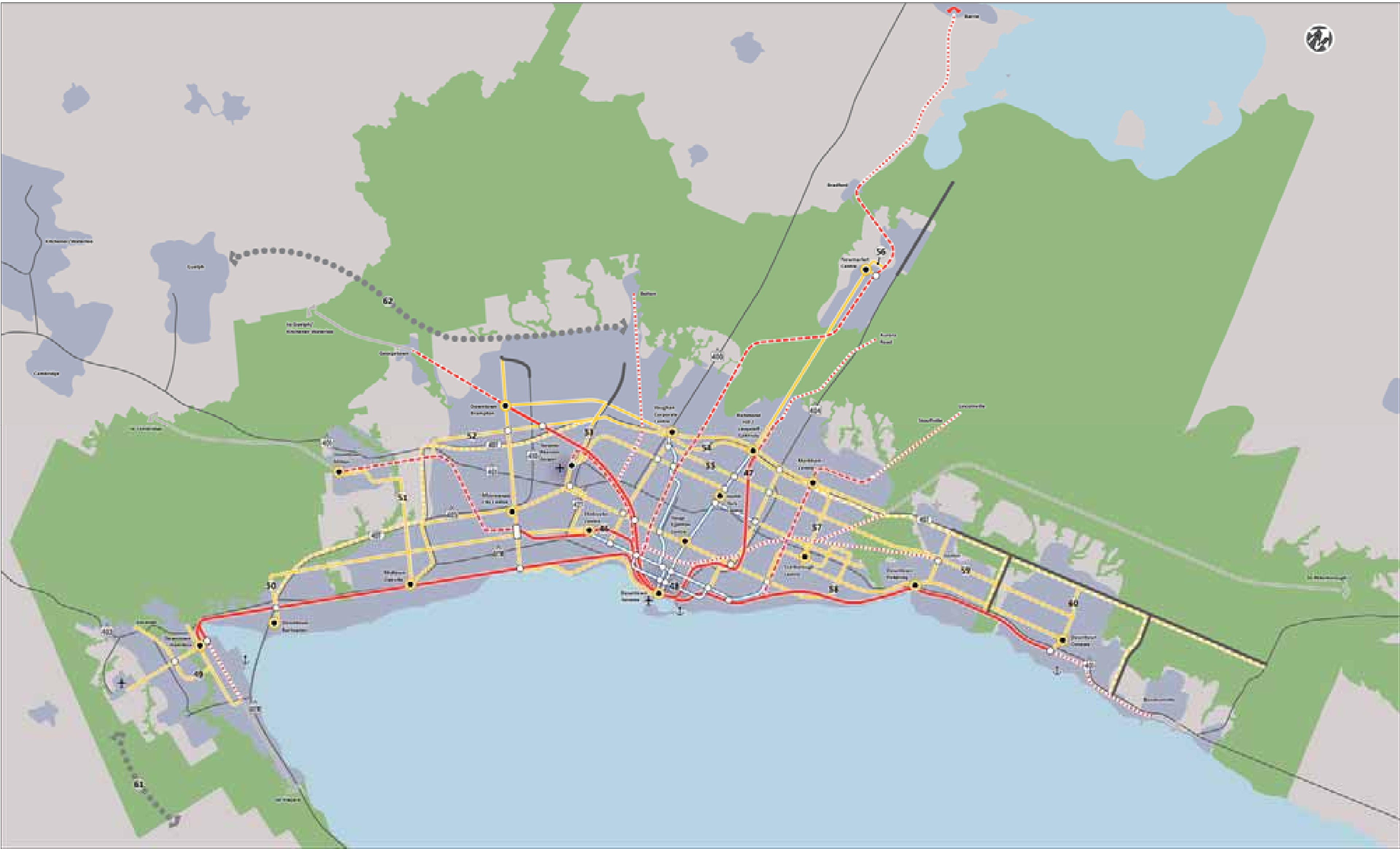
GHG Emissions Forecasting Methodology

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

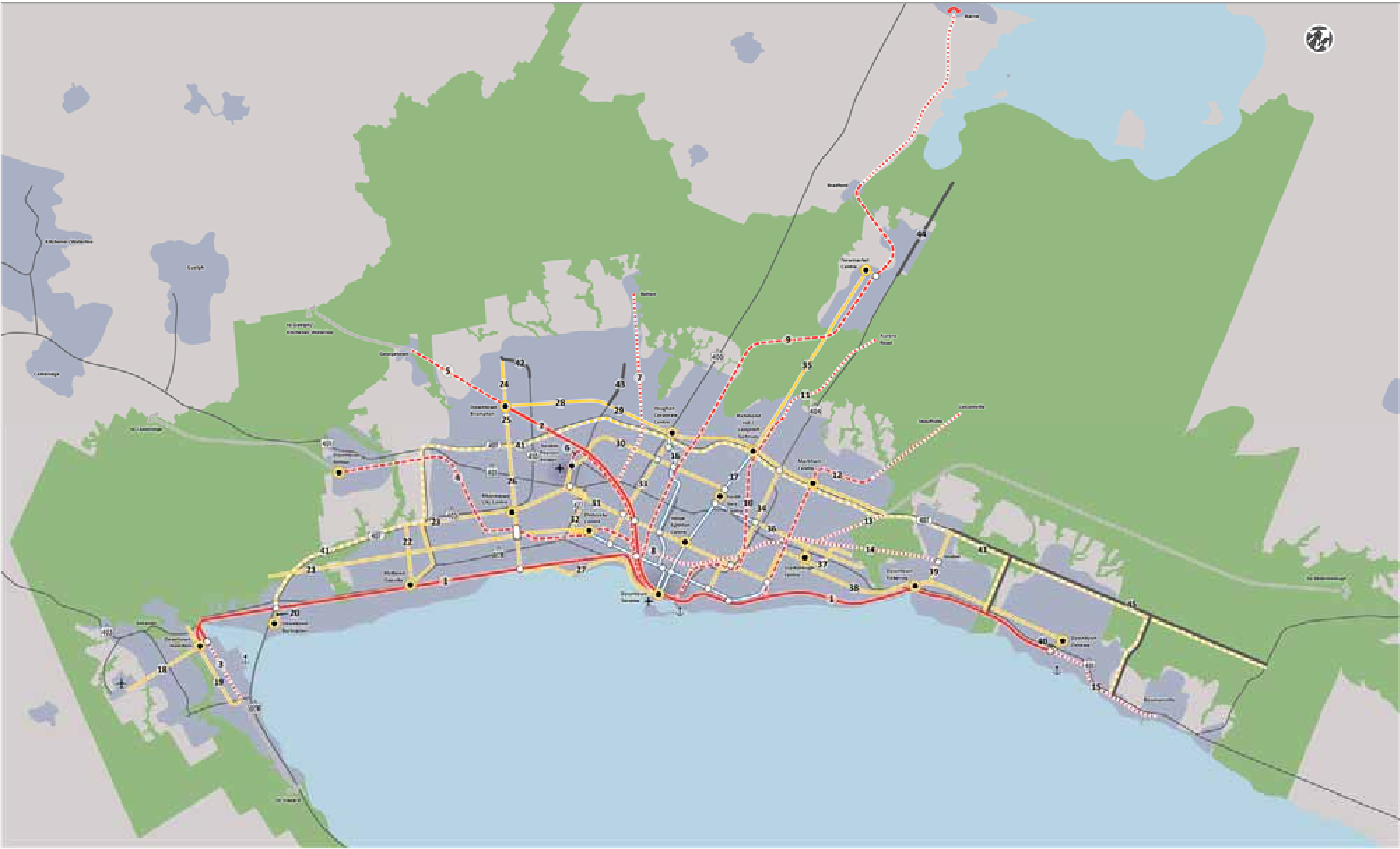
Existing Regional Rapid Transit Network



The Region in 25 Years



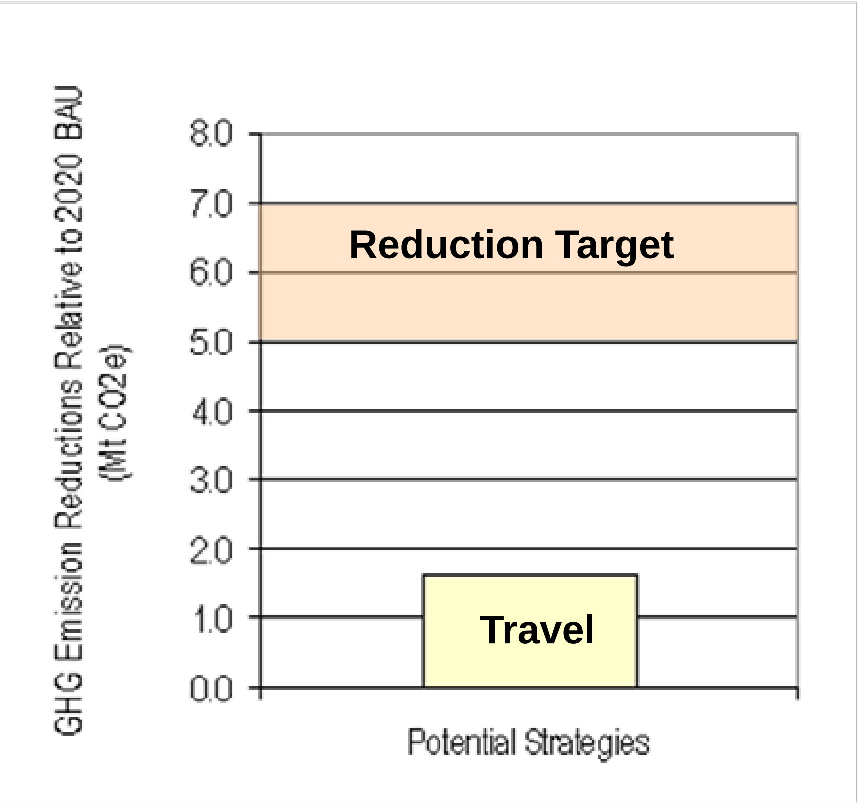
The Region in 15 Years



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



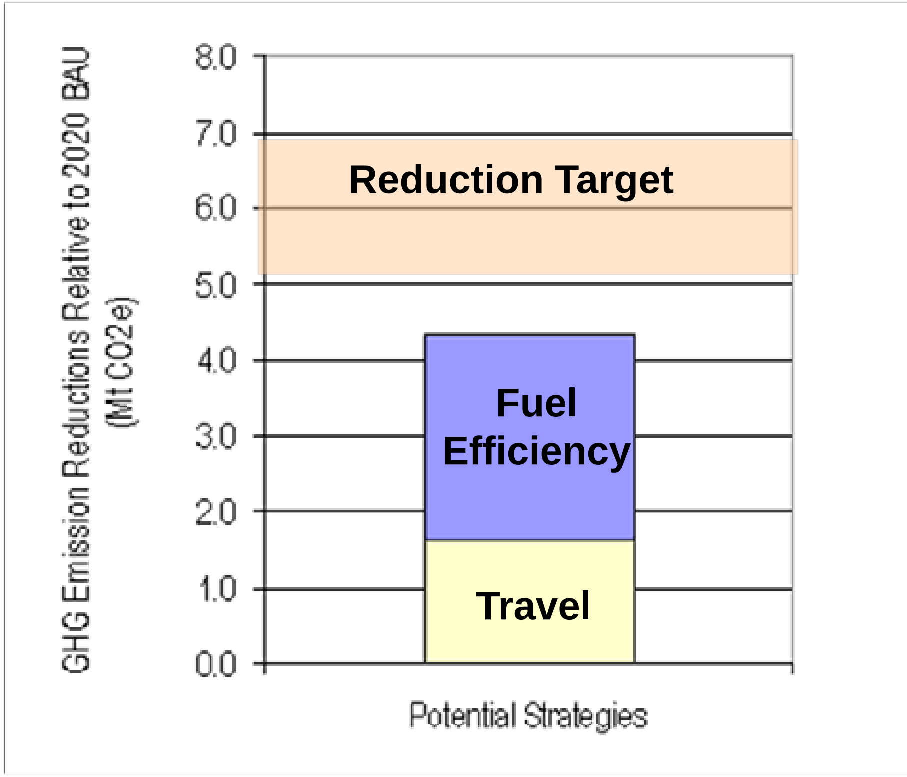
Promoting Modal Shift and Reducing Vehicle Travel Demand

- 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

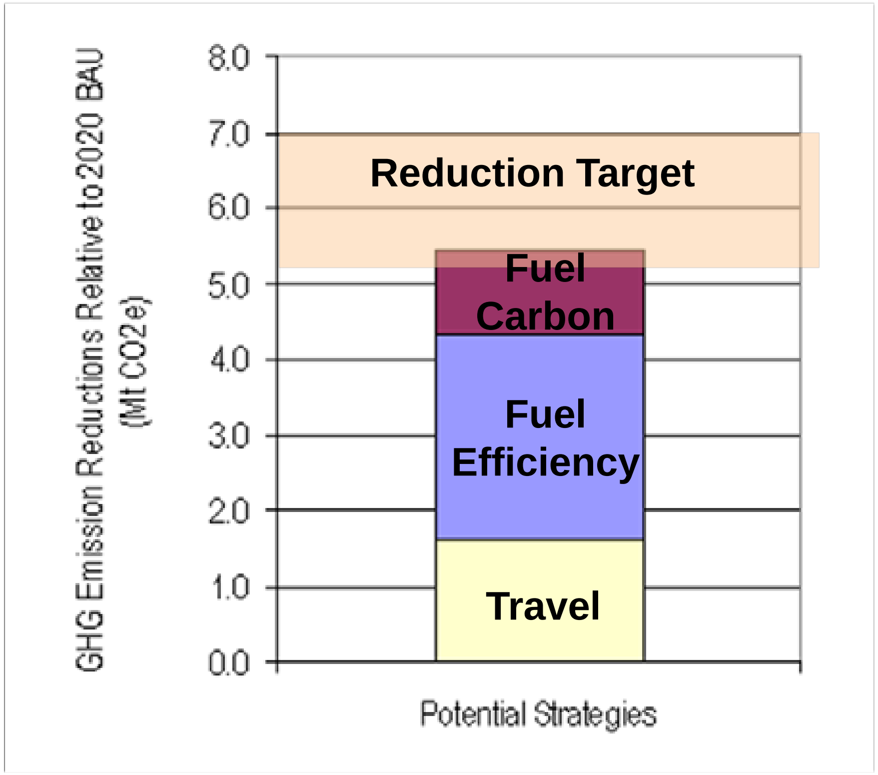
2.7 Mt CO2e reduction



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

METROLINX

LINKING PEOPLE TO PLACES • ON Y VA

An agency of the Government of Ontario

www.metrolinx.com

Joshua Engel-Yan

Joshua.engel-yan@metrolinx.com

Public transit: the key to reducing Greenhouse gases, the Montreal case

Jocelyn Grondines
Société de transport de Montréal

Catherine Laplante
Les Conseillers ADEC Inc.

