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Sustainable Prosperity

SUSTAINABLE COMMUNITIES

Policy Bundles for Reducing Transportation Emissions in Large Cities

Key Messages

- Transportation - the movement of goods and people from one location to another - is responsible for about one quarter of Canada's greenhouse gas (GHG) emissions.[1] Some modes of transportation also create air pollution and traffic congestion, which in turn contribute to health and ecological impacts and lost economic productivity. All of these impose economic costs on households, businesses, and governments.
- The bulk of transportation-related emissions arise from the road travel generated by individual choices about where to live, work or study and how to travel between these locations, and by the shipment of goods by road. This Policy Brief focuses on passenger emissions, the major contributor to growth in transportation GHGs.
- Municipalities have many policy tools to manage these emissions. Fiscal measures can reinforce land use, transit investment and other mode shift strategies. For example, market-based instruments (MBIs) make GHG-intensive transportation choices more expensive and lower the relative cost of alternative modes of transportation, while complementary services and regulations increase the availability of these alternatives and reduce urban sprawl.

1 Environment Canada. (2013). *National Inventory Report 1990-2011: Greenhouse Gas Sources and Sinks in Canada - Executive Summary*. Retrieved from http://www.ec.gc.ca/Publications/A07ADAA2-E349-481A-860F-9E2064F34822%5CNationalInventoryReportGreenhouseGasSourcesAndSinksInCanada19902011.pdf

Sustainable Prosperity is a national research and policy network, based at the University of Ottawa. SP focuses on market-based approaches to build a stronger, greener, more competitive economy. It brings together business, policy and academic leaders to help innovative ideas inform policy development.

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This Policy Brief is based on two research papers (*MBIs, Climate Change, and Sustainable Transportation Governance in Cities* and *Climate Change and Transportation Governance: Looking for Lessons in New York City, London, and Paris*) written by David Gordon, PhD Candidate, University of Toronto. Additional research and writing support was conducted by Dana Krechowicz. Alex Wood and Michelle Brownlee provided valuable comments. Sustainable Prosperity would like to thank Stephen Brydon (Manager, Environment and Climate Action, BC Transit) and Geoffrey Singer (Senior Analyst, Transportation and Urban Solutions, Pembina Institute) for their thoughtful reviews.

- This Policy Brief draws on the experiences of three large cities that have successfully bundled a mix of policy tools to revitalize and expand their public transit - London, New York and Paris. Each city has used regulation, services, and MBIs in different combinations to induce behavioural change and make alternative modes of transportation more accessible.
- Canadian policy makers can learn from these international experiences. Canada is the only G8 country without a national, long term public transportation funding strategy, and this paper identifies the importance of co-ordinated multi-level government strategies to support the shift towards sustainable transportation.
- Reducing transportation-based emissions in Canadian cities would improve urban living, and set an example for other urbanizing jurisdictions around the world. However, change of the scope and scale required will require federal and provincial governments to support city governments by providing resources and facilitating regional and national policy coordination.

The Issue

Transportation is essential to modern urban life, enabling people and goods to move around and come together in productive and enabling ways. However, as urban populations expand, successful transportation management is a growing characteristic of liveable, prosperous, and economically competitive cities.

Transportation is a major source of greenhouse gases (GHGs), and emissions from this source are projected to continue to rise.[2] In North America, transportation is the sole sector in which oil consumption is not projected to decline.[3] North America accounts for over one third of transportation-related GHG emissions globally, and emissions from transportation in American and Canadian cities have trended either flat or upward despite technology-related efficiency gains over the past half-century.[4]

Freight transportation is an important source of transportation GHG emissions in Canada, and expected to grow by approximately 23% by 2020.[5] However, the major contributor to transportation-related GHG growth is passenger emissions, and these are the focus of this Policy Brief. In Canada, emissions from road transportation rose by 40% between 1990 and 2011, with most of this growth

2 International Energy Agency. (2011). CO2 *Emissions from Fuel Combustion: Highlights.* Retrieved from http://www.iea.org/co2highlights/co2highlights.pdf

3 Creutzig,F., Edenhofer,O., Flachsland,C., McGlynn, E., Minx, J., & Brunner, S. (2010). *Cities: Car Industry, Road Transport and an International Emission Trading Scheme – Policy Options.* Retrieved from ideas.climatecon.tu-berlin.de/documents/reports/CITIES%20REPORT.pdf

4 Creutzig et al., 2010; OECD. (2010). *Cities and Climate Change.* OECD Publishing; U.S Department of Transportation. (2010). *Transportation's Role in Reducing U.S. Greenhouse Gas Emissions, Volume 1: Synthesis Report. Report to Congress.* Retrieved from http://ntl.bts.gov/lib/32000/32700/32779/DOT_Climate_Change_Report_-_April_2010_-_Volume_1_and_2.pdf

5 Environment Canada. (2013). *Canada's Emissions Trends.* Retrieved from http://www.ec.gc.ca/ges-ghg/985F05FB-4744-4269-8C1A-D443F8A86814/1001-Canada%27s%20Emissions%20Trends%202013_e.pdf

attributable to a rise in passenger transportation.[6] Passenger transportation emitted 96 Mt CO2e in 2011, over half of all transportation emissions in Canada.[7] While emissions from passenger transportation are expected to decline slightly by 2020, passenger transportation will continue to be a major source of transportation emissions.

This Policy Brief focuses on how local governments can address urban passenger transportation-related GHG emissions, and examines international experience with local government policies that bundle market-based instruments, services, and regulations.

The Knowledge Base

Transportation now accounts for nearly one quarter of total GHG emissions in Canada, and was the largest contributor to Canada's total GHG emissions in 2010.[8] Transportation emissions accounted for 49% of the total increase in Canadian GHGs in the period between 1990 and 2011.[9]

Emissions from passenger transportation (private vehicles) increased at nearly twice the pace of population growth between 1990 and 2007, a function of steadily increasing reliance on automotive transportation and increasing travel distances.[10] In Canada's largest cities, transportation generates a major share of GHG emissions, as shown in Table 1 below.

Nearly 80% of all trips in Canada are made by car, and the average travel distance to work increased by 9% from 1996-2006.

Source: Statistics Canada. (2010). Greenhouse Gas Emissions from Private Vehicles in Canada, 1990-2007. Retrieved from http://www.statcan.gc.ca/pub/16-001-m/16-001-m2010012-eng.pdf

Table 1: Emissions from the transportation sector as percentage of total city-wide GHG emissions

City	Transportation Emissions as Percent of City-Wide GHG Emissions	Year
Toronto	36%	2008 [11]
Vancouver	37%	2008 [12]
Montreal	48%	2003 [13]
Calgary	27%	2008 [14]
Ottawa	34%	2008 [15]

6 ibid

7 ibid

8 Environment Canada. (2013). *National Inventory Report 1990-2011: Greenhouse Gas Sources and Sinks in Canada - Executive Summary.* Retrieved from http://www.ec.gc.ca/Publications/A07ADAA2-E349-481A-860F-9E2064F34822%5CNationalInventoryReportGreenhouseGasSourcesAndSinksInCanada19902011.pdf

9 ibid

10 Nearly 80% of all trips in Canada are made by car, and the average travel distance to work increased by 9% from 1996-2006. See Statistics Canada. (2010). *Greenhouse Gas Emissions from Private Vehicles in Canada, 1990-2007*. Retrieved from http://www.statcan.gc.ca/pub/16-001-m/16-001-m2010012-eng.pdf; UK Transport Research Laboratory. (2010). *T-Mapper Transport Measures and Policies to Promote Emissions Reductions.* Retrieved from http://www.embarq.org/sites/default/files/TMAPPER_Full_Web.pdf

11 City of Toronto. (2013). *Summary of Toronto's 2011 Greenhouse Gas and Air Quality Pollutant Emissions Inventory.* Retrieved from http://www.toronto.ca/legdocs/mmis/2013/pe/bgrd/backgroundfile-57187.pdf

12 City of Vancouver. (2009). *2008 Greenhouse Gas Emissions Inventory: Summary and Methodologies.* Retrieved from http://vancouver.ca/sustainability/climate_protection.htm