TAC – March 2010

Partners

Joint effort : MTQ and the STM

- Traffic assignments – MTQ
- Public transit assignments – STM
- Economic measures – ADEC

Objectives

- Assess the impact of an increase in transit services (Network Development Plan - NDP) on the production of Greenhouse gases
  - Increase public transit services by 16% to obtain an 8% increase in ridership (PQTC)
- Evaluate the impact of imposing a fare by distance for cars

Presentation

1. Introduction
2. Approach and methodology
3. Results
4. Recommendations

1. Introduction

- What does the STM do for the environment?
- Why the PQTC green plan?

1.1 Greenhouse gas emissions

- The STM produced 146,661 tones of GES in 2008, 120,865 of which are related to buses and service vehicles
  - 1.1 % of total emission attributable to activity in the Montreal Community (13,7 Mt)
  - 2.2 % of emissions coming from transportation (6,7 Mt)
  - 3.2 % of emission generated by passenger transportation (4,6 Mt)
- Average emission of 49 gCO_2eq / passenger-km for STM
  - Compared to a car which emits approximately 235 $gCO_2éq$/km
  - Bus : 180 gCO_2eq/passager-km
  - Metro : close to nill

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 1-1.5 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 General approach

- Estimate related economic costs for the STM
- Evaluate environmental impact
- Calculate elasticity

2.1.1 NDP/STM 2008-2011

- Metro:
  - Extend Line 5 to Pie-IX/Jean-Talon
  - Increase frequency for lines 1, 2, 4 and 5
  - Globally increase vehicle-km by 30%
- Add commuter train to the East of Montreal
- Bus:
  - Improve 50 lines : 10% more vehicle-km
  - BRT on Pie-IX towards the down-down area
  - Express Viau, Notre-Dame and in the West Island
  - Add 240 km of buss lanes
  - Increase bus services in the West Island and to Trudeau international airport

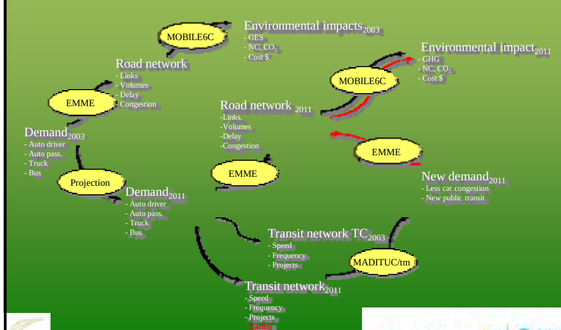
2.1.2 Scenarios

- 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

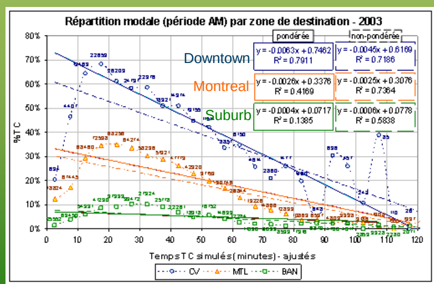
2.2 Methodological elements

- 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
    - Value of time:
      - Travel purpose
      - Personnel income by SDR
- GHG emissions EMME / Mobile 6C

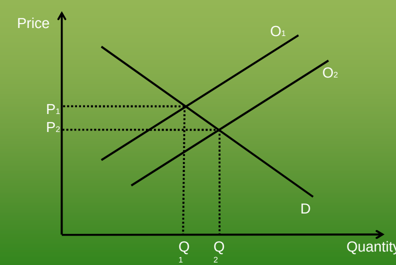
2.2 Analytical diagram



2.4 Factors of influence in modal share



2.4.1 Elasticity



2.4.1 Elasticity

TC/ Fuel Price	USA	Melbourne	Adelaïde	Brisbane
LRT	0,27 à 0,38			-
Train	0,17	0,48	0,09	0,0
Bus	0,04	0,22	0,21	0,26
BRT	-	-	0,28	0
All modes combined	0,12	0,22	0,22	0,14

Source : Currie, 2008

2.4.3 Increase in generalized car travel prices

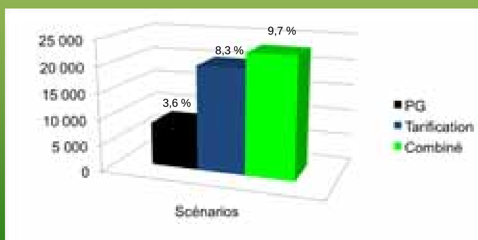
- Calculate the additional cost of car travel following the implementation of fare by distance
  - Based on average fuel consumption of 13.48 L/100Km
  - A 1$/Litre increase equals a 13.48 ¢ per km charge
  - Transformation of additional fuel cost into relative travel time of auto travel

3. Results

- Passenger volumes
- Modal shift
- Emissions
  - Reduction du to modal shift
  - Increases bus services: STM
  - Economic outcome
- Elasticity

3.1 Load profile: new users

3.2 Impact on ridership – 2011



3.3 Environmental impact

	CO (T)	HC (T)	NO_x (T)	SO_2 (T)	PM(T)	CO_2 (T)
Service increase (+)	12,720	2,311	375	n/a	1,114	+ 9,224
Modal shift S1 (-)	503	28	35	0.3	1.3	- 23,793
Modal shift S2 (-)	1,252	69	87	0.8	3.3	- 58,936
Modal shift S3 (-)	1,397	76	97	0.9	3.7	- 65,913

Source : EMME (MTQ)

3.3.1 Reduction in energy consumption

Origine	LOS		Fare by distance		LOS and Fare	
	1,000 L/Yr	('%)	1,000 L/Yr	(%)	1,000 L/Yr	(%)
Downtown	76	0.7%	140	0.5%	189	0.6%
Montreal Center	1,590	15.0%	3,805	14.5%	4,501	15.3%
Montreal East	1,255	11.8%	2,475	9.4%	3,154	10.7%
Montreal West	[illegible]	20.1%	4,016	15.3%	4,779	16.2%
Laval	1,392	13.1%	3,462	13.2%	3,970	13.5%
Northern Ring	1,804	17.0%	4,670	17.7%	4,891	16.6%
Sothern Ring	908	8.5%	2,887	11.0%	2,954	10.0%
South shore	1,464	13.8%	[illegible]	18.5%	[illegible]	17.0%
Total	10,629	100.0%	[illegible]	100.0%	29,452	100.0%

3.3.3 Economic benefits of modal shift

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

Gains	S1	S2	S3
Time and fuel taxes	4.9 $	26.2 $	37.4 $
VOC	16.4 $	40.7 $	45.5$
Fuel	6.5 $	16.2 $	18.1 $
Pollution emissions	2.0 $	5.1 $	5.7 $
Accidents	10.3 $	25.4 $	28.5 $
Total	**40.2 $**	**113.6 $**	**135.1 $**

3.4 Cost related to the increase in bus services

Additional bus services		2008	2009	2010	2011
Additional busses (cumulative)		90	121	185	234
Vehicles-Km (M)	6 h/day*17,8 Km/h *bus	2.40	3.23	4.97	6.25
Driver (M$)	65$/h	8.77	11.80	18.14	22.82
Operations (M$)	0,8593$/km	2.06	2.78	4.27	5.37
Fuel (M$)	0,585$/L	0.93	1.26	1.91	2.41
Total cost	(M$)	11.76	15.82	24.32	30.60
Pollution cost	(M$)	19.62	25.27	33.40	38.20
Total ($)	(M$)	**31.39**	**41.09**	**57.72**	**68.79**

3.5 Economic outcome

- Generalized transportation cost reduction- 2011 (M$ 2006)

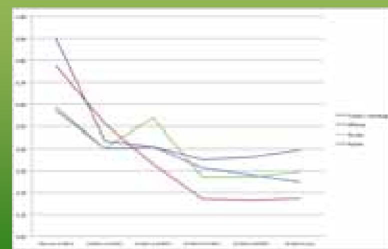
Socio economic gains	S1	S2	S3
Direct benefits – modal shift	+ 40.2 $	+ 113.6 $	+ 135.1 $
Indirect benefits – congestion reduction	+ 108.4 $	+ 261.6 $	+ 299.7 $
Additional cost for STM	- 68.8 $	- 68.8 $	- 68.8 $
Total	**79.8 $**	**306.4 $**	**366.0 $**

3.6 Elasticity

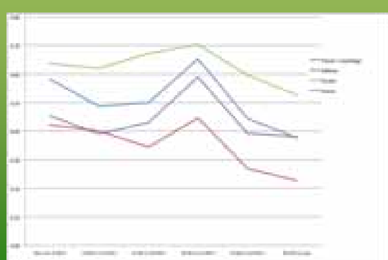
- Elasticity of demand/prix du transport as a result of an increase in services

[illegible]

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 et 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 peek 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,….

Post conclusion: OD-2008

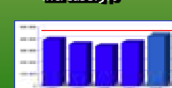
Déplacements AM	Territoire complet	Territoire comparable				
MODES	2008	2008c	2003c	1998c	1993c	1987c
Tous	2 216 000	1 948 000	1 893 000	1 795 000	1 662 000	1 572 000
Motorisés	1 976 000	1 720 000	1 696 000	1 593 000	1 466 000	1 368 000
Auto	1 402 000	1 203 000	1 219 000	1 130 000	997 000	885 000
TC	440 000	427 000	371 000	337 000	356 000	395 000
Autre motorisés	191 000	148 000	146 000	152 000	150 000	132 000
Non motorisés	232 000	214 000	194 000	193 000	190 000	205 000

Déplacements AM	Territoire complet	Territoire comparable				
(Variation)	2008	2008c	2003c	1998c	1993c	1987c
Tous	-	+2,8%	+5,5%	+8,0%	+5,7%	
Motorisés	-	+1,3%	+6,4%	+8,7%	+7,2%	
Auto	-	-1,3%	+7,9%	+14,5%	+14,8%	
TC	-	+15,0%	+10,0%	-5,3%	-9,7%	
Autre motorisés	-	+1,6%	-3,9%	+1,6%	+13,2%	
Non motorisés	-	+10,2%	+0,3%	+1,9%	-7,4%	

Reduction -1%

Car

Increase15%



Public transportation

The team!

- ADEC:
  - Catherine Laplante
  - Gilles Joubert
  - Alain Doyon
- MTQ:
  - Louis Gourvil
  - Martin Noël
  - André Babin
- STM:
  - Jocelyn Grondines
  - Jean-François Cantin
  - Michel Bourbonnière
  - Robert Stafford

ADEC

STM

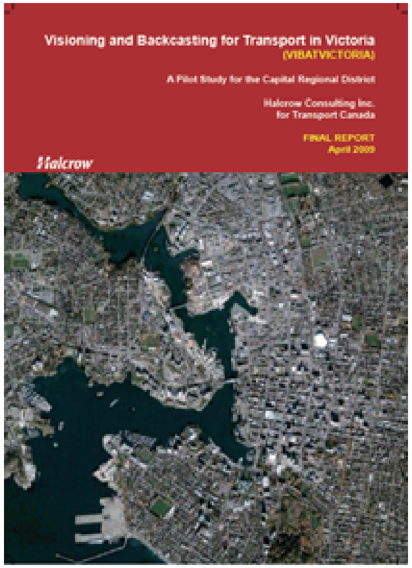
Visioning and Backcasting for Transport (VIBAT-Victoria)

Greenhouse Gas Emission Quantification and Forecasting Workshop

Dr Robin Hickman
Dave Crowley

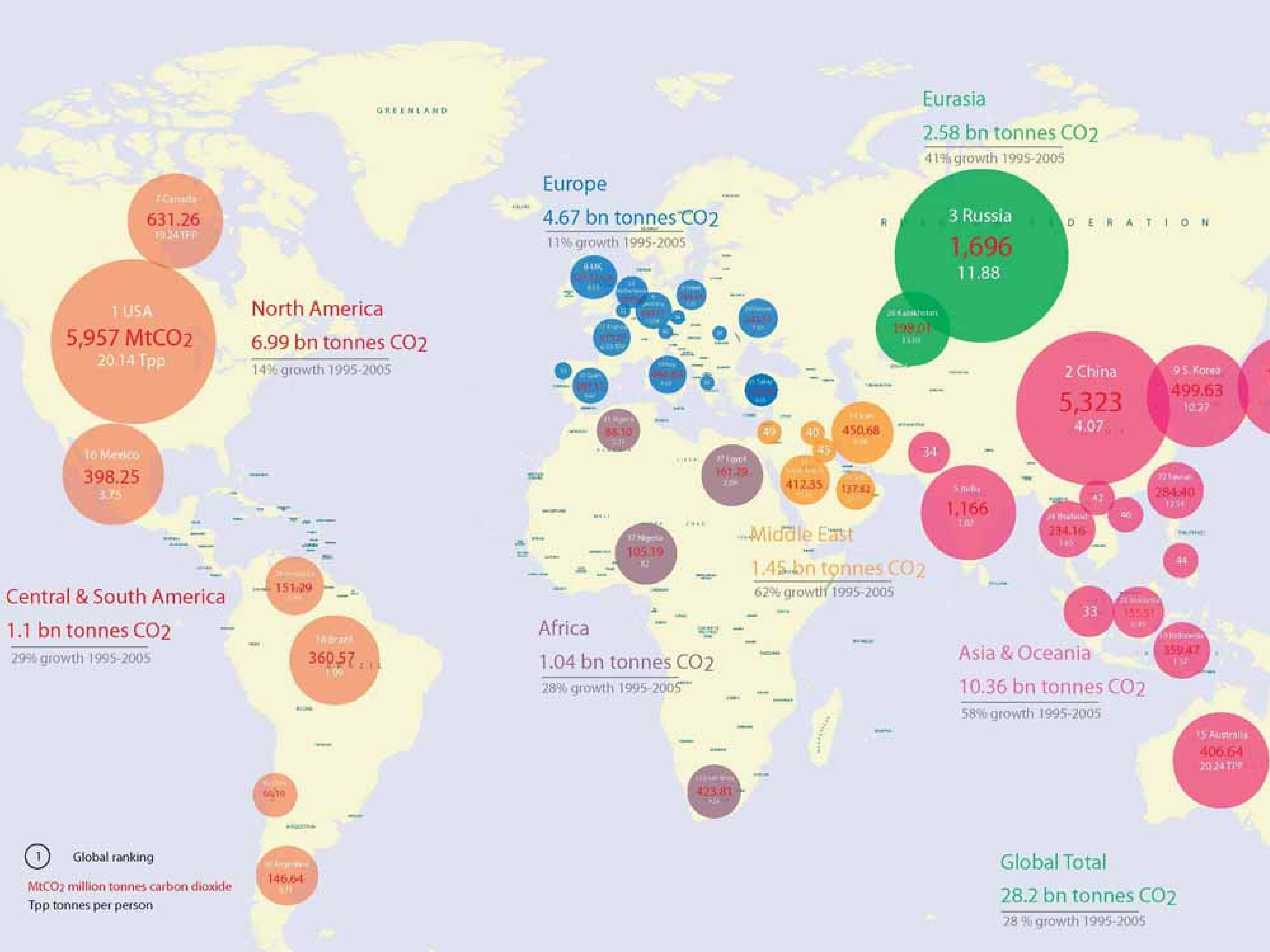
Halcrow
UNIVERSITY OF OXFORD

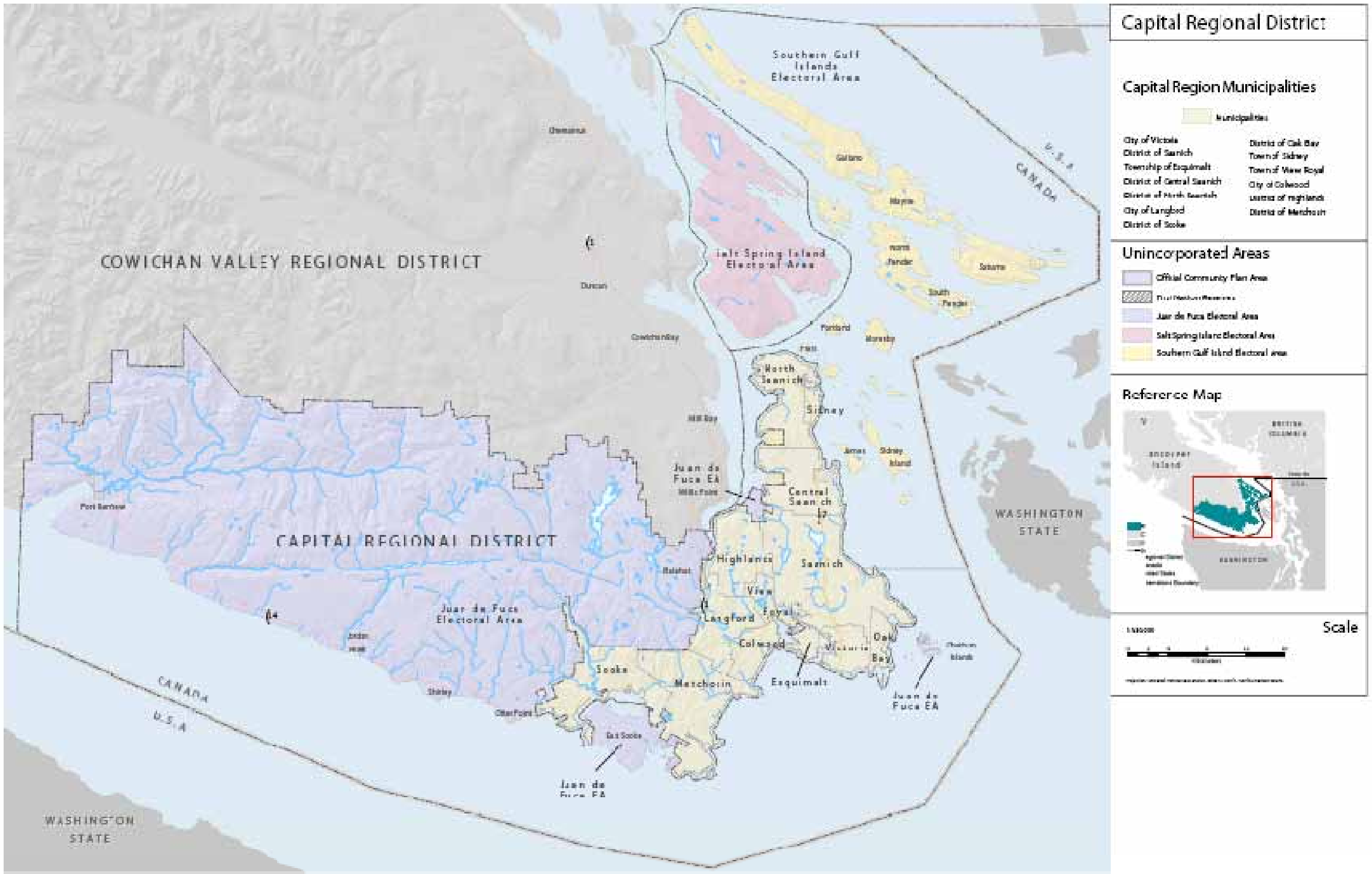
Outline



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

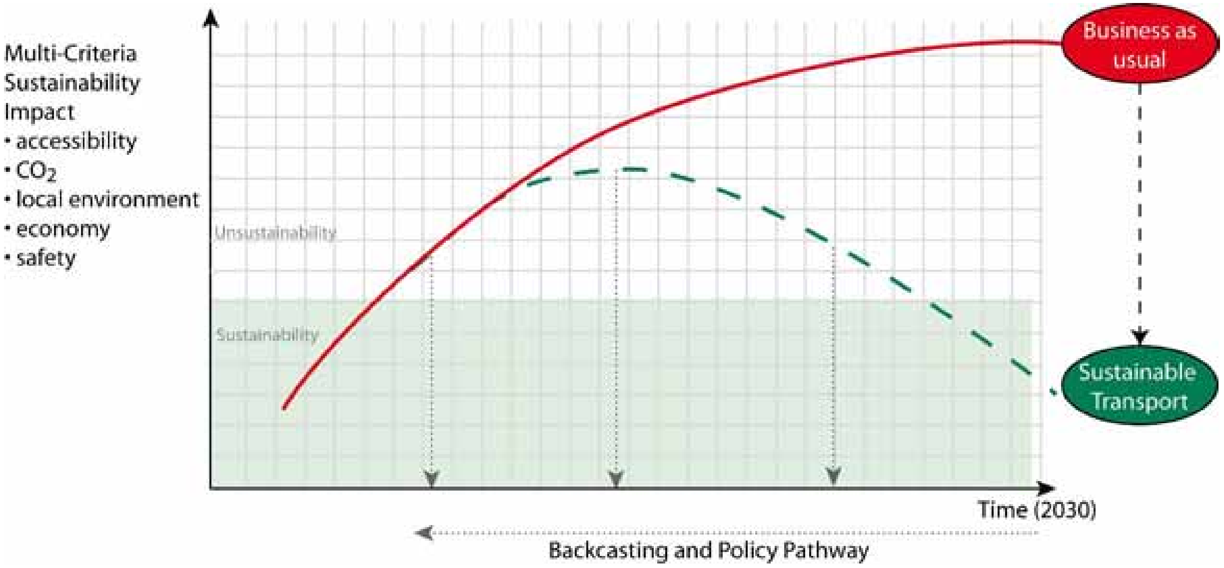
Halcrow UNIVERSITY OF OXFORD


GREENLAND
Eurasia
2.58 bn tonnes CO2
41% growth 1995-2005
Europe
4.67 bn tonnes CO2
11% growth 1995-2005
North America
6.99 bn tonnes CO2
14% growth 1995-2005
7 Canada
631.26
10.24 TPP
1 USA
5,957 MtCO2
20.14 Tpp
16 Mexico
398.25
3.75
3 Russia
1,696
11.88
R
D E R A T I O N
198.07
2 China
5,323
4.07
9 S. Korea
499.63
10.27
450.68
412.35
137.82
49
40
45
34
5 India
1,166
42
46
284.40
234.16
44
33
359.47
Middle East
1.45 bn tonnes CO2
62% growth 1995-2005
88.10
161.39
105.19
423.81
Central & South America
1.1 bn tonnes CO2
29% growth 1995-2005
151.29
360.57
146.64
Africa
1.04 bn tonnes CO2
28% growth 1995-2005
Asia & Oceania
10.36 bn tonnes CO2
58% growth 1995-2005
15 Australia
406.64
20.24 TPP
1
Global ranking
MtCO2 million tonnes carbon dioxide
Tpp tonnes per person
Global Total
28.2 bn tonnes CO2
28 % growth 1995-2005



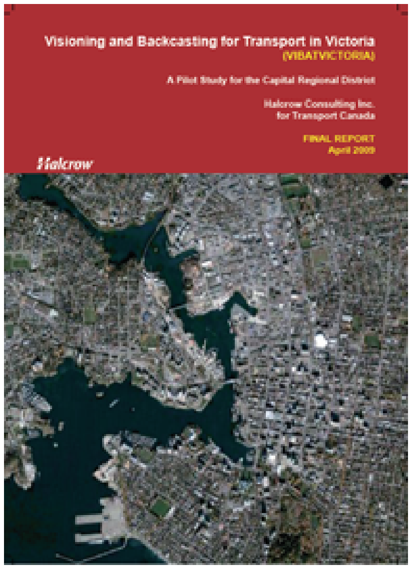
Capital Regional District
Capital Region Municipalities
Municipalities
City of Victoria
District of Saanich
Township of Esquimalt
District of Central Saanich
City of Langford
District of Sooke
District of Oak Bay
Town of Sidney
Town of View Royal
City of Colwood
District of Metchosin
Unincorporated Areas
Official Community Plan Area
Juan de Fuca Electoral Area
Salt Spring Island Electoral Area
Southern Gulf Island Electoral Area
Reference Map
Scale
COWICHAN VALLEY REGIONAL DISTRICT
CAPITAL REGIONAL DISTRICT
Southern Gulf Islands Electoral Area
Salt Spring Island Electoral Area
Juan de Fuca Electoral Area
Galiano
Mayne
North Pender
South Pender
Saturna
Duncan
North Saanich
Sidney
Juan de Fuca EA
Central Saanich
Highlands
Saanich
View Royal
Langford
Colwood
Victoria
Oak Bay
Sooke
Metchosin
Esquimalt
Juan de Fuca EA
Juan de Fuca EA
WASHINGTON STATE
WASHINGTON STATE
CANADA
U.S.A

Scenario Testing and Backcasting



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

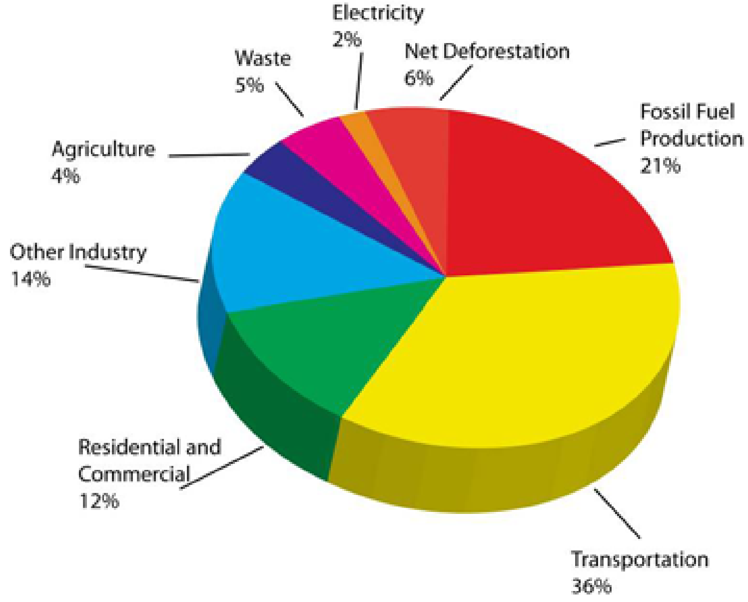
VIBAT-Victoria Methodology

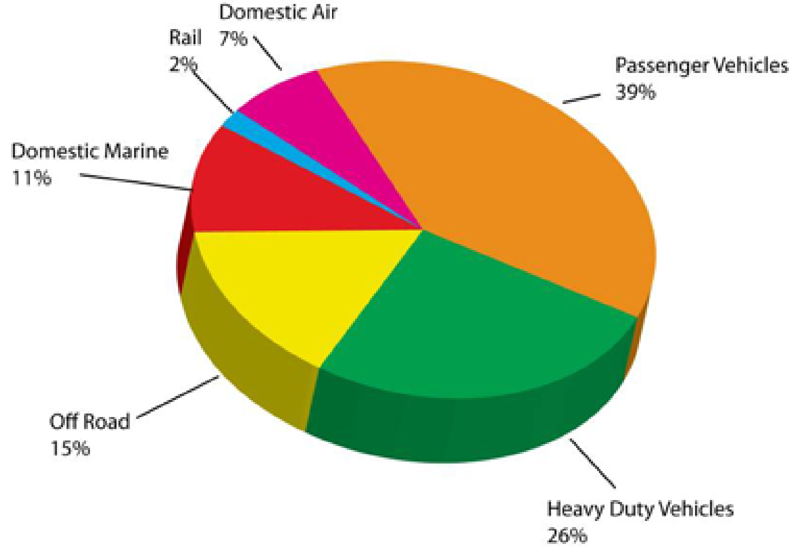


Systematic packaging of interventions/sifting, and scenario testing/optioneering:

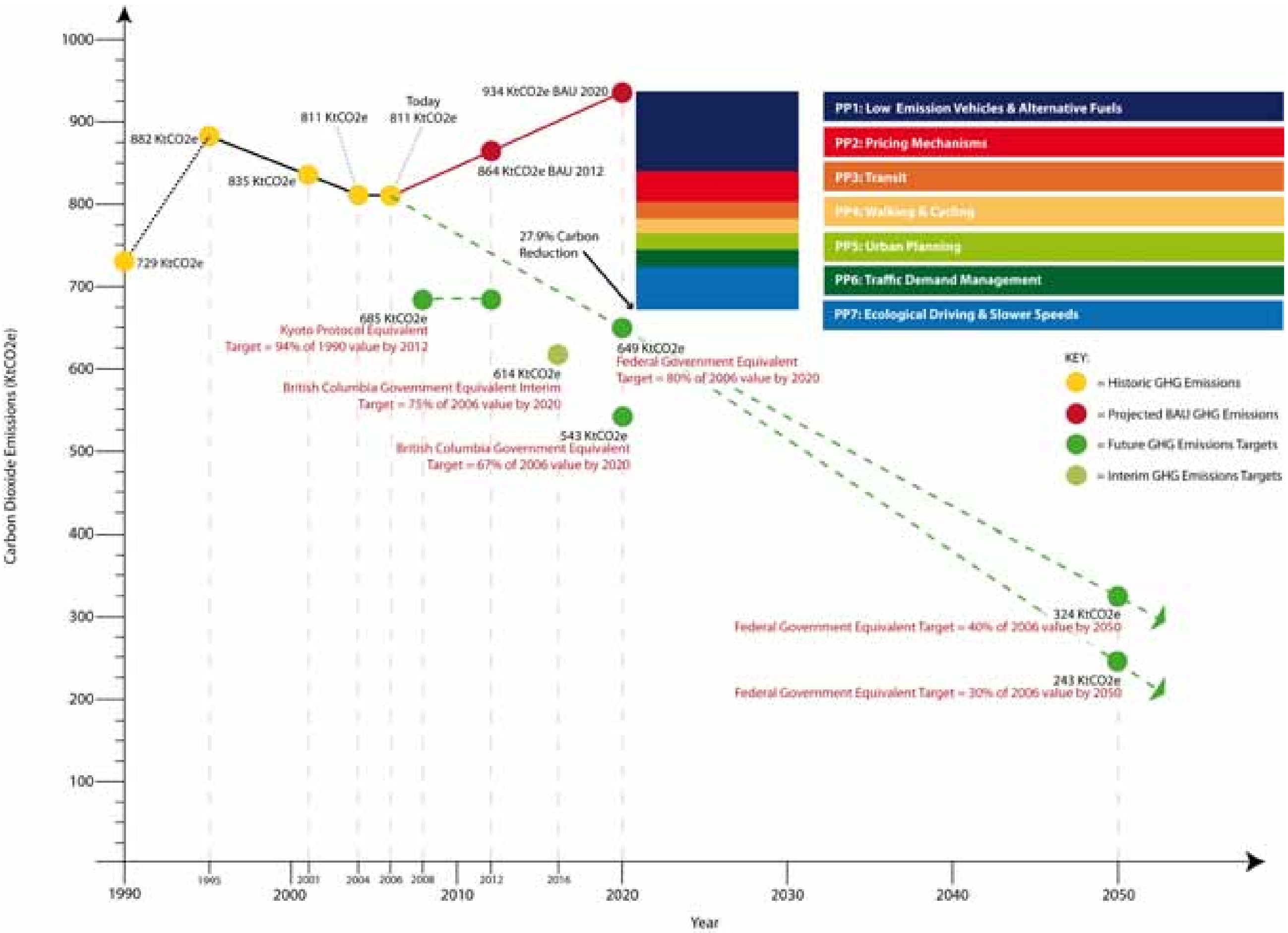
- Consider likely policy interventions (OCC remit and beyond)
- Group interventions into packages
- Model impacts against CO2
- [Potential for wider multi-criteria (WebTAG): local environment, economy, accessibility and safety]
- Cluster policy packages, at various levels of application, into scenarios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

B.C. Baseline

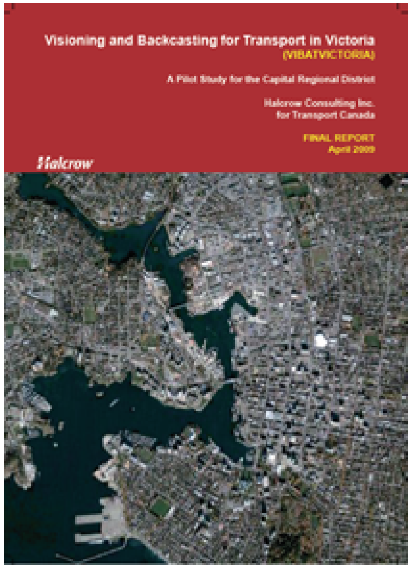

Electricity
2%
Net Deforestation
6%
Waste
5%
Fossil Fuel
Production
21%
Agriculture
4%
Other Industry
14%
Residential and
Commercial
12%
Transportation
36%


Domestic Air
7%
Rail
2%
Passenger Vehicles
39%
Domestic Marine
11%
Off Road
15%
Heavy Duty Vehicles
26%

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		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%
Mediu m	'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.

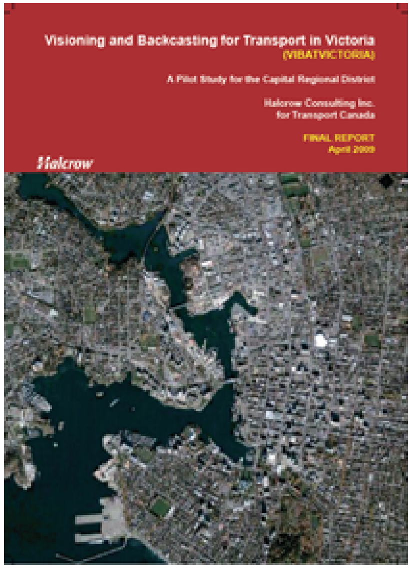
PP5: Urban Planning		GHG Emission s Reductio n (KtCO2e)	GHG Emissions Reduction (%) of 2020 BAU
Current	Some efforts to improve densities and develop around the public transit network		
Low	'Low level' of further intensity of application – thickening of densities along key public transport corridors	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.

Exploratory Results

Policy Package Description		Implementation Level	GHG Emissions Reduction (KtCO2e)	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%

Modelling Approach

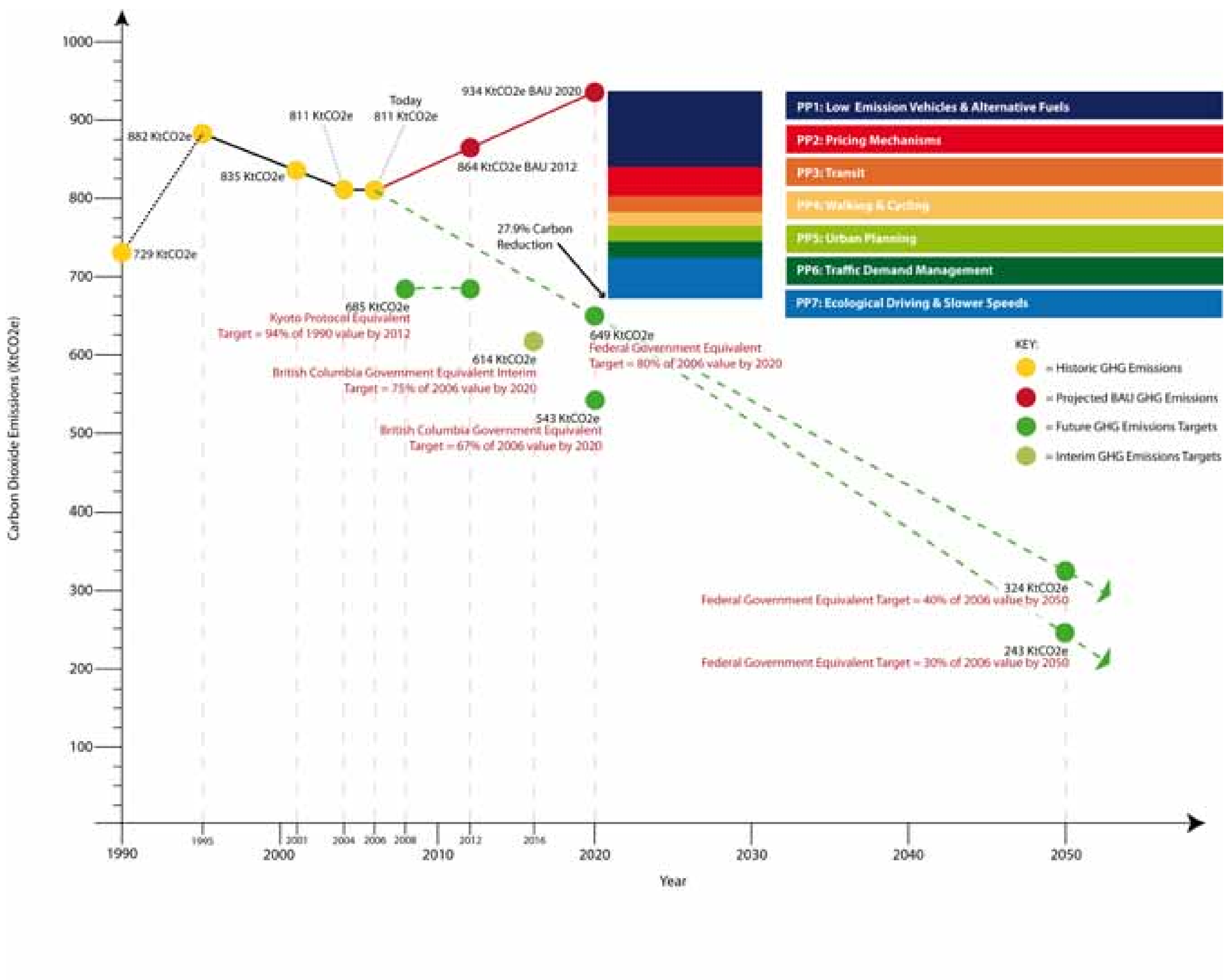


- **A road-based transport and carbon simulation spreadsheet model**
- **use of Canadian version of US EPA MOBIL emission model (v. 6.2C)**

[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

Vibat

Home | Vibat India & Delhi | Vibat London | Vibat UK | People | Papers & Publications

papers & publications

Hickman, R. and Banister, D. (2007)
Looking over the horizon: Transport and reduced CO2 emissions in the UK by 2030. Transport Policy, 14 (5), pp. 377-387.
› read more

Hickman, R. et al (2009)
Vibat London reports and TC-SIM now available.
› read more

partners

Halcrow
TSU
UCL
Space Syntax
UrbanBuzz
Zupa

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.

contact

r Robin Hickman
ssociate Director,
ransport Research Sector,
alcrow Group Ltd,
ondon,
6 7BY

hickmanro@halcrow.com
www.halcrow.com

Research Fellow
Transport Studies Unit
University of Oxford, South Parks Road
Oxford, OX1 3QY

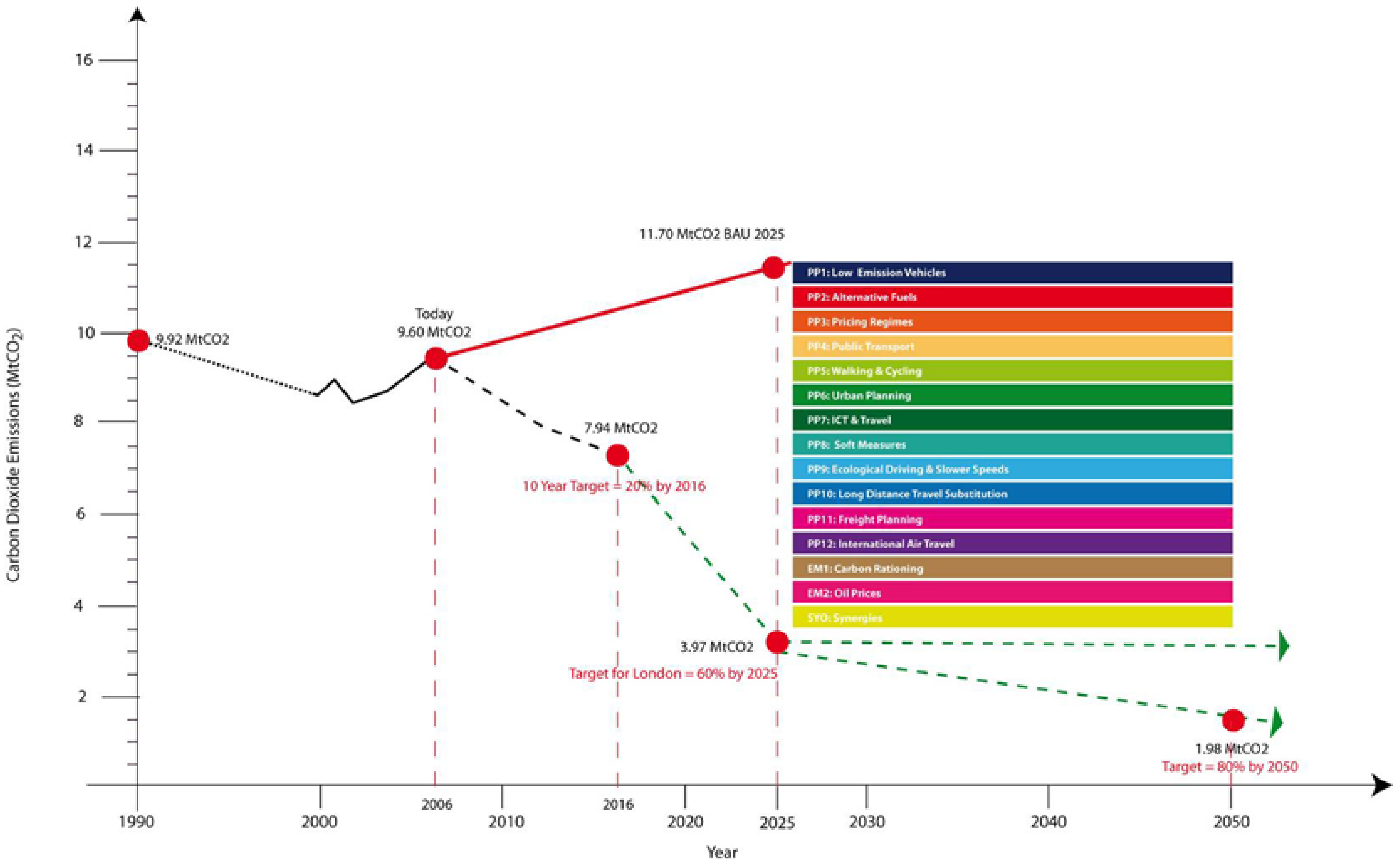
› robin.hickman@ouce.ox.ac.uk
› www.tsu.ox.ac.uk/people/rhickman.php