13 City of Montreal. (2007). *Montreal Community Sustainable Development Plan 2010-2015.* Retrieved from http://ville.montreal.qc.ca/pls/portal/docs/PAGE/PES_PUBLICATIONS_EN/PUBLICATIONS/VERSION_SYNTHESE_EN.PDF

14 Includes emissions from gasoline and diesel. City of Calgary. (20011). Calgary Community GHG Reduction Plan.. Retrieved from http://www.calgary.ca/UEP/ESM/Documents/ESM-Documents/Calgary_GHG_Plan_Nov_2011.pdf

15 City of Ottawa. (2012). *Memo – 2004 and 2008 Greenhouse Gas Inventories, Reduction Measures, and Approach to Future Targets.* Retrieved from http://ottawa.ca/calendar/ottawa/citycouncil/ec/2012/05-03/B-IPD%20-%20GHG.htm

Costs of Transportation-Related Externalities

The costs related to the generation of these emissions are difficult to quantify. The reliance on automotive transportation in Canadian cities is responsible for a variety of immediate and measurable negative impacts, such as congestion and air pollution. Congestion costs Canadian cities between CAD $3.1 and $4.6 billion annually.[16] The Greater Toronto Area (GTA) alone bears an annual cost of CAD $3.3 billion in terms of lost productivity,[17] a reflection of the magnitude of that city's transportation challenge. When ranked against 24 comparable global cities on the basis of mode of travel to work and commute times, a recent report ranked Toronto 14th and 15th respectively.[18]

Accounting for pollution, GHGs, noise, vehicle collisions and time delays from traffic congestion, road use in Canada is estimated to cost $27 billion per year.[19] The negative effects of congestion on local health further compound these costs. The National Roundtable on the Environment and the Economy (NRTEE) estimated that premature mortality attributable to poor air quality in Canada's four largest urban centers would lead to a total annual cost of CAD $6.5 billion by 2050.[20] Smog emissions in Toronto kill approximately 440 people per year, and cost the economy $2.2 billion per year.[21] It is not surprising, then, that recent survey research identifies a well-integrated multi-modal public transit system as a core characteristic of a "green" and economically competitive city.[22]

The Role of Urban Form

The relationship between urban form and transportation choices is well-established. At the global level, while urban population doubled during the 20th Century, the amount of land occupied by urban settlements tripled.[23] The proportion of Canadians living in urban areas has been rising for more than 150 years and now stands at 81%.[24] As cities "sprawl" outwards and population density decreases, they become less transportation-efficient: residents become increasingly auto-dependent, emit more pollution, and pay more for transportation.[25] The correlation between greenhouse gas emissions from motor vehicle transport and sprawling urban form[26] yields positive environmental impacts from managing urban growth.

16 Urban Transportation Task Force. (2012). *The High Cost of Congestion in Canadian Cities.* Retrieved from http://www.comt.ca/english/uttf-congestion-2012.pdf

17 More conservatively, FCM suggests that congestion has a total cost to the Canadian economy of $5 billion CAD. Federation of Canadian Municipalities. (2013). *Transit and Transportation Issues.* Retrieved from http://www.fcm.ca/home/issues/transit-and-transportation.htm

18 Toronto Board of Trade. (2013). *Toronto as a Global City: Scorecard on Prosperity 2013.* Retrieved from http://www.cou.on.ca/publications/reports/pdfs/scorecard_2013-1

19 Transport Canada. (2008). *Estimates of the Full Cost of Transportation in Canada.* Available at http://www.tc.gc.ca/media/documents/policy/report-final.pdf

20 National Roundtable on the Environment and the Economy. (2011). *Paying the Price: The Economic Impacts of Climate Change for Canada.* Retrieved from http://coastalchange.ca/download_files/external_reports/NRTEE_%282011%29_%20ClimateProsperity_1.pdf

21 Campbell,M., Bassil,K., Morgan, C., Lalani, M., Macfarlane, R., & Bienfeld, M. (2007). *Air Pollution Burden of Illness from Traffic in Toronto – Problems and Solutions.* Available at http://www.toronto.ca/health/hphe/pdf/air_pollution_burden.pdf

22 LSE Cities. (2012). *Going Green: How Cities are Leading the Next Economy.* Available at http://lsecities.net/publications/reports/going-green-how-cities-are-leading-the-next-economy/

23 Angel, S., Sheppard, S., & Civco, D. (2005). *The Dynamics of Global Urban Expansion*. Washington, DC: The World Bank

24 Human Resources and Skills Development Canada. (2013). *Canadians in Context – Geographic Distribution.* Available at www4.hrsdc.gc.ca/.3ndic.1t.4r@-eng.jsp?iid=34

25 Kennedy, C., Miller, E., Shalaby, A., Maclean, H., Coleman, J. (2005). The Four Pillars of Sustainable Transportation. *Transport Reviews,* 25 (4), 393–414.

26 Bart, I. (2010). *Urban sprawl and climate change: A statistical exploration of cause and effect, with policy options for the EU.* Available at www.sciencedirect.com/science/article/pii/S0264837709000374.

For example, there is a strong positive relationship between urban density and mode of transportation – as urban density increases, the modal share of non-motorized and public transportation (transit, walking, cycling) goes up while the amount of energy used per passenger declines.[27]

Strategies to Reduce Emissions and Influence Transportation Choices

These trends create a powerful imperative for Canadian governments, at all levels, to reduce GHG emissions from transportation. These can be lowered through three key strategies: reducing demand for transportation, shifting from higher to lower emitting transportation modes and fuels, and increasing the efficiency of the existing transportation system.[28]

At the municipal level of government, policies can reduce individual *demand* for transportation (and hence reduce emissions) by influencing options about where individuals live, work, and play. This can both reduce the need for travel and the length of trips, and alter the mode of travel. For example, land use zoning can increase densification, and the clustering of residential, working, and entertainment activities in closer proximity to public transit makes zero carbon active transportation modes such as cycling and walking both plausible and appealing. Concurrently, parking and road pricing and zoning can make private vehicle use less appealing.

Cities can also *supply* mobility options that reduce transportation emissions, for example by using their own public procurement powers to support market transformation within their own vehicle fleets, using higher efficiency transit vehicles and low-carbon energy sources to power public transportation, or improving the efficiency of traffic patterns.

Levers for Change: Municipal Options

The jurisdictional authority granted to municipalities, which varies by province, will determine the specific actions municipalities can take to reduce transportation-related GHGs. Local political dynamics and choices made by city officials will further influence the approaches taken.

Cities have four primary levers with which to drive change. They can demonstrate the benefits and possibilities of change through their direct control of City assets and operations.[29] They can use outreach, information, and educational campaigns and efforts to influence residents' behaviour and choices. More directly, they can provide services to their local constituents.

27 World Bank. (2010). *Cities and Climate Change: An Urgent Agenda.* Retrieved from http://siteresources.worldbank.org/INTUWM/Resources/340232-1205330656272/CitiesandClimateChange.pdf

28 eutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). (2012). Urban Transport *Climate Change Action Plans: Examples from Hamburg, London and Tokyo*. Retrieved from http://www.tdm-beijing.org/files/UTClimateChangeAP_144dpi.pdf

29 Cities can engage in self-governance by taking actions that directly affect the operations of city government itself. However, given that the direct impact of self-governing is limited to only a small proportion of total city emissions, self-governing is a decidedly limited means of addressing the issue of sustainable transportation.

And finally, they can incent or command changes in behaviour through regulation and policies for matters within their jurisdictional or legislative authority.[30] The influence of these levers is augmented if they are combined in an integrated fashion.

Municipalities can influence transportation choices through regulation and through the services they provide.[31] But this, on its own, may be insufficient to drive transformative change in mobility patterns: international case studies reveal that financial incentives for behavioral change, created through market-based instruments (MBIs), have been a key part of the policy bundle behind major modal shifts.[32] All three approaches can be applied to both the demand and the supply side of the local mobility equation.

Designing Policy to Address Transportation Emissions

This Brief explores the potential for bundling MBI incentives with more traditional local government policy tools, such as spending on transportation infrastructure and services (service provision), and zoning, traffic calming, driving and parking restrictions (regulations) to reduce emissions and encourage more sustainable forms of transportation. In this Brief, MBIs are described as policy tools that impose a direct cost to the user. The fee exists either to change behaviour by encouraging less expensive alternative modes of transportation, or to collect revenues to finance alternative transportation infrastructure. In contrast, other policy tools such as service provision and regulations are not financially motivated, and act to change behaviour by redesigning transportation systems to be more sustainable. However, often these policy options do not exist in isolation and the most effective transportation strategies are those that integrate financially-motivated MBIs with non-financially-motivated regulations and service provision in a deliberately coordinated approach. The distinctions between these three policy tools are described in the following section.

Market-Based Instruments (MBIs)

A market-based instrument (MBI) influences demand by adjusting prices to incorporate social or environmental costs not traditionally included in the price of the good or service. For example, road use contributes to urbanization, traffic congestion and emissions, with negative impacts on arable land, natural habitat, human health, and economic productivity. MBIs that price road use signal the true cost of mobility choices, and offer a price incentive for users to make lower impact choices. These instruments also potentially provide a source of revenue that cities can re-invest into transportation infrastructure and services. However, because they impose direct, measurable, and immediate costs on users, they are susceptible to political pushback and resistance by the constituencies that pay the new price.

30 Bulkeley, H., Kern, K. (2006). Local Government and the Governing of Climate Change in Germany and the UK. Urban Studies, 43 (12), 2237–2259.

31 OECD, 2010

32 Stavins, R. (2002). Lessons with the American Experiment with Market-Based Environmental Policies. In Donahue, J., Nye, J. (Eds.), *Market-based Governance: Supply Side, Demand Side, Upside, and Downside* (173-201). Washington, DC: Brookings Institutions Press.

Two common transportation MBIs are road pricing and parking fees

Road Pricing: This aims to reduce the use of roads, or shift time of road use, by charging for access. A prominent example is a central city congestion charge, used in London, Singapore, Stockholm and Milan. Road users pay to use the road system in specified regions of the city; the fee may change with time of day. Another form of congestion charge is regional freeway toll-roads, which can be applied if there is limited freeway access to the city. A third form, High Occupancy Toll (HOT) lanes, charges drivers for use of lanes typically reserved for vehicles with multiple passengers.

Parking Fees: Free parking is the expectation rather than the exception in North America,[33] making parking fees an important but under-utilized MBI available to cities.[34] Parking-related MBIs typically operate in one of two ways. The price of on-street parking can be adjusted in real-time to create more turnover in parking spaces on city roads. This reduces traffic circling—in London, UK, for instance, cars searching for on-street parking account for roughly 33% of road traffic in London.[35] The price of on-street parking can also be adjusted across the board as a means of driving modal shift. A study of five UK cities found that a doubling of parking fees led to a drop in car use of 20%.[36]

Service Provision

Local governments exist in large part to supply services to their residents. Investments in enhancing public transportation, increasing alternative transportation infrastructure, and providing alternative transportation services will reduce transportation-related GHG emissions. These can be financed, in part, with revenue from price-oriented MBIs, thus acting on both the demand and supply sides of the mobility equation. This financing model is rare in Canada. In many situations it is more politically feasible to finance these investments from general revenue since the cost is spread across a broader tax base and is less visible. However, this approach diminishes economic efficiency. [37]

Governments can also re-allocate existing services to make alternative transportation modes available to city dwellers.

Enhanced Public Transportation Services: Increasing the supply of public transit or other low-carbon modes of transportation can also reduce barriers to modal shifting. Examples include construction and expansion of underground and above-ground rail systems (i.e. subways, trams), and enhanced bus service.

33 Research suggests that 99% of all automobile trips in the US make use of free parking. Shoup, D. (2011). *The High Cost of Free Parking. Chicago: American Planning Association.*

34 An alternative option to increasing the cost of on-street parking is to raise the property tax on land dedicated to surface parking. See for example Burda, C., Allan,T., Dunn,B., Lintner, A., McClenaghan, T., & Zizzo, L. (2012). *Live Where You Go: Encouraging location-efficient development in Ontario.* Available at http://www.pembina.org/pub/2354

35 Kodransky, M., & Hermann, G. (2011). *Europe's Parking U-Turn: From Accommodation to Regulation.* Retrieved by http://www.itdp.org/documents/European_Parking_U-Turn.pdf

36 Dasgupta, M. et al. (1994). *The Impact of Transport Policies in Five Cities.* Available at http://www.trl.co.uk/online_store/reports_publications/trl_reports/cat_traffic_and_transport_planning/report_impact_of_transport_policies_in_five_cities.htm

37 Prud'homme, R. & Kopp, P. (2008). Worse than a congestion charge: Paris traffic restraint policy. In Richards, H., Bae, C., (Eds.), *Road Congestion Pricing in Europe,* (252-273). Cheltenham, UK, Northampton, MA: Edward Elgar. The authors suggest that the cost of road-restriction and road space reallocation in Paris far exceed their benefits but do not include GHG emissions in their analysis.

Bus Rapid Transit (BRT) aims to mimic the service and performance of underground rail-based public transit. This approach to low-cost/high-capacity public transit was pioneered in Latin America in the mid-1970s, and is catching on around the world.* Bogotá first developed the TransMilenio BRT system in 2000 and has gradually expanded it. Financed by local government revenues, a dedicated fuel tax, grants from the national government, and international climate change funds, the system moves 45,000 passengers per hour/per direction, has reduced average commuting time by 31%, and has achieved substantial reductions in local air pollutants as well as GHG emissions.** TransMilenio buses operate on a network of over 80km of dedicated and physically separated lanes, physical space that has been reallocated from cars to buses.***

Notes:
* In 1990 there were 10 BRT systems in operation, in 2000 there were 23, and as of 2012 there are 146 BRT. See http://brtdata.org/
** TransMilenio was also the first transportation project to be certified to generate credits under the UNFCCC Clean Development Mechanism (CDM) system. See Center for Clean Air Policy. (nd). *Reducing Traffic Congestion in Bogota Through Bus Rapid Transit and Non-Motorized Transport*. Available at ccap.org/assets/CCAP-Booklet_Colombia.pdf
*** The TransMilenio network of dedicated bus lanes is scheduled to expand by over 130km as part of its Phase III development

Alternative Transportation Infrastructure: Increasing the supply of public space allocated to alternative transportation infrastructure such as bike lanes and pedestrian walkways may also enable modal shift. One approach to this is road re-purposing, which is a service provision mechanism to convert road space (streets, parking spaces) into pedestrian zones or physically separated bike or bus lanes.

Copenhagen has invested heavily in building and expanding bike infrastructure. One third of the city's road transportation budget is allocated to cycling-related expenditures and investments, and the city aims to increase spending in this area.* Copenhagen has over 345 km of physically separated bike paths, as well as a network of bike routes that connect the city with outlying suburbs.** The city has converted a substantial number of on-street parking spaces into bike lanes and pedestrian pathways: 400 parking spaces were converted between 1995 and 2000, while the total amount of pedestrian pathways increased by over 4000 square meters.*** Additionally, Copenhagen has optimized traffic signals on certain roads and routes through the city in order to provide cyclists with consecutive green lights – a system known as the "green wave" – improving average trip speed by 10%.† The city provides accommodation for bicycles on suburban trains and on the subway system, and has expanded bike-parking facilities at public transportation stations.†† As a result, biking comprised 20% of all trips, and 36% of work commuters' trips as of 2005.†††

Notes:
*Pucher, J. & Buehler, J. (2007). *At the Frontiers of Cycling: Policy Innovations in the Netherlands, Denmark, and Germany*. Retrieved form http://ejb.rutgers.edu/faculty/pucher/Frontiers.pdf
**ibid
*** Kodransky & Hermann, 2011
†Pucher & Buehler, 2007
††ibid
†††ibid