Professor David Banister
Professor of Transport Studies
Transport Studies Unit,
University of Oxford,
South Parks Road,
Oxford,
OX1 3QY

www.vibat.org

Halcrow | University of Oxford

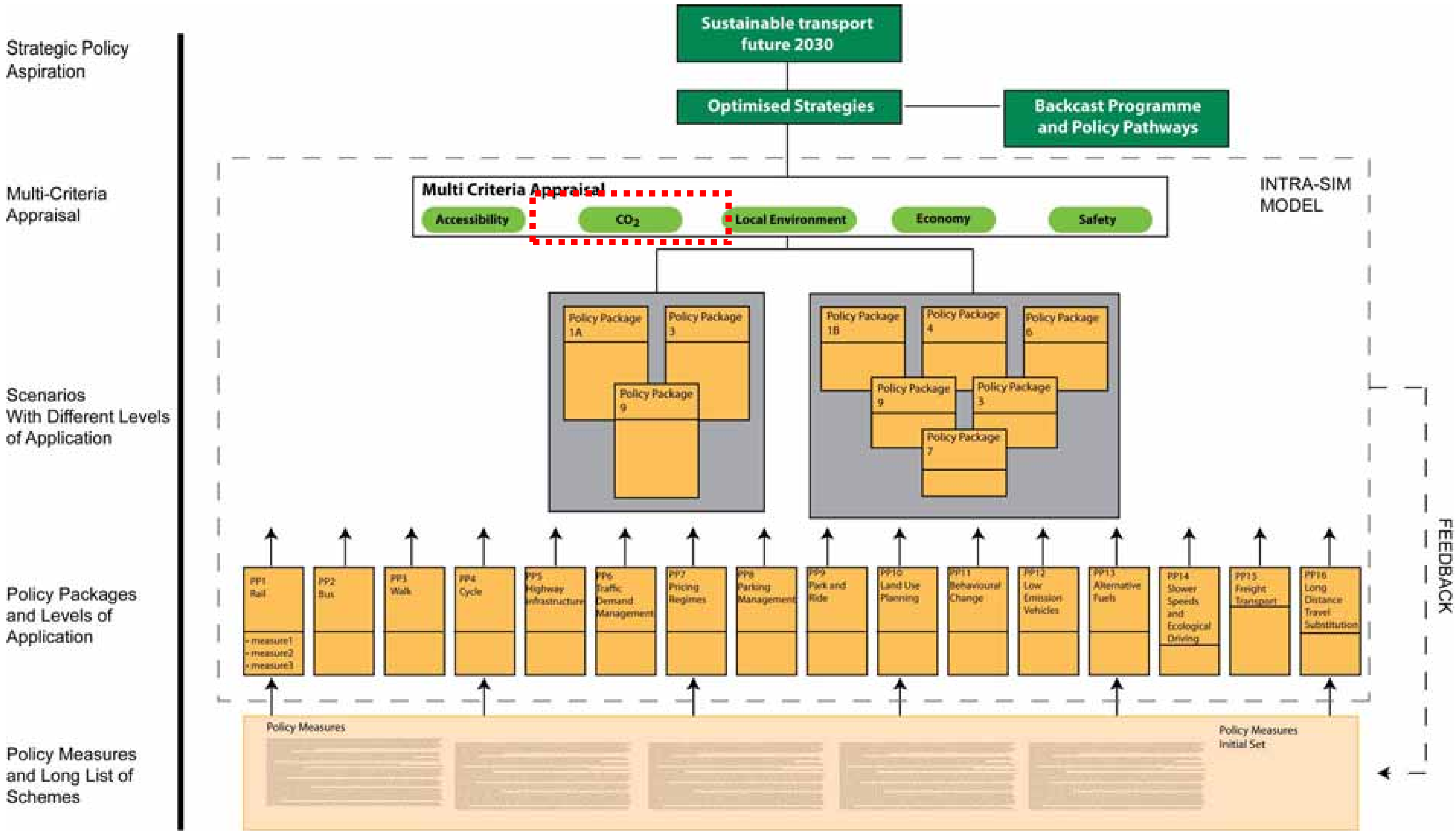
The Projection and Mitigation Pathway



Backcasting (the programme from 2025)

Halcrow | UNIVERSITY OF OXFORD

The CO2/Multi-Criteria Analysis Methodology



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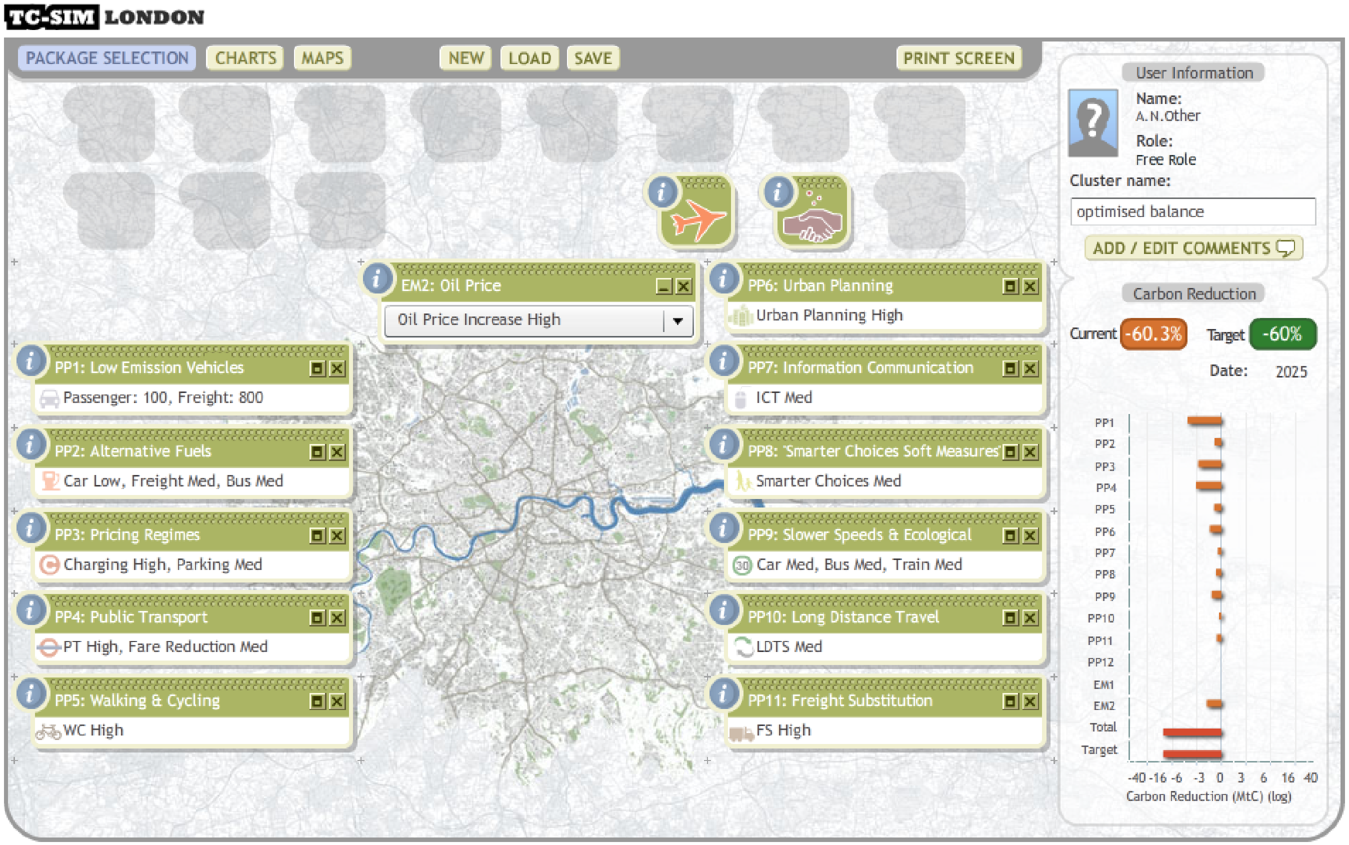
TC-SIM London



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

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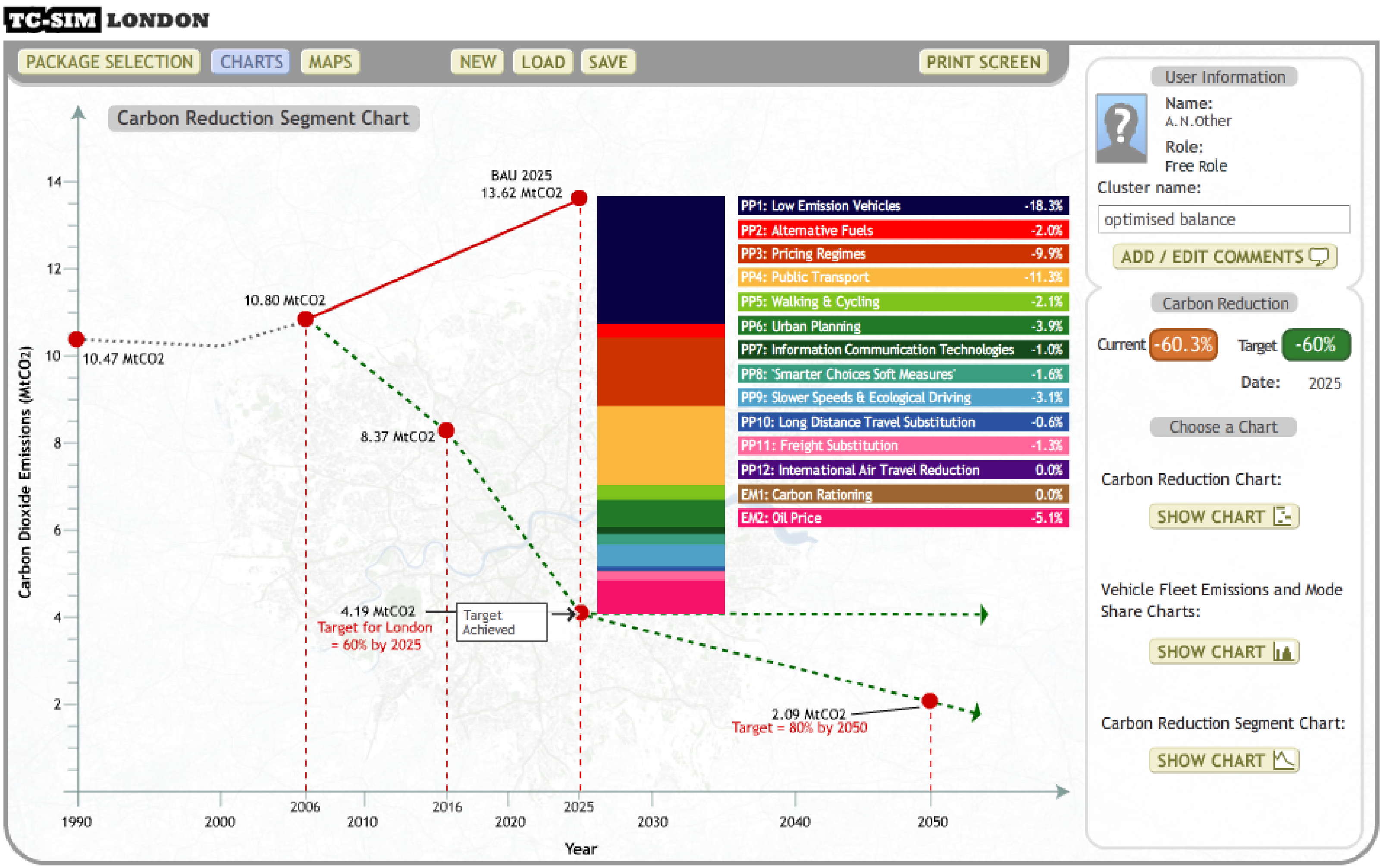
‘Optimising’ the strategy



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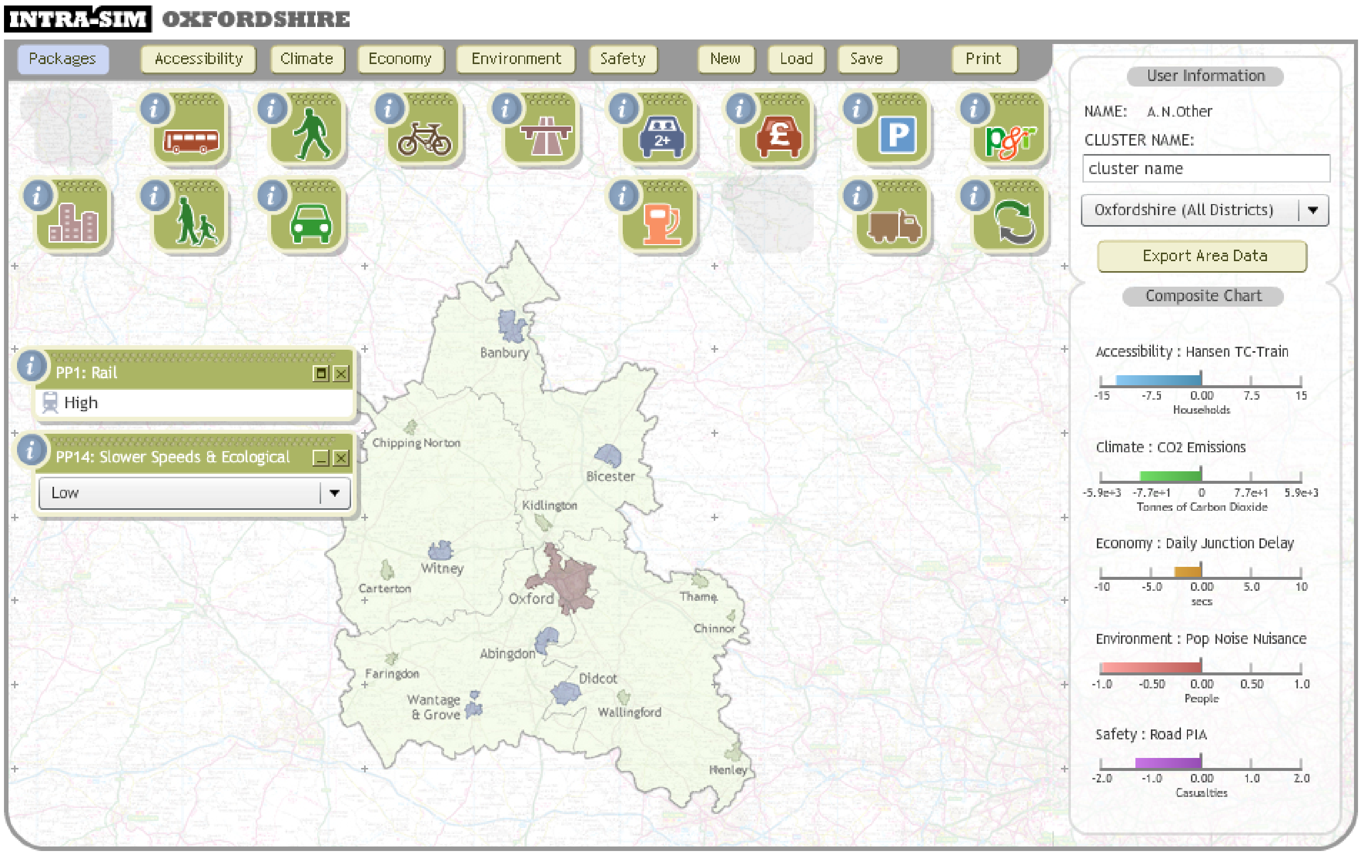
INTRA-SIM Oxfordshire



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

intrasim

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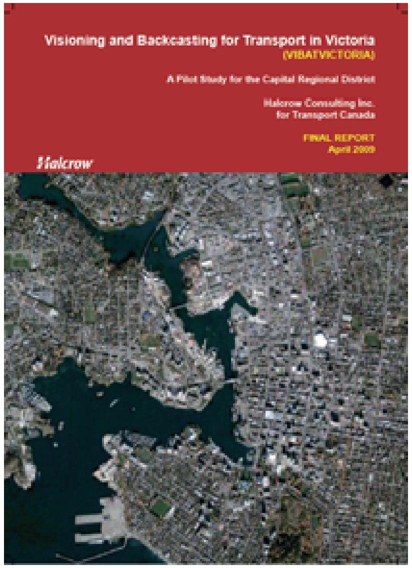
Conclusions



- 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

Further Application?

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.

Transport Canada, Ottawa 25 March 2010

Visioning and Backcasting for Transport (VIBAT-Victoria)

Greenhouse Gas Emission Quantification and Forecasting Workshop

Dr Robin Hickman
Dave Crowley

Halcrow Consulting Inc.

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)

Moving Cooler

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Process, Results, and Next Steps

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 leadership you can trust.

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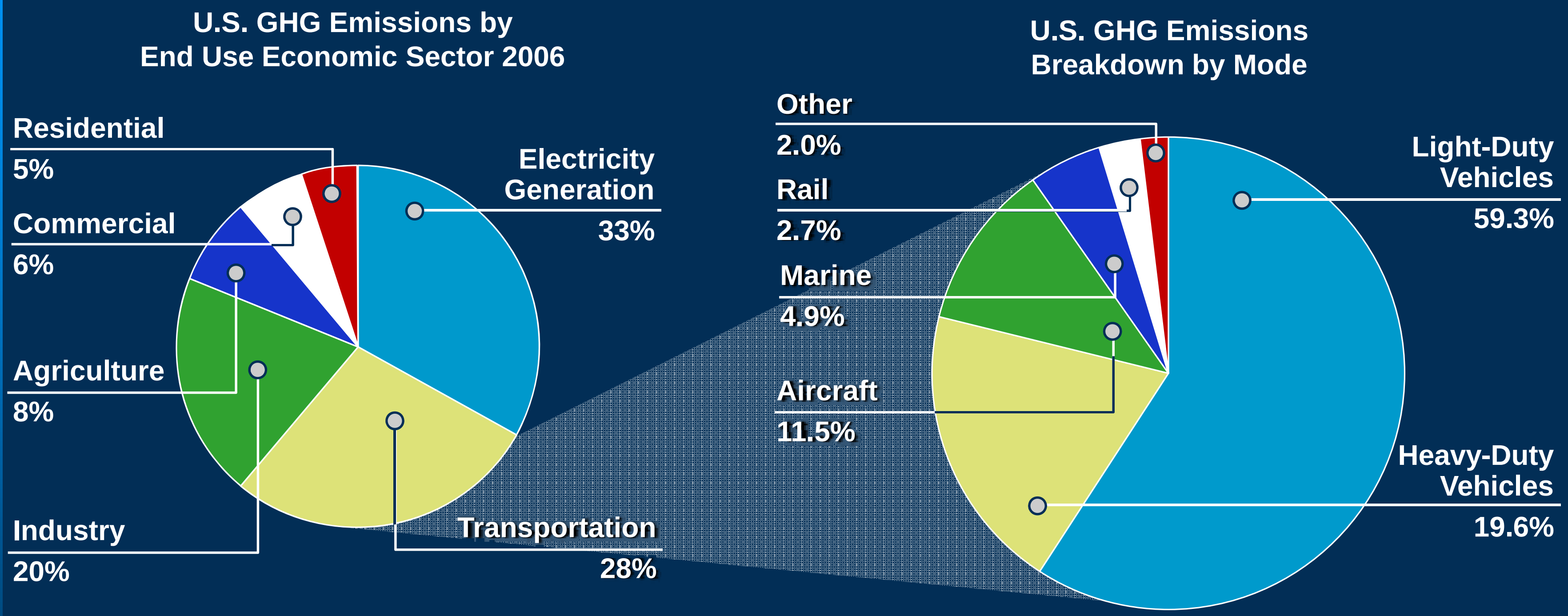
Transportation's Contribution to U.S. GHGs



Source: Environmental Protection Agency (EPA). "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007," April 2009, http://epa.gov/climagechange/emissions/usinventory.html.

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- **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

Moving Cooler

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

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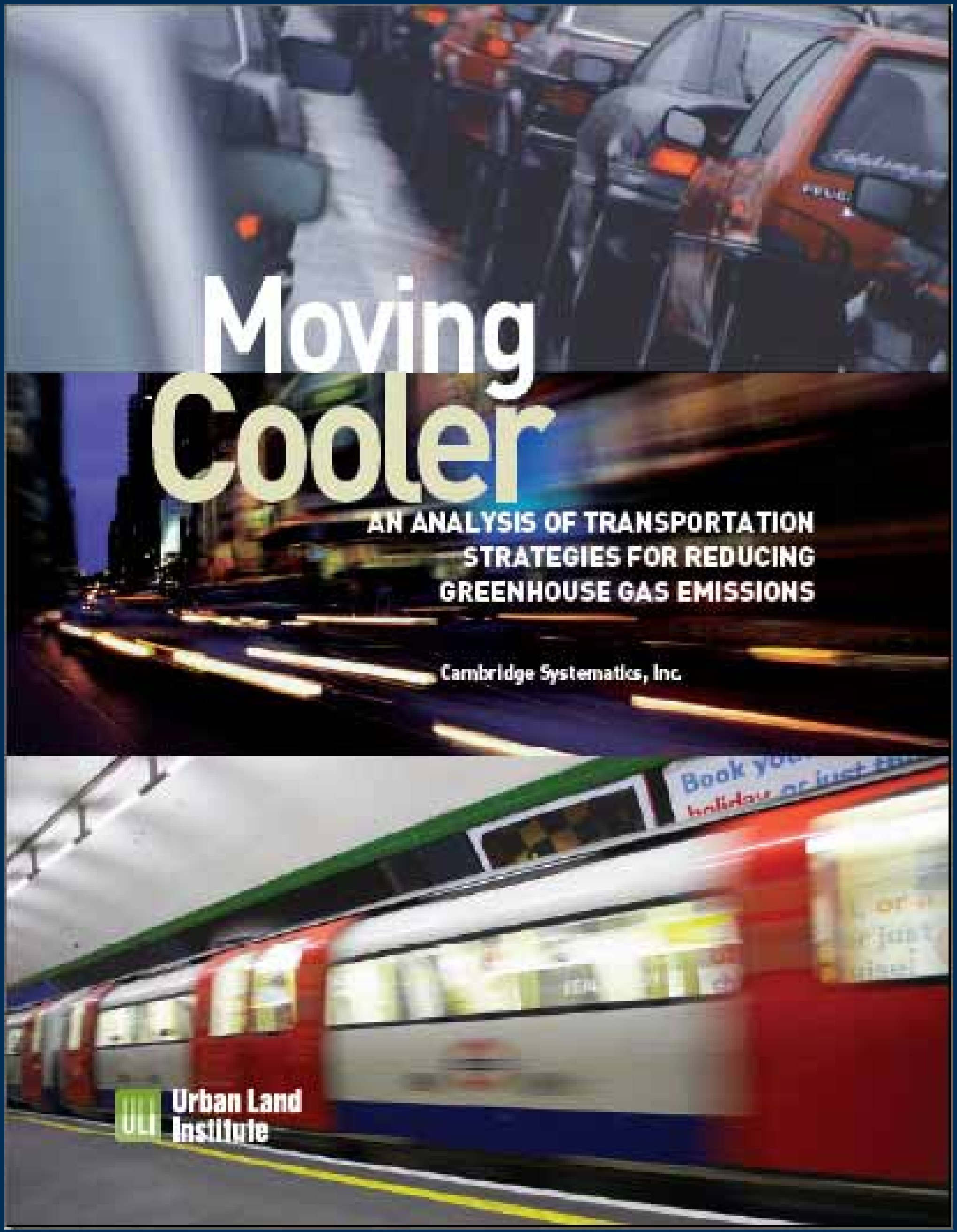
Moving Cooler
AN ANALYSIS OF TRANSPORTATION STRATEGIES FOR REDUCING GREENHOUSE GAS EMISSIONS
Cambridge Systematics, Inc.
ULI Urban Land Institute

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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**

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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

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Levels of Implementation Vary

Example – Pricing Strategies

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Federal	VMT Fees Motor Fuel Tax or Carbon Price
State	Intercity Tolls PAYD Insurance
Regional	Parking Pricing Congestion Pricing
Local	Parking Pricing Cordon Pricing

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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

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Moving Cooler

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**

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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

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*AEO high fuel price scenario.

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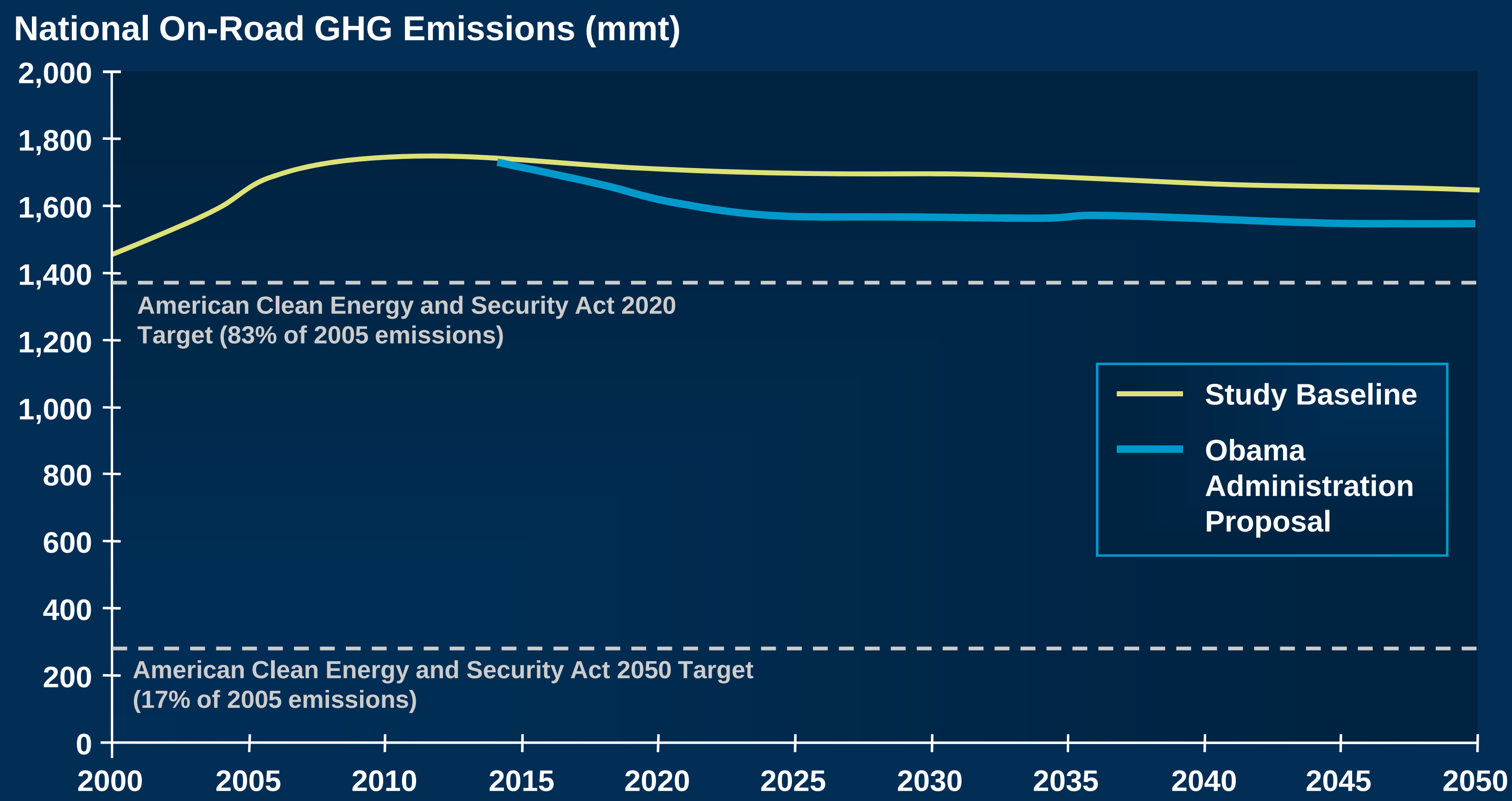
Moving Cooler Baseline to 2050



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.

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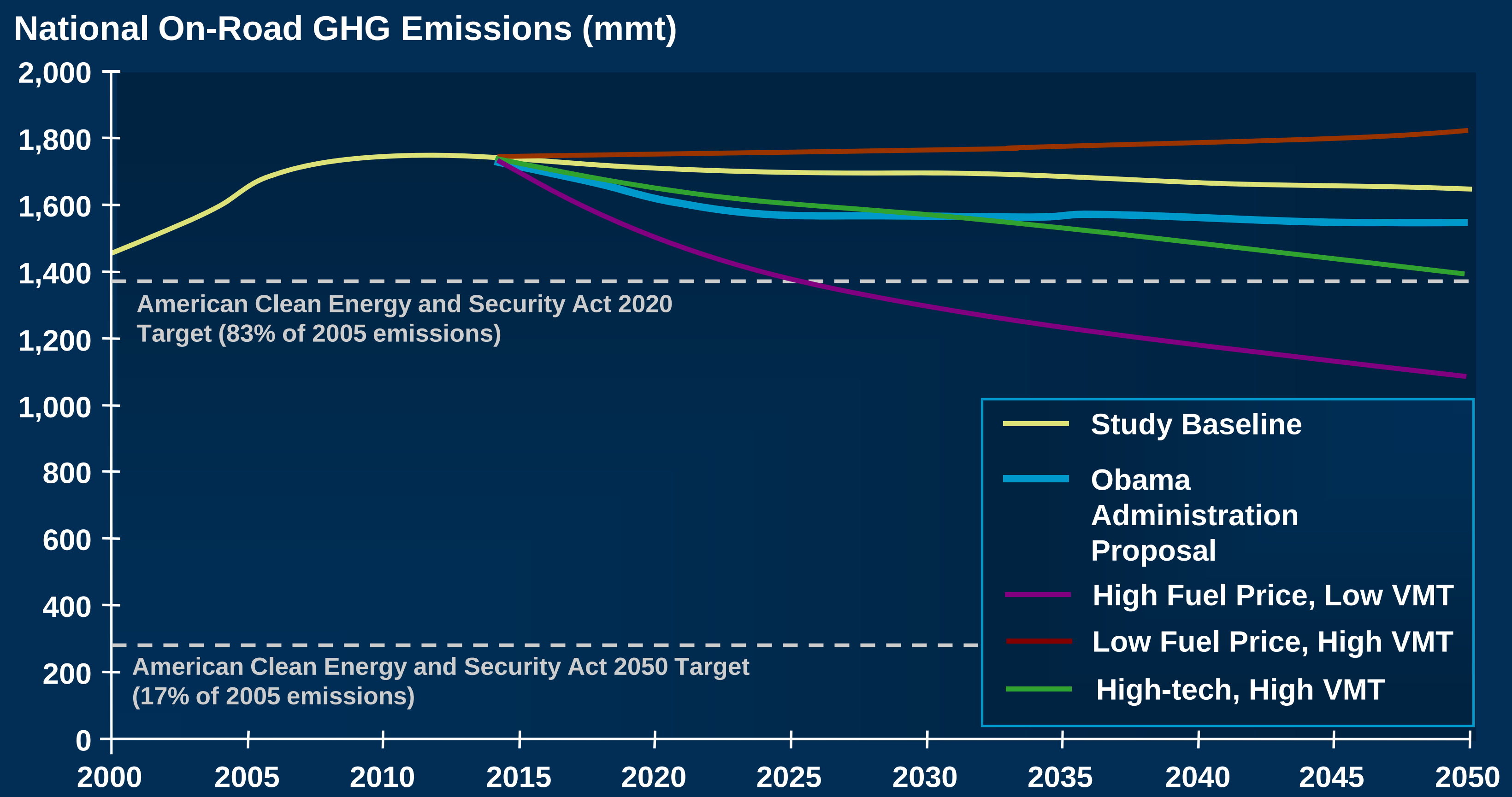
Moving Cooler Sensitivity Tests to 2050