Bogotá has created 300 km of paved bike paths, introduced a program that shuts down 120 km of streets to vehicular traffic every Sunday, imposed a license plate-based road rationing system that only allows 60% of private vehicles to access the city during peak times, and reduced or eliminated on-street parking by re-purposing road space to non-vehicular uses.* The combination of these measures increased modal share for bus transit as well as a shift from private vehicle to BRT (one study estimates that 10% of BRT ridership consists of users who previously drove a private vehicle to work).**

Sources:
* Center for Clean Air Policy. (nd). *Reducing Traffic Congestion in Bogota Through Bus Rapid Transit and Non-Motorized Transport*. Available at: ccap.org/assets/CCAP-Booklet_Colombia.pdf
** Wright, L. (2004). *The Limits of Technology: Achieving Transport Efficiency in Developing Nations.* Available at http://eprints.ucl.ac.uk/108/

Alternative Transportation Services: The reallocation of public funds towards alternative transportation services such as bike and car-sharing systems signals changing attitudes towards transportation. These options have lower upfront and ongoing costs than traditional public transit. These car and bike sharing programs can be operated as private, not for profit, or municipally-owned operations, or hybrids. Cities often contract out operational responsibilities in exchange for advertising/branding opportunities. In the case of car-sharing systems, cities often offer further encouragement by providing parking spaces. Bike-share systems, pioneered in the 1960's, have increasingly caught on since the mid-2000s. Bike share systems have been implemented in over 300 cities around the world as a complement to traditional public transit, providing an option to cover short-distance trips within city limits at a relatively low incremental cost. Car share systems operate in a similar manner, and reduce demand for car ownership. Car share programs have also been found to have a reduction on total greenhouse gas emissions as individual households shed cars and drive less. [38]

38 Martin, E. and Shaheen, S. (2011). Greenhouse Gas Emission Impacts of Carsharing in North America. Transactions on Intelligent Transportation Systems, 12 (4). Retrieved from http://76.12.4.249/artman2/uploads/1/Greenhouse_Gas_Emission_Impacts_of_Carsharing_in_North_America_1.pdf

The bike share system in Hangzhou, China is currently the largest in the world. Developed in 2008, the Hangzhou system quickly expanded to over 60,000 bikes and 2600 stations throughout the city. The aim of the system is to provide, along with other modes of public transportation (BRT and subway systems), an integrated alternative to automobile transportation. The Hangzhou system is supported by a network of dedicated, physically separated bike lanes, has an average of 240,000 trips per day (out of a total population of 6.7 million) and uses a scaled payment schedule (free for the first hour of use, and priced at increasing increments for every hour of use beyond the first hour) with a payment system that is fully integrated across all modes of transportation.*

Sources:
*ICLEI . (2011). *Ecomobility Case Study – Hangzhou.* Retrieved from http://www.ecomobility.org/fileadmin/template/project_templates/ecomobility/files/Publications/Case_stories_EcoMobility_Hangzhau_PDF_print.pdf; Falk, T. (2010, June 6). World's largest bike-share system in China dwarfs popular U.S. program . [Blog]. Retrieved from http://www.smartplanet.com/blog/cities/worlds-largest-bike-share-system-in-china-dwarfs-popular-us-program/611

Regulations

Local governments can also directly regulate road use and parking—a common example includes road space rationing and associated zoning bylaws.

Road Space Rationing: An alternative to road pricing is road rationing, in which access to roads is capped and allocated to users. Road rationing systems are typically based on license numbers, and limit access during peak hours. The extent of the rationing can be updated in order to increase or reduce the amount of cars allowed into the system. Road rationing systems can be found in Mexico City, Santiago, Sao Paulo, La Paz, Bogotá, Quito, and Beijing. One difference between congestion charges and road rationing is that, while the former allows individuals with the financial means to avoid behavioral change by simply paying more to continue driving, the latter is, nominally at least, more equitable in that it applies equally to all drivers regardless of financial capacity. However, the financial capacity of wealthy households to own more than one car may give them the ability to circumvent this restriction on their mobility.[39]

Road space rationing can also include zoning changes that either change the intended use of space or limit the amount of on-street parking available in cities as a means of increasing its implicit cost. Policies such as these, if overall road supply is held relatively constant, decrease the subsidization of automotive transportation and can be used to redirect public funds towards alternative modes of transportation.

39 Road space rationing can be transitioned into a demand-side MBI if individual allocations are made to be transferable. Proposals have been mooted to convert road-space rationing programs into local trading initiatives (whereby all citizens would be granted a certain amount of road space credits, and would then be free to either use them or sell them to others) but no city has adopted such an approach. See Kockelman, K. & Kalmanje, S. (2005). Credit-based congestion pricing: a policy proposal and the public's response. *Transportation Research Part A: Policy and Practice*, 12. DOI:10.1016/j.tra.2005.02.014

Zurich and Hamburg both use local zoning regulations to cap the total amount of on-street parking in their respective city centers, and the latter mandates that for every new on-street parking spot created, another must be removed.* Amsterdam and Zurich have shifted from a minimum to a maximum parking space requirement in new developments in an effort to limit or reduce total new parking spaces that are created in the city.** Amsterdam mandates that new developments with close proximity to public transportation supply very limited amounts of new parking spaces while those with limited access to public transportation include more.***

Sources:
* Kodransky & Hermann, 2011
** ibid
*** ibid

Cities around the world are implementing strong measures to reduce the negative impacts of auto-dependent urban transportation patterns, including climate change. Policy tools such as MBIs, service provision, and regulations are being employed regularly to drive residents towards alternative modes of transportation.

Lessons Learned from New York City (NYC), London and Paris

New York, London, and Paris demonstrate very different experiences with, and approaches to, the bundling of these policy tools, and several ways in which climate change and sustainable transportation policy can be integrated to achieve the common goal of reducing GHGs from transportation. However, in practice these three policy tools function best when integrated with each other. In the case of regulation and service provision, there is a significant amount of overlap between policy options. For example, policies that are designed to offer increased services (such as alternative transportation) are also ultimately driven by regulations which support these changes. In practice it may be difficult, and not necessary, to distinguish policy tools beyond the financial/non-financially motivated component.

Each city has received international recognition for its sustainable transportation policies[40] and each has had success in driving down transportation sector emissions. These three cities also illustrate the pitfalls of poor intra- and inter-governmental coordination, and the ways in which this can undermine otherwise well-designed efforts to drive behavioral change.

40 Institute for Transportation & Development Policy, Sustainable Transport Award website. Available at: http://www.itdp.org/get-involved/sustainable-transport-award

Each city has received international recognition for its sustainable transportation policies and each has had success in driving down transportation sector emissions. These three cities also illustrate the pitfalls of poor intra- and inter-governmental coordination, and the ways in which this can undermine otherwise well-designed efforts to drive behavioral change.

New York City:

New York City has the highest rate of public transit commuting in the United States and a car ownership rate less than half of the US average.[41] As a result, transportation accounts for a smaller share of total GHG emissions in New York City (21%) than the national average (33%).[42] However, transportation still represents, after the buildings sector, the second largest source of emissions in the city.[43] The bulk of emissions from the transportation sector come from on-road vehicles. Passenger and freight vehicles account for 86% of transportation emissions with public transit accounting for the remaining 14%.[44] There has been some success in driving down emissions from transportation in the city: the percentage of total citywide GHG emissions from transportation declined from 26% in 1995 to 21% in 2010.[45] This decline has come entirely from on-road transportation emissions, which dropped from 23% to 18% across this timeframe.[46] In absolute terms, emissions from transportation have declined from 13 Mt (1995) to 11.4 Mt (2010) despite a population increase of just over 11%.[47]

"New York City transportation emissions have declined from 13 Mt in 1995 to 11.4 Mt in 2010 despite a population increase of over 11%".

Sustainable Transportation Policy and Planning: New York began aggressively engaging in local climate policy in 2007 with the launch of *PlaNYC*, a thirty year integrated economic development and sustainability plan cutting across, and linking together, multiple areas of action including transportation.[48] Based on projected increases in city population of roughly 10% (an additional 800,000 citizens) by 2030, PlaNYC aims to develop a forward-looking plan to accommodate this increase in a sustainable manner. *PlaNYC* is integrated with the NYC Department of Transportation's Sustainable Streets 2008 planning document. The two plans outline actions to drive down emissions from transportation with an overall goal of reducing total GHG emissions 30% by 2030. [49] The Office of Long-Term Planning and Sustainability, created in 2006, has oversight and coordination responsibilities for sustainability actions across the metro region.

41 Parshall, L. Haraguchi, M., Rosenzweig,C., & Hammer, S. (2011). *The Contribution of Urban Areas to Climate Change: New York City Case Study, in Cities and Climate Change.* Retrieved from http://www.unhabitat.org/downloads/docs/GRHS2011/GRHS2011CaseStudyChapter03NewYork.pdf

42 ibid; City of New York. (2011). *Inventory of New York City Greenhouse Gas Emissions.* Retrieved from http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/greenhousegas_2011.pdf

43 City of New York, 2011

44 ibid

45 ibid

46 ibid; City of New York. (2007a). *Inventory of New York City Greenhouse Gas Emissions.* Retrieved from http://www.nyc.gov/html/om/pdf/ccp_report041007.pdf

47 United States Census Bureau, State & County Quick Facts Website. Available at: http://quickfacts.census.gov/qfd/states/36/3651000.html; City of New York 2007a; 2011. Transportation emissions in 2008 were 11.73 Mt and in 2009 were 9.86 Mt – thus confirming the overall downward trend but suggesting that attention be paid to the impact of exogenous factors such as the global/US economic crisis and local weather fluctuations.

48 City of New York. (2007b). *PlaNYC: A Greener, Greater New York* Retrieved from http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/full_report_2007.pdf

49 City of New York Department of Transportation. (2008). *Sustainable Streets.* Retrieved from http://www.nyc.gov/html/dot/downloads/pdf/ss09_update_lowres.pdf; City of New York, 2007

MBIs:

Bridge and tunnel tolls long pre-date sustainability planning and policy intervention in New York City. The application of these policies to reduce emissions and congestion has been limited, and attempts to expand them have been met with considerable resistance.

Road Pricing: A congestion charge was the primary component of the transportation section of *PlaNYC*. The proposed system was to be funded in part by a federal grant and had broad support from the public and business community. However, it was defeated in the State Legislature, which has jurisdictional authority in such matters. This was a major blow to efforts to reduce demand for automobile transportation and illustrates the political challenge of bridging the interests of city and surrounding suburbs, as well as the implications of poor inter-governmental coordination.[50]

Parking Fees: New York is renowned for underpriced curbside parking and over-allocation of residential curbside parking permits, both of which lead to over-consumption of curbside parking and result in considerable traffic circling and double parking.[51] Two programs increase the cost of curbside parking spaces during peak hours as a means of reducing demand. In 2000 the city introduced the *Commercial Curbside Parking Program*, featuring variable rate meter parking in the central business district (CBD) for commercial vehicles.[52] The program replaced complex and under-enforced parking regulations with dedicated commercial vehicle parking spaces with rates that increase in hourly increments. This is intended to reduce parking-related congestion and related negative behaviors (parking shortages for commercial vehicles, double parking, traffic circling). In 2008, the city introduced ParkSmart NYC as a pilot project with variable meter rates for curbside parking, using price signals to alter parking behaviour during peak business hours.[53] The program successfully reduced parking space occupancy during peak hours, and it has been expanded as a result.[54]

50 Schaller, B. (2010). *New York City's Congestion Pricing Experience and Implications for Road Pricing Acceptance in the United States*. Retrieved from http://www.nyc.gov/html/dot/downloads/pdf/schaller_paper_2010trb.pdf

51 Shoup, D. (1997) . The High Cost of Free Parking. *Journal of Planning Education and Research*, 17 (1), 3-20.

52 Weinberger, R. Kaehny, J., & Rufo, J. (2010). *US Parking Policies: An Overview of Management Strategies.* Retrieved from http://www.itdp.org/documents/ITDP_US_Parking_Report.pdf

53 ibid

54 New York City Department of Transportation, Motorists & Parking Website. Available at: http://www.nyc.gov/html/dot/html/motorist/parksmart.shtml

Service Provision:

In part because congestion pricing was defeated, New York City has implemented supply-side policies to drive modal shift from automobile to alternative modes of transportation.

Enhanced Public Transit: The Select Bus Service (SBS), introduced in 2008, is part of a broader effort to reduce passenger loads on the subway system by improving above ground bus service. Based on the Bus Rapid Transit model, it reduces trip times through integration of pre-boarding payment, multi-door entry/exit, and dedicated bus-lanes monitored by traffic cameras.[55] Two SBS routes are in operation, in the Bronx and midtown Manhattan, with several more planned. While implications in terms of reduced emissions are difficult to quantify, the SBS routes have led to a 7% to 9% increase in ridership and a 20% increase in average bus speed.[56]

Alternative Transportation Services and Infrastructure: Over 270 miles of new bike lanes - including 20 miles of bike lane that are physically separated from the road – and 3100 new bike racks[57] have boosted bike commuters by 60% while reducing bicycle fatalities by 54% between 2001 to 2010.[58] These numbers are projected to increase with New York's new[59] 10,000 bike/600 station Citi Bike bike share program, modeled on similar systems in London and Paris. In addition, the city has reallocated road space through the creation of parking-lane protected cycling lanes.[60] However, even with these increases, bike commuting amounts to less that 1% of all commuting trips,[61] and bike lanes and parking facilities, on a per capita basis, are much lower in New York than in other cities.[62] New York City has yet to integrate cycling with other modes of public transportation, providing little capacity for bike parking, storage, or carriage on city buses and subways.[63]

55 Weinstock, A., Hook, W., Replogle, M., & Cruz, R. (2011). *Recapturing Global Leadership in Bus Rapid Transit.* Retrieved from http://www.itdp.org/documents/20110526ITDP_USBRT_Report-HR.pdf. The Institute for Transportation and Development Policy does not officially recognize the SBS system as BRT as it does not have physically separated bus lanes, pre-board payment systems, or distinctive raised stations.

56 ibid

57 Gronewald, N. (2010, June 8). Pedestrians, Bicyclists spar for space in NYCs new no-car zones. *The New York Times.* Retrieved from http://www.nytimes.com/gwire/2010/06/08/08greenwire-pedestrians-bicyclists-spar-for-space-in-nycs-n-3563.html?pagewanted=all; New York City Department of Transportation, Bicyclists Website. Available at: http://www.nyc.gov/html/dot/html/bicyclists/bikemain.shtml

58 Gelinas, N. (2012). *Ungridlocked.* Retrieved from http://www.city-journal.org/2012/22_2_nyc-transportation.html; Pucher, J., Buehler, R.,& Seinen, M. (2011). Bicycling Renaissance in North America? An Update and Re-Appraisal of Cycling Trends and Policies. Transportation Research A, Vol. 45. Retrieved from http://www.utrc2.org/sites/default/files/pubs/bike-renaissance-journal_0.pdf

59 The Citi Bike bikeshare program commenced in May 2013. More information available at: http://citibikenyc.com/

60 Kodransky & Hermann, 2011

61 Byrnes, M. (2011, Sept. 21). Is *Bicycling Commuting Really Catching On? And if so, Where?* Retrieved from http://www.theatlanticcities.com/commute/2011/09/substantial-increases-bike-ridership-across-nation/161/. See also Pucher et al., 2011. New York lags far behind US leaders such as Portland (5.8%), Seattle (3%), Minneapolis (3.9%) as well as Canadian cities such as Vancouver (3.7%), Montreal (2.4%), and Toronto (1.7%)

62 Pucher et al., 2011. New York has 8 km of bike lane/capita as of 2010. Compare with Montreal (27 km/capita), Washington, DC (27 km/capita), Minneapolis (70 km/capita), and Portland (73 km/capita). The figures for bike parking facilities are similar, with New York at 75 spaces/capita as compared with Montreal (802 spaces/capita), Washington, DC (1056 spaces/capita), Minneapolis (4599 spaces/capita), and Portland (725 spaces/capita)

63 ibid

Regulation:

Road Space Rationing and Zoning: Road space has been re-allocated through the creation of pedestrian-only zones, expanded sidewalks, and the conversion of curbside parking into public seating areas.[64] *Green Light for Midtown*, initiated in 2009, involved repurposing large sections of existing road into pedestrian-only zones (with public seating) along with dedicated bike lanes. Additional measures were taken to improve traffic flow. The conversions have resulted in increased travel speeds for automobiles, substantial decreases in pedestrian and vehicle-related injuries, and increased pedestrian volumes.[65] Over 20% of the city has been rezoned with the goal of increasing population density around areas well-served by transit.[66] These regulations have the potential to substantially impact the demand for travel, as well as the non-automotive modal share, by enabling growth in parts of the city that are well-served by transit and encouraging increased population density and mixed use.[67]

London (UK):

In London, CO_2 emissions from transportation have remained constant at roughly 21% of the citywide total over the past two decades, and in absolute terms have shown a small increase of 0.14 Mt CO2.[68] On a per capita basis, however, emissions from transportation have been reduced considerably – population increased by nearly 13% over the same span of time.[69] Road traffic in the city trended downward between 2000 and 2009, with total car distance traveled declining by 6.5% while the percentage of all trips made in the city by car/motorcycle transportation dropped from 43% to 37%.[70] At the same time, public transportation (subway, bus, and rail) increased from a 34% to 41% share of all trips in the city and cycling doubled from 1% to 2% of all trips. [71] From 2000 to 2009 bus transportation increased from 15% to 21% of all trips within the city. Cycling in London increased by 83% between 2002 and 2008. Nonetheless, the percentage of Londoners traveling by bicycle remains much closer to the North American average and far below front-running European cities such as Amsterdam and Copenhagen.[72]

Despite population growth of 13%, transportation-related emissions on a per-capita basis have declined along with levels of total road traffic, distance travelled and trips made by cars and motorcycles.

64 New York City Department of Transportation, Pedestrians & Sidewalks Website. Available at: http://www.nyc.gov/html/dot/html/sidewalks/sidewalks.shtml

65 New York City Department of Transportation, About DOT Website. Available at http://www.nyc.gov/html/dot/html/about/broadway.shtml

66 Furman Center for Real Estate and Urban Policy. (2010). How Have Recent Rezonings Affected the City's Ability to Grow? Retrieved from http://furmancenter.org/files/publications/Rezonings_Furman_Center_Policy_Brief_March_2010.pdf. Between 2003 and 2007 over 70% of all upzonings (rezoning actions that increase population density by >10%) took place in areas within a ½ mile walk of an entrance to the subway system or other regional rail services.

67 City of New York, 2007b

68 Greater London Authority. (2011). *State of the Environment Report for London, June 2011.* Available at http://data.london.gov.uk/datastore/package/state-environment-report-london-june-2011. The most recent data show emissions a decline in CO2 emissions from road transportation, from 19.5% of total city GHG emissions in 2005 to 18.8% in 2010, in absolute terms of decline of 0 .74 Mt CO2e

69 Greater London Authority, 2011

70 ibid

71 ibid

72 Pucher, J. & Buehler, J. (2007). *At the Frontiers of Cycling: Policy Innovations in the Netherlands, Denmark, and Germany.* Retrieved form http://ejb.rutgers.edu/faculty/pucher/Frontiers.pdf

Sustainable Transportation Policy and Planning: Enacting legislation mandates the Greater London Authority (GLA) to produce and periodically review a spatial development strategy for London that integrates economic, transportation, environmental, and social interests.[73] In response to chronic underinvestment in public transportation, projections regarding increases in population and work commuting, and costs related to congestion and carbon pollution, in 2006 the city produced *T2025: Transport Vision for a Growing World City*, a 20 year strategic planning document. The plan includes the objective of reducing CO_2 emissions from transport by 22% by 2025. It is integrated with both the Climate Change Action Plan (2007) and the city's foundational strategic planning document, The London Plan (2004).[74] Oversight for transportation actions is the responsibility of Transport for London (TfL), an arms-length agency over which the Mayor has considerable influence, while sustainability policies across the metro region are overseen by GLA staff.

MBIs:

London is a pioneer in the use of pricing mechanisms to drive transformation in the transportation sector, and relies heavily on such measures to induce change as well as fund investment in alternative options.

Road Pricing: A central city congestion system was introduced in 2003. All vehicles (with the exception of emergency vehicles, public transport, taxis, and high efficiency vehicles) pay a price to enter this central zone.[75] Vehicles are identified, and payments allotted, through the use of a camera and license place recognition system. The immediate results were significant – after one year there was a 21% decrease in overall traffic, a 30% decline in congestion, and a 43% increase in cycling.[76] The system showed a net profit of £137 million in 2006, with the bulk of this (82%) used to fund improvements in the bus network.[77] In spite of these positive effects, attempts to expand the system were rescinded following concerted political resistance.

As a complement to the congestion system, the city created a Low Emissions Zone (LEZ) in 2008 that covers most of the city. The LEZ sets pollution standards for all vehicles operating in the zone, with strict financial penalties on vehicles that do not meet the standards. The full-time system is supported by a camera and automatic license plate recognition system linked to a database of registered vehicles.[78]

73 Ween, C. (2012). London, England: A Global and Sustainable Capital City. In T. Beatley (Ed.), *Green Cities of Europe: Global Lessons on Green Urbanism. London:* Island Press.

74 Greater London Authority. (2007). London CO2: *Action Today to Protect Tomorrow. The Mayor's Climate Change Action Plan.* Retrieved from http://legacy.london.gov.uk/mayor/environment/climate-change/docs/ccap_summaryreport.pdf; Greater London Authority. (2004). The London Plan. Retrieved from http://legacy.london.gov.uk/mayor/strategies/sds/london_plan/lon_plan_all.pdf; Transport for London. (2006). *T2025: Transport Vision for a Growing World City.* Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.135.5972&rep=rep1&type=pdf. The GLA updated the London Plan in 2011 and the Transport Strategy in 2010. While the GLA has officially adopted a GHG mitigation target of 60% below 1990 levels by 2025, it has also explicitly acknowledged its' reliance on actions taken by other levels of government in order to achieve this objective.

75 Ween, 2012

76 ibid

77 Transport for London. (2008). *Central London Congestion Charging. Impacts Monitoring.* Retrieved from http://www.tfl.gov.uk/roadusers/congestioncharging/6722.aspx:

78 Litman, T. (2011). London Congestion Pricing: Implications for Other Cities. Retrieved from http://www.vtpi.org/london.pdf

Several GLA boroughs have updated on-street parking fees, making use of differential rates based on time of day (peak vs. non-peak) level of vehicle CO_2 emissions (higher polluting cars pay more), and free parking for electric and car share vehicles.[79]

Service Provision:

While pricing mechanisms have been the major thrust of London's policy intervention, several supply-oriented initiatives decrease the relative cost of alternative modes of transportation and encourage modal shifting.

Enhanced Public Transportation Services: Roughly 80% of net revenue generated from the congestion charge program is invested in improvements to the bus system. Beginning in 2000, the city introduced nearly 200 miles of dedicated bus lanes, providing real-time service information at bus stops and on buses, and prioritizing traffic signals for bus transport.[80] These measures contributed to an increase in ridership of nearly 60% from 2001 to 2009.[81] The Underground metro system was upgraded – expanding service, increasing system efficiency through better signaling and coordination, and upgrading stations. The introduction of a single fare, integrated payment system – the Oyster Card – facilitated use of public transportation and movement between subway, bus, and light rail by speeding up transfers and boarding.[82]

Alternative Transportation Infrastructure and Services: A 6000 bike/400 station bike share system, modeled on the Parisian Velib', was introduced in London in 2010. Funded through a sponsorship naming-rights deal with Barclays Bank, the system is complemented by four dedicated bike lanes linking the outer areas of London with the core, and a network of bike lanes throughout the city. The vast majority of these bike lanes, however, are not physically separated from car traffic, and the city makes relatively minimal use of traffic-calming measures. An increase in the annual cycling budget by over 330% between 2000 and 2007 was used to expand the cycling network in the city, provide education and cycle safety training, increase the number of parking facilities for bikes throughout the city, and improve the integration of biking with other modes of public transit.[83] The provision of cycling facilities is mandatory in all public facilities and cycling and pedestrian infrastructure are mandatory components for all new developments requiring GLA approval.[84] However, cycling continues to hold a very low mode share – 1.6% of all trips as of 2010.[85]

79 Kodransky & Hermann, 2011.; Greater London Authority, 2011. Jurisdiction over on-street parking was officially devolved to borough councils as part of The Road Regulation Act (1991). Similarly, the GLA has little direct control over parking regulations. However, several boroughs have updated or discarded parking minimums for new developments in areas that are well-served by public transit.