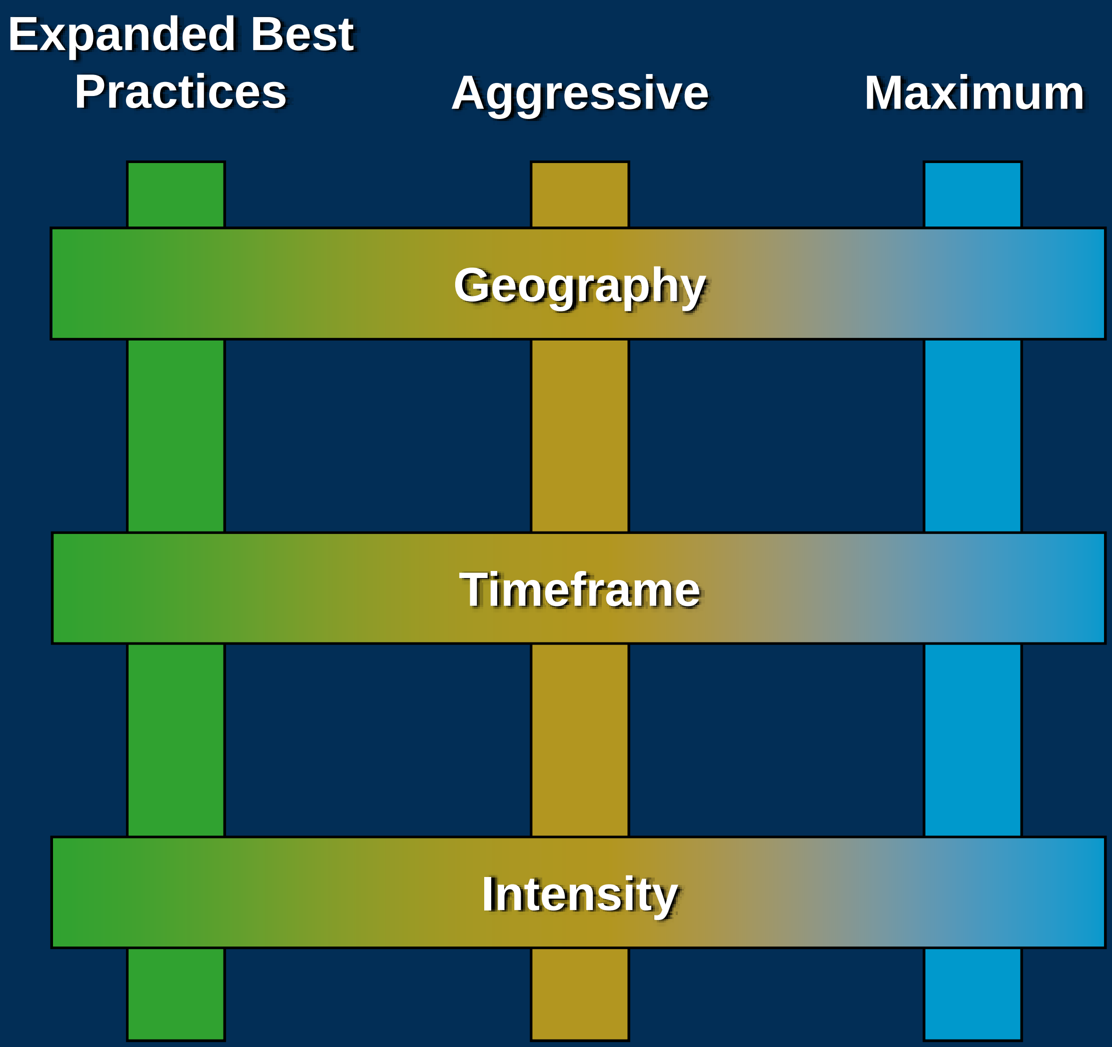
- High Fuel Price/Low VMT: Fuel prices increase dramatically, resulting in lower VMT and improved vehicle technology.
- Low Fuel Price/High VMT: Lower fuel prices drive higher VMT growth and less investment in improved technology.
- High-technology/High VMT: Technology progresses rapidly, leading to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

CAMBRIDGE SYSTEMATICS

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



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3 Deployment Levels per Strategy

Example – Pricing Strategies Sample Parameters

	Expanded Current Practice	More Aggressive	Maximum Effort
Geographic Scope	Large Urban Areas	Large and Medium Urban Areas	Large, Medium, and Small Urban Areas
Intensity	Peak Hour at $0.45/Mile	Peak Hour at $0.69/Mile	Peak Hour at $0.69/Mile
Timeframe	Complete in 15 years	Complete in 10 years	Complete in 10 years

CAMBRIDGE SYSTEMATICS

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

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Example Findings

Individual Strategies

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

CAMBRIDGE SYSTEMATICS

Moving Cooler

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**

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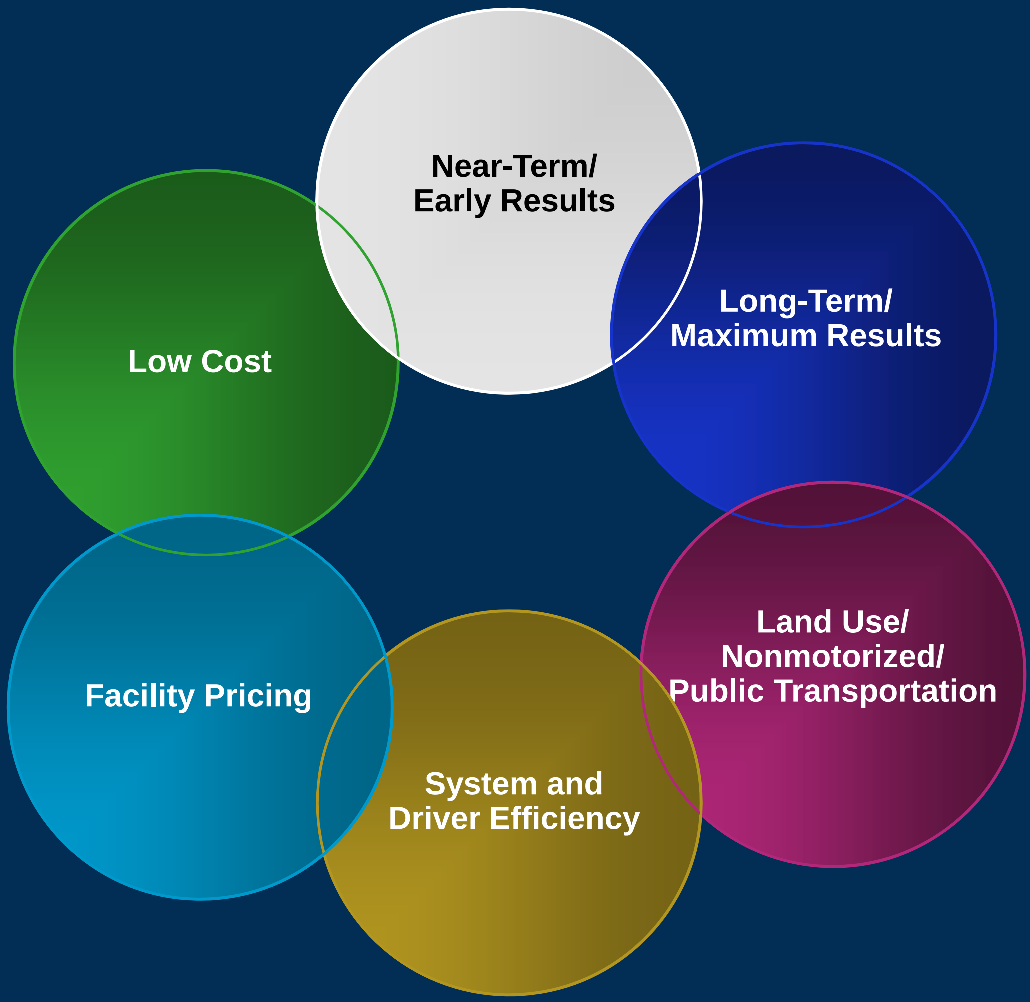
Strategy Bundles
Illustrative Analysis



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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

Moving Cooler

- 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.

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Range of Annual GHG Reductions of Six Strategy Bundles

Aggressive and Maximum Deployment

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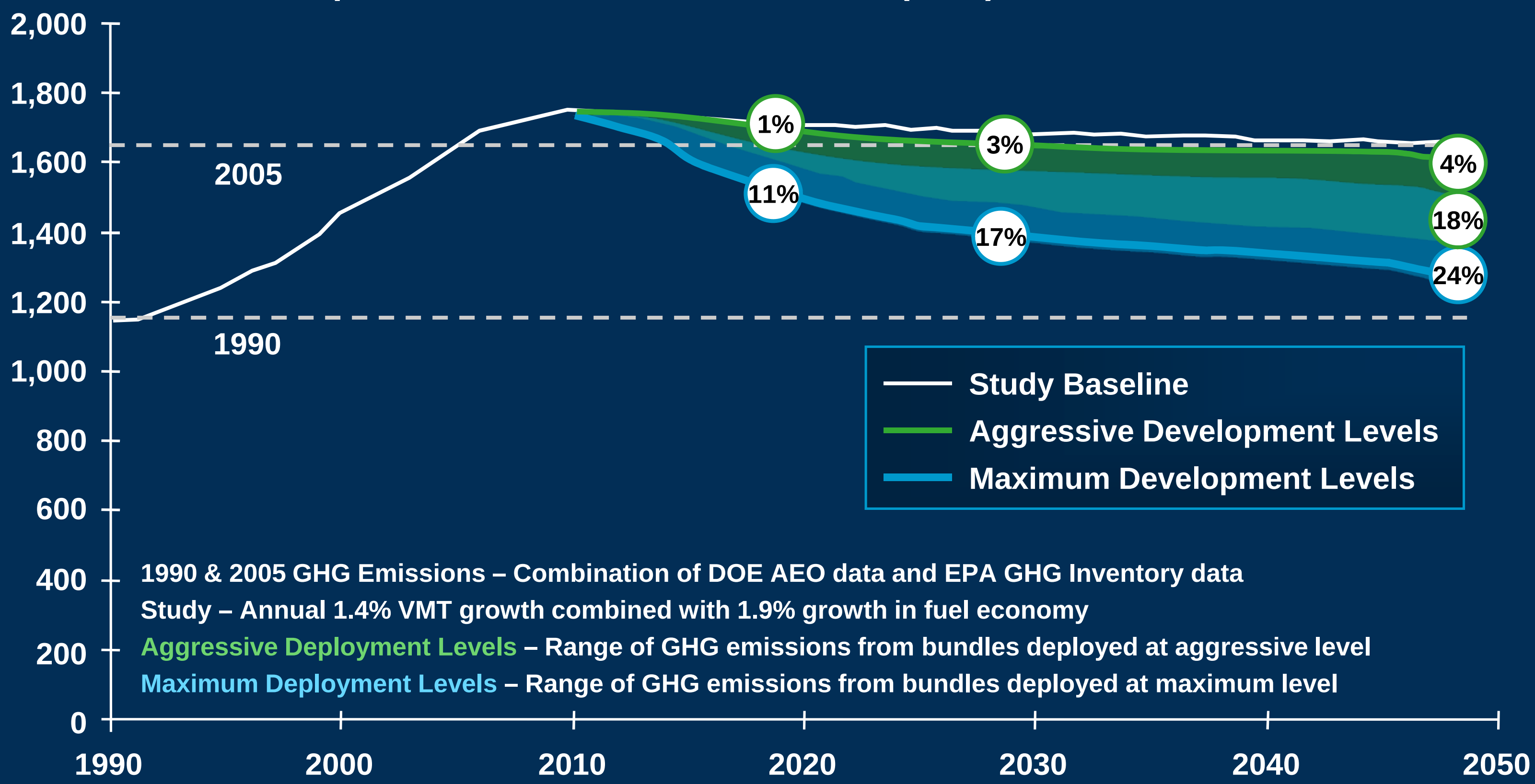
Total Surface Transportation Sector GHG Emissions (mmt)



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.