80 Ween, 2012; Greater London Authority, 2007; Greater London Authority, 2011

81 Ween, 2012

82 Ween, 2012; Greater London Authority, 2007

83 eutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). (2012). *Urban Transport Climate Change Action Plans: Examples from Hamburg, London and Tokyo.* Retrieved from http://www.tdm-beijing.org/files/UTClimateChangeAP_144dpi.pdf

84 Greater London Authority, 2004; Greater London Authority, 2007; Greater London Authority, 2011

85 Pucher et al., 2011

A supportive infrastructure for electric vehicles is being developed, with charging points throughout the city (400 currently installed; 1300 planned by 2013) and mandatory charging points (or capacity to install) in all new developments requiring GLA approval.[86] These measures are relatively recent, and so it is difficult to ascertain their effect. Public and road space has been re-allocated to increase walkability, including widening sidewalks, tree planting, construction of pedestrian bridges across the River Thames, and provision of information and services to citizens.[87] However, authority for the reallocation of road space away from automobiles and the use of traffic calming measures is at the council level, leaving the GLA with limited capacity to use this approach.

Re-allocating road space for alternative modes of transportation is a primary component of Paris' transportation policies.

Paris:

Paris is one of the densest cities in the world and has a well-developed transit system and a highly compact and walkable urban profile.[88] Transportation accounts for 24% of total GHG emissions in the City of Paris.[89] Emissions from transportation decreased by 1% between 2004-2009, despite population growth of roughly 3%.[90] Over this time, emissions from passenger vehicles declined substantially (-16%), while emissions from public transit showed a slight increase (+5%) likely as a result of modal shifting to bus, rail, and tram systems.[91] The total distance traveled by car in Paris decreased by 13% from 2003 to 2007.[92] The focus of sustainable transportation policy in Paris has been to re-allocate road space away from private automobiles and towards alternative modes of transportation and increase the availability, quality, and frequency of public transit services.

Sustainable Transportation Policy and Planning: The city first explicitly engaged in climate change and transportation governance in 2007 with the release of the Paris Transportation Plan (PTP) and Paris Climate Plan. The PTP set out to reduce GHG emissions from transportation 25% by 2013, and by 60% by 2020 (relative to 2004 baseline emissions) by reducing car use while shifting transportation to low and no-carbon modes such as walking, cycling, and public transportation.[93]

86 Greater London Authority, 2011

87 Ween, 2012

88 Weinstock, Hook, Replogle, & Cruz, 2011. The corresponding figures for the GLA and New York City are 4761/square km (GLA) and 2,050 (New York City).

89 Mairie de Paris. (2009). *Bilan Carbone 2009.* Retrieved from http://observatoire.pcet-ademe.fr/data/bilan_carbone_2009_4pages_fr.pdf

90 ibid

91 Separate data indicate that between 2001 and 2007 – prior to development of the PDP – car traffic declined by 19% in Paris. See Laurian, L. (2012). Paris, France: A 21st Century Eco-City. In T. Beatley (Ed.), *Green Cities of Europe: Global Lessons on Green Urbanism.* London: Island Press.

92 Weinstock, Hook, Replogle & Cruz, 2011

93 Mairie de Paris. (2007). *Paris Climate Protection Plan.* Available at http://www.energy-cities.eu/Paris-climate-protection-plan; Edwards, T. & Smith, S. (2008). *Transport Problems Facing Large Cities.* Retrieved from http://www.parliament.nsw.gov.au/prod/parlment/publications.nsf/key/TransportProblemsFacingLargeCities/$File/TransportFINALindex.pdf

The PTP reaches beyond the jurisdictional authority of the city, aiming for a regional approach to transportation sustainability. [94] Implementation, oversight and coordination is the responsibility of the Urban Ecology Agency, located within the Department of Parks and Environment, but is limited as a result of jurisdictional fragmentation. [95]

MBIs:

Paris has made limited use of MBIs as a result of jurisdictional fragmentation and political resistance.[96] However, the city has increased the cost of parking, removed minimum parking requirements for new developments within a 500-meter range of existing metro stops, and reduced the supply of on-street and curbside parking. Political resistance was, at least in part, overcome by simultaneously reducing the cost of street parking for residents living in the outer neighborhoods. Road space previously dedicated to on-street parking has been reallocated to other uses such as Velib' and Autolib' docking stations and motorcycle/scooter parking. Total on-street parking supply in the city was reduced 9% from 2003-2007, while at the same time 95% of free parking spaces were converted to paid parking spaces.[97] These measures, first adopted in 2001, are correlated with an 11% decline in traffic in the city. [98]

Service Provision:

Enhanced Public Transportation Services: Paris, together with regional and national stakeholders, introduced the Mobilien bus network in 2004. Mobilien is a BRT system with 17 lines with dedicated, physically separated lanes, priority signaling, and raised stations, supported by real-time service information. While implementation has lagged behind objectives, the system has contributed to a 17% increase in total number of trips using public transportation in the city.[99]

Alternative Transportation Infrastructure and Services: A substantial amount of road-space has been re-allocated to cyclists, pedestrians, and bus traffic. Over 440 km of cycling lanes have been added since 2001, for a total network of over 640 km.[100] The city has built 190 km of dedicated lanes that are shared by buses and taxis, a portion of which (nearly 70 km) are physically separated.[101] In 2007 Paris introduced the Velib' bike share system with 20,000 bikes and 1,450 docking stations located throughout the city.

94 Mairie de Paris, 2007.

95 Travers, T. (2006). Governance for Metropolitan Sustainability. *In Competitive Cities in the Global Economy.* OECD Publishing.

96 Prud'homme & Kopp, 2008. There is some indication that the National Government did consider a congestion charge system for the City of Paris in 2006 but it was not supported by the City Government and was dropped as a result of political resistance.

97 Kodransky & Hermann, 2011

98 ibid

99 D'argent, C. Huard, A., Fremiot, A. & Lefebvre, P. (2012). *Shared mobility /Shared spaces: Parisians examples.* Retrieved from www.impacts.org/euroconference/Paris2012/presentations/1_Paris.pdf

100 ibid

101 Laurian, 2012

The second-largest such system in the world, Velib' currently has over 220,000 subscribers and an average of over 100,000 trips per day.[102] The city then introduced Autolib', a car-sharing service, in 2011, featuring 1,700 electric vehicles and 1,100 charging stations located throughout the city.[103]

Regulations:

Road Space Rationing: Regulations allowing two-way cycling on one-way roads in low-speed zones effectively add 700 km of bike lanes across the city.[104] The regulations, combined with increased road space for alternative modes of transportation, have contributed to a 48% increase in cycling as a percentage of total trips in the city, as well as a 20% decrease in public vehicle and 11% decrease in truck and tour bus use.[105] However, the modal share for cycling in Paris (2.5%) remains much lower than other European cities such as Amsterdam (37%) and Copenhagen (20%).[106]

The Quartiers Verts (Green Neighbourhoods) program was launched in 2002 to slow traffic and increase pedestrian safety and comfort (wider sidewalks, speed bumps, pedestrian crossings, bike lanes, tree plantings, reduced speed limit). These neighbourhoods now cover over 21% of the total area of the city.* Paris has also aggressively updated the allocation of public space to pedestrians. From 2001-2009 the total area allocated to streets was decreased by 5% while the allocation to sidewalks was increased by 13%.** Time-specific car-free zones close some city roads to car traffic and open them up to cyclists and pedestrians.*** The most prominent examples are Paris Plage, which shuts down a large section of the Pompidou Expressway to car traffic for one month in the summer, and Paris Respire, which converts central city roadways to pedestrian-only zones each Sunday.†

Sources:
* Laurian, L. (2012). Paris, France: A 21st Century Eco-City. In T. Beatley (Ed.), Green Cities of Europe: Global Lessons on Green Urbanism. London: Island Press.
** ibid
*** ibid
†70,000 cars per day use this road, which traverses Paris and runs alongside the Seine River.