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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

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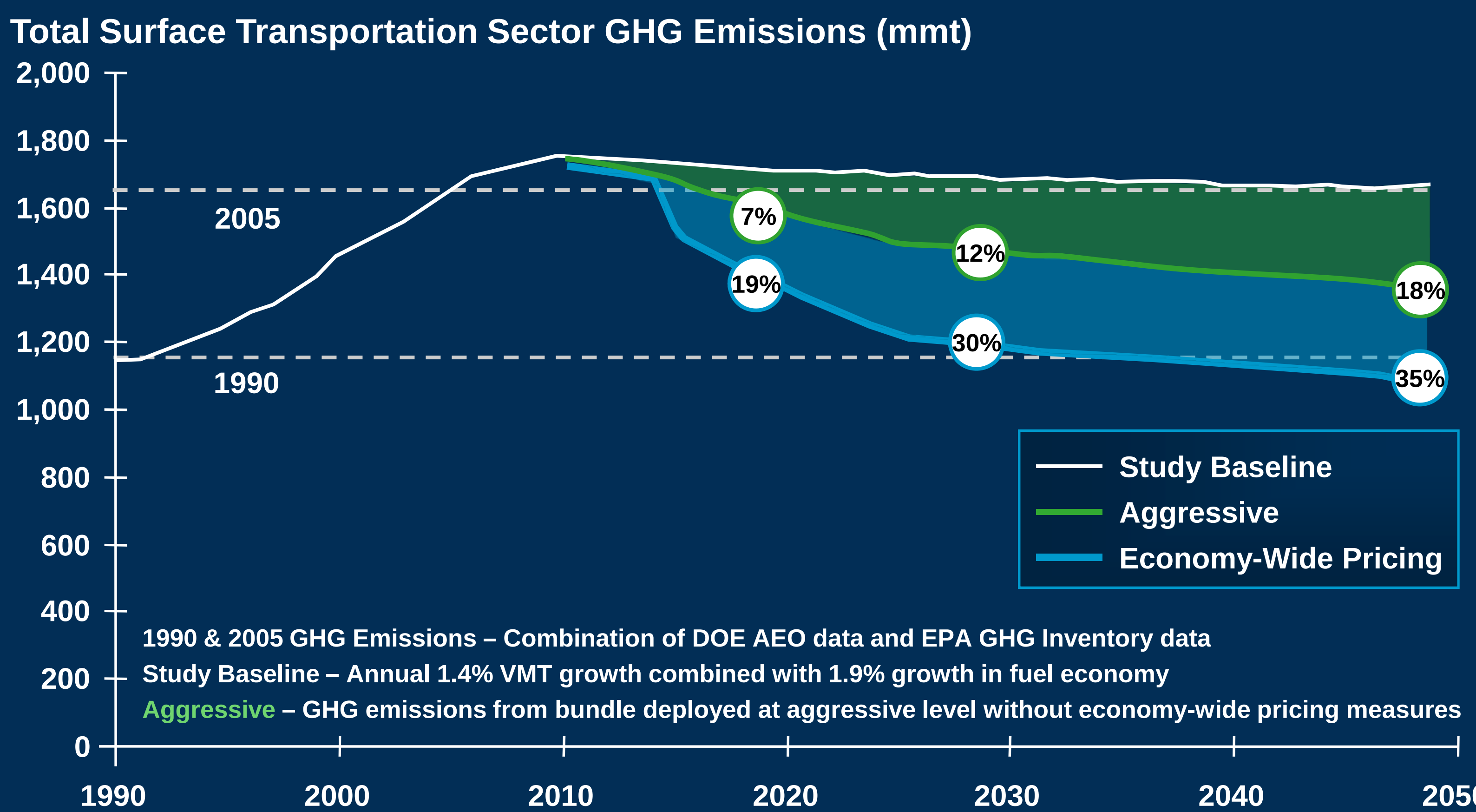
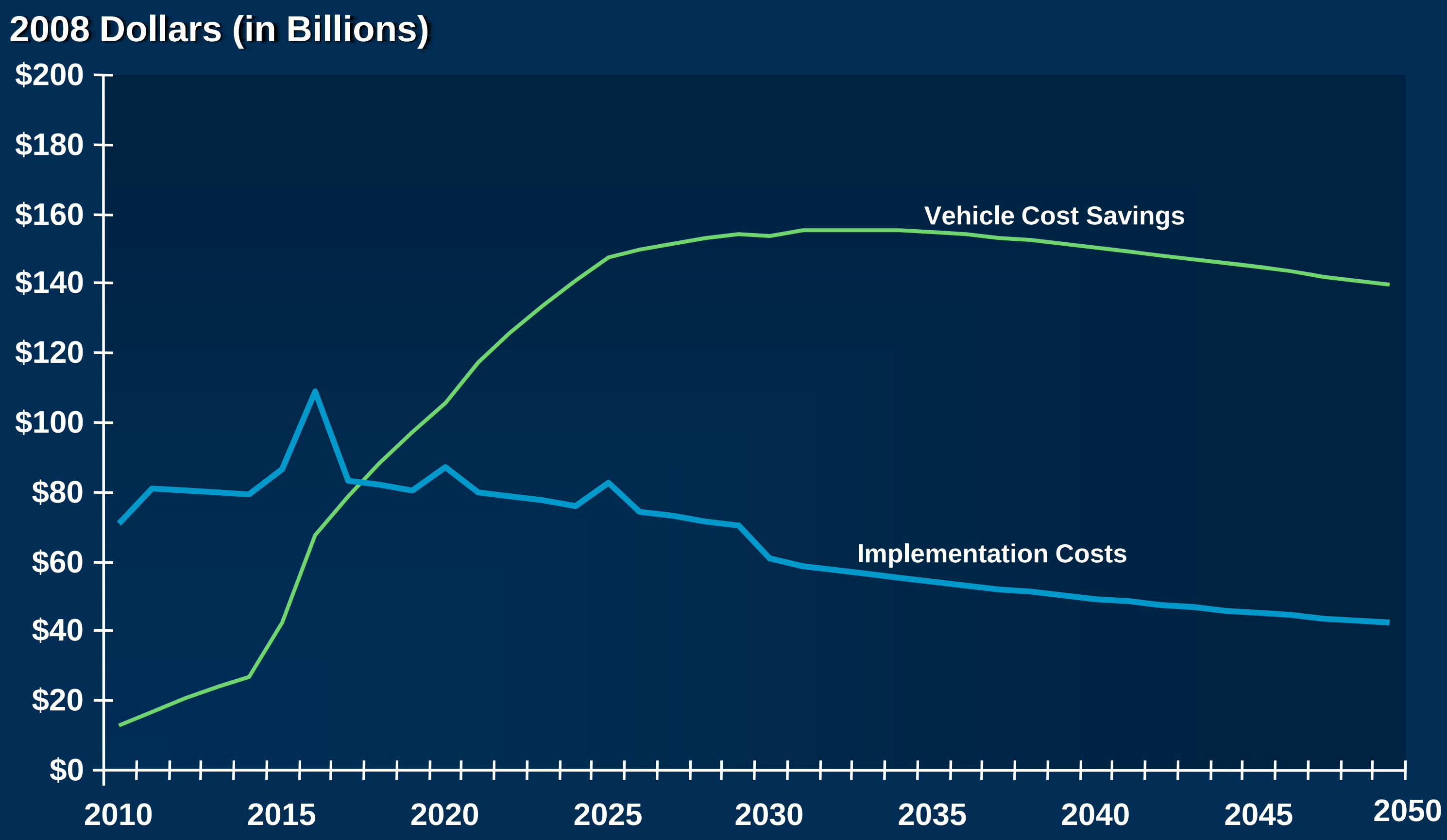
Economy-Wide Pricing



Direct Vehicle Costs and Costs of Implementing Strategy Bundles



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

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- 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

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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

Moving Cooler

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

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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

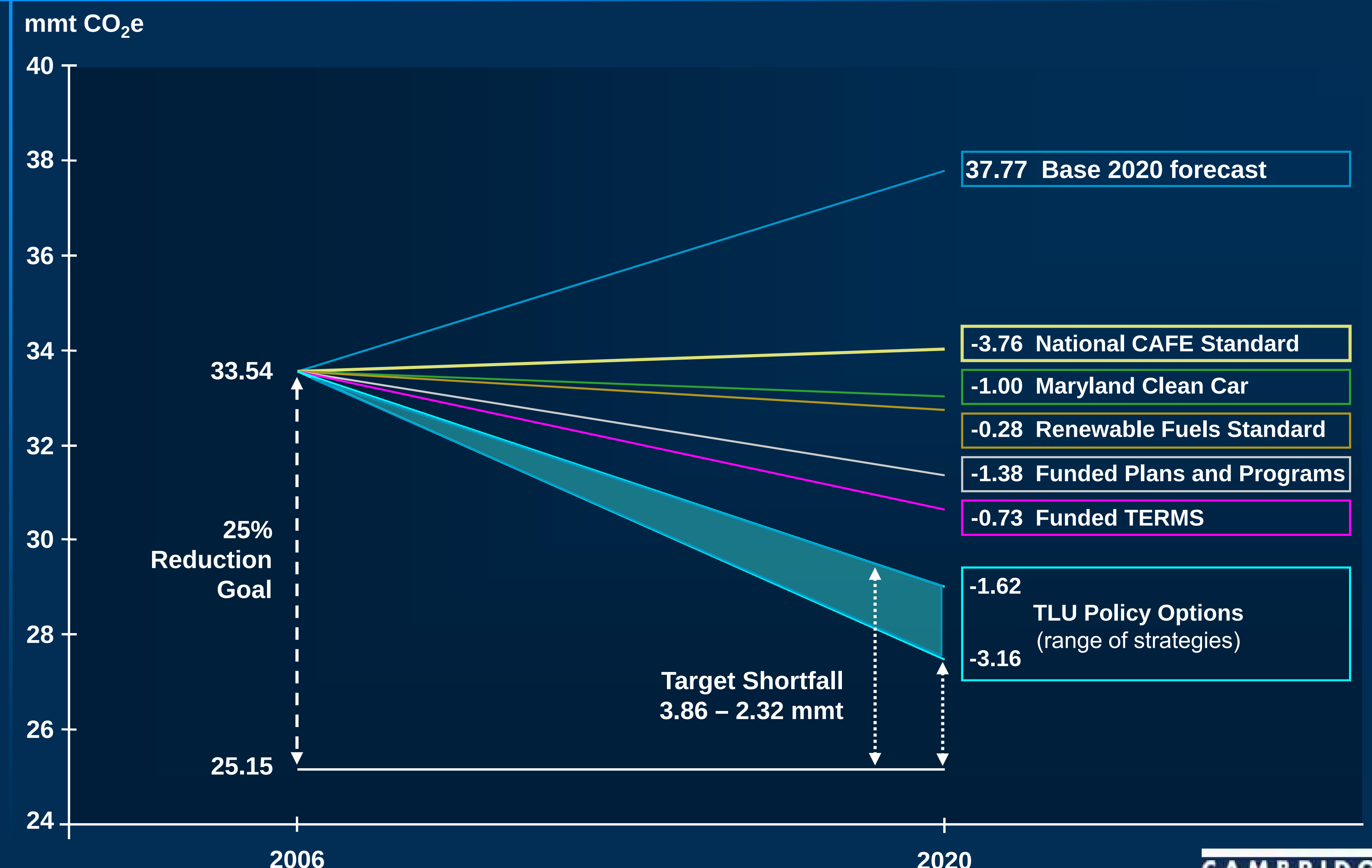
Next Steps – Policy and Practice

- **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

Moving Cooler



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Moving Cooler

For More Information…

http://movingcooler.info

http://www.uli.org/Books

jpotter@camsys.com

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Levels of Implementation Vary

Example – Operational/ITS Strategies

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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

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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

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Strategy Parameters

7 Area Types

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	Density/Level of Transit	
Large Urban	Hi	Low
Medium Urban	Hi	Low
Small Urban	Hi	Low
Nonurban		

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Land Use
Key Assumptions

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- 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

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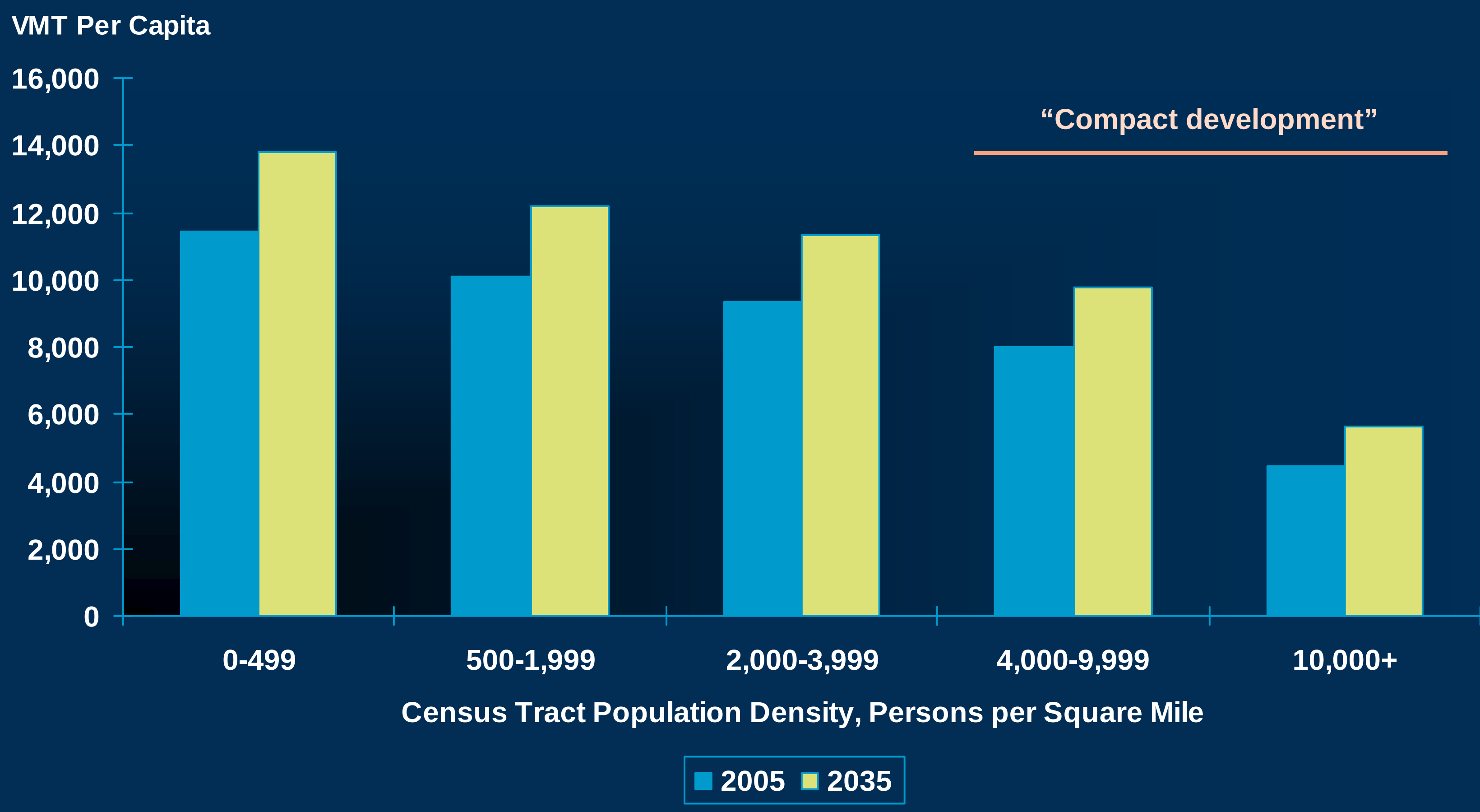
VMT Per Capita by Population Density



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

Lexington, MA:
2,000-4,000 ppsm

Watertown, MA:
4,000-10,000 ppsm

Somerville, MA:
>10,000 ppsm

Image source: TeleAtlas and Google Earth.