102 The Bike-sharing Blog. Available at: http://bike-sharing.blogspot.ca/search/label/Paris
103 Autolib' Website. Available at: https://www.autolib.eu/
104 ibid
105 Nadal, L. (2008). Bike Sharing Sweeps Paris Off Its Feet. *Sustainable Transport*, 19. Retrieved from http://www.itdp.org/documents/st_magazine/ITDP-ST_Magazine-19.pdf
106 Pucher & Buehler, 2007

Implications for Policy-Makers

This Policy Brief reviews market-based policy options for addressing transportation challenges in cities, and the experience with bundling these with services and regulation in three international cities. The following conclusions are of direct relevance to policy-makers engaged in the development of urban and transit policy in Canada.

- ***Use Market Incentives Through Both Demand and Supply Interventions:***
  Adjusting prices leads individuals to reconsider the extent, and mode, of their travel. Fiscal measures can reinforce land use, transit investment and other mode shift strategies and the three case studies illustrate the flexible bundling of market-based instruments with services and regulations to encourage change in the transportation sector. For example, London's congestion charging system combined with the Low Emission Zone helps to dissuade driving in the city centre. In order to effectively drive change in the transportation sector and reduce GHG emissions, an integrated combination of policy tools is needed. However, experience shows that over-emphasizing one approach in the policy bundle at the expense of others is likely to be unproductive, since it reduces the resilience of local policy and increases the risks of political resistance.

- ***Leverage Co-Benefits; Beware of Cross-Purposes:***
  Increasing sustainability in the transportation sector can be framed in multiple ways. These include: improving public health, economic productivity, quality of life, and creating economic and employment opportunities. Co-benefits thus offer a powerful means of overcoming local political resistance, getting transportation-related issues onto the local agenda, and implementing transformative policies. However, sensitivity to the possible tensions between competing objectives is needed.[107] While Paris has re-purposed road space into pedestrian or cycling infrastructure to encourage modal shifts in the city core, the benefits of these actions are not felt in areas of the city that rely on longer-distance commuting or that have lower access to public or alternative modes of transportation. Therefore, cities should use the multiple modes of authority they possess to pull multiple policy levers, while remaining sensitive to the ways these policies interact with each other.

- ***Integrate and Balance Policy Interventions:***
  Responsibilities for actions related to transportation are often distributed across multiple city departments and agencies (streets, land-use and zoning, transportation,

107 Bulkeley, H, Betsill, M. (2003). *Cities and Climate Change: Urban Sustainability and Global Environmental Governance.* London, UK: Routledge.

parks) requiring coherence and coordination so that actions are synergistic and not at cross-purposes. Integration across sectors, departments, and authority mechanisms likely requires integration of transportation actions into broader sustainability plans and objectives, high-level oversight within city government, and ongoing review and revision in order to remain sensitive to unintended consequences and contingencies. As the range of possible interventions expands, they need to be coordinated across municipal departments and agencies and integrated with overarching climate and sustainability strategies. In New York, zoning to encourage a shift to alternative modes of transportation and reduce travel demand was undermined by continued subsidies to automotive transportation through mandated minimum parking provision for all new developments and underpriced or free on-street parking.[108] Effective polices are those that integrate policy interventions in broader sustainability planning and objectives.

- ***Empower Cities and Enable Flexibility:***

  Pricing mechanisms can both influence behavioural change and generate revenue for municipal services and infrastructure. However, pricing mechanisms can be politically undesirable as they inherently increase visible costs for local users. Increased financial support from upper levels of government enables cities to design innovative policy options that do not rely entirely on the ability to levy charges and fees on local citizens. For example, the UK government, by providing financial and jurisdictional authority to the GLA, enabled the city to implement both the congestion zone and regulatory measures such as the Low Emissions Zone. Paris, on the other hand, is jurisdictionally reliant on other actors (regional and national government). This limits the capacity of the city to combine regulatory and provision measures with pricing schemes, which may undermine the ability to achieve transportation sector objectives. Providing access to a substantial and stable pool of financial resources can allow cities to complement MBIs with improvements in alternative transportation infrastructure and services that might not otherwise be possible due to local resource constraints.

- ***Improve Coordination:***

  While cities have various jurisdictional, authority, and policy levers with which to encourage and enable meaningful change, they nonetheless require coordination or cooperation with other levels of government in order to produce transformative change.[109] Cities, after all, are embedded in broader metropolitan agglomerations or economic regions, and thus the challenges of governance are increasingly regional in addition to municipal.[110] Simply put, while city governments may address transportation

108 McDonnell, S., Madar, J., Been, V. (2011). Minimum Parking Requirements and Housing Affordability in New York City. *Housing Policy Debate*, 21(1), 45-68.

109 Gordon, D. (2013). Between Local Innovation and Global Impact: Cities, Networks, and the Governance of Climate Change. *Canadian Foreign Policy Journal,* 19(3), 288-307.

110 Berube, A. & Rode, P. (2010). *Global MetroMonitor: The Path to Economic Recovery.* Retrieved from http://www.brookings.edu/research/reports/2010/11/30-global-metro-monitor

within city borders, it is increasingly difficult to address transportation actions taking place outside of them. Long-range commuting and exurban sprawl, and the gaps in public transit that often exist between outer edges and the urban core may completely offset improvements in transportation within the city.[111] This can lead to political tension between the city core and the suburbs, and to resentment if policies are keyed towards one set of constituents (inner core transit-reliant households) at the perceived cost of others (suburban households that lack meaningful transportation alternatives).[112] For example, Paris experiences a stark distinction between the inner city and the rest of the regional agglomeration: the former well-served by public and alternative transit services and infrastructure and exhibiting much higher modal shares as a result; the latter remaining car-oriented and poorly connected to the dense network of alternative transportation services and infrastructure. Managing these sorts of tensions will require the resources and political capacity of higher levels of government: to provide investments or incentives that can satisfy the legitimate concerns of suburban households regarding unfair cost imposition; to create and empower regional governing bodies or act as regional coordinators; to give cities the authority to implement policy mechanisms; to invest in public transportation services and infrastructure linking urban fringe to city core. Canada is the only G8 country without a national, long term public transportation funding strategy, and this paper identifies the importance of co-ordinated and integrated multi-level government strategies to support the shift towards sustainable transportation. In Canada, coordination between cities, provinces, and the federal government has been, historically, quite limited.[113] However, coordination across all levels of government will be necessary if cities, and Canada in general, are to achieve transformation in the transportation sector.[114]

111 This includes emissions related to inter-urban air travel, which is not included in municipal city-wide emissions inventories and is an increasing source of GHG production that is very difficult to govern on a city by city basis.

112 Taylor, Z. (2011). *Who Elected Rob Ford and Why? An Ecological Analysis of the 2010 Toronto Election,* Paper presented at the annual CPSA conference, Waterloo, ON. Available at: http://www.cpsa-acsp.ca/papers-2011/Taylor.pdf; Hulchanski, D. (2007). *The three cities within Toronto: income polarization among Toronto's neighbourhoods*, 1970–2000. Retrieved from http://www.urbancentre.utoronto.ca/pdfs/curp/tnrn/Three-Cities-Within-Toronto-2010-Final.pdf

113 Gore,C. (2010). The limits and opportunities of networks: municipalities and Canadian climate change policy. *Review of Policy Research,* 27 (1), 27- 46.

114 A promising step in this regard are recent efforts by the federal government to engage cities in consultations regarding renewal of the national infrastructure fund. See Federation of Canadian Municipalities. *Infrastructure: about the issue.* Available from: http://fcm.ca/home/issues/infrastructure/about-the-issue.htm

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