

JCCTRP Working Paper Series 2018-1

# Decarbonizing Road Transportation in Ontario

BY COLLEEN KAISER, PHD CANDIDATE

YORK UNIVERSITY FACULTY OF ENVIRONMENTAL STUDIES



NOVEMBER 28, 2018

## CORRECT CITATION

Kaiser, Colleen (2018) *Decarbonizing Road Transportation in Ontario*. JCCTRP Working Paper 2018-1. Joint Clean Climate Transport Research Partnership (JCCTRP): Montreal.

## COPYRIGHT

This Working Paper is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License. It may be freely quoted and reproduced provided the source is acknowledged. No use of this publication may be made for resale or other commercial purposes.



This working paper is intended to stimulate discussion within the research community and among users of research, and its content may have been submitted or will be later submitted for publication in an academic journal. Comments and feedback are welcome. Any opinions stated herein are those of the authors and do not necessarily reflect the opinions of the JCCTRP.

## FINANCIAL DISCLOSURE

This paper was produced with support of the JCCTRP which has received a Partnership Development Grant from the Canadian Social Sciences and Humanities Research Council (SSHRC).

## ABOUT THE JCCTRP

The Joint Clean Climate Transport Research Partnership (JCCTRP) is a new research partnership that brings together leading universities, private research institutes, businesses and non-profit organizations from Quebec, California, Ontario and Vermont working on transport and climate policy. Its Secretariat is based at the *École des sciences de la gestion* at the *Université du Québec à Montréal (ESG-UQÀM)*. The ultimate goal of the JCCTRP is to identify the technical, economic and political factors shaping the potential for effective, cost-effective, and politically viable low-carbon transport and climate mitigation policy, and understand their implications for emissions trading.

WEB: [WWW.JCCTRP.ORG](http://WWW.JCCTRP.ORG)

EMAIL: [INFO@JCCTRP.ORG](mailto:INFO@JCCTRP.ORG)

CONTENTS

**Executive Summary ..... 1**

**Introduction ..... 4**

**Ontario: Climate change policies..... 5**

    Early Legislation Related to GHG emissions and Air Pollution..... 5

    Ontario Climate Change Policy to June 2018 ..... 7

        Climate Change Action Plan ..... 11

**Reducing emissions from the passenger transportation sector..... 12**

    Cleaner Vehicles ..... 13

        Reducing emissions from ICE vehicles ..... 14

        Policies to Promote Alternative Clean Vehicles (EVs, ZEVs, Hybrids etc.)..... 19

        Funding and Support for Research and Development, Industry Partnerships, and Local Industry Development ..... 21

        Government Procurement and Pilot Projects ..... 23

        Information Measures ..... 23

    Transportation Demand Management..... 24

        Transit-Integrated Land-Use Planning, Smart-Growth Measures..... 24

        Other TDM Measures..... 31

**Reducing Emissions from the Freight Transportation Sector ..... 33**

**Potential changes under the new Progressive Conservative government..... 35**

**Conclusion..... 36**

**References ..... 38**

**Appendix A: A note on ‘rebound effects’ and perverse incentives..... 49**

## EXECUTIVE SUMMARY

There has been a growing interest and body of research on sustainable transportation systems; as the second largest producer of carbon emissions globally (Kivimaa and Virkamäki 2014), intensified focus on the transportation sector makes logical sense given the growing significance of transportation-related emissions and the pressing challenge of global climate change. Transportation systems are multifaceted and interlinked, requiring much more than the dominant focus on the technological efficiency of vehicles (Kivimaa and Virkamäki 2014), especially given the ambition of climate targets and the complexity involved in effectively promoting a socio-technical transition to a low-carbon transportation system. Reflecting this need, there has been a growing interest and focus on demand side management and a broadening of scope in transport planning, witnessed by an increase in diverse short and long-term measures, such as improved cycling and walking infrastructure, car-sharing, teleworking, pricing mechanisms, increased supply of public transit and (critical for long-term change) strategic land-use planning geared at promoting sustainable transportation modes (Kivimaa and Virkamäki 2014).

Transportation-related emissions account for nearly one third of Ontario's greenhouse gas (GHG) emissions, the largest of any share, making the reduction of these emissions "the biggest opportunity - and also the biggest challenge - to achieving Ontario's 2020 GHG reduction target." (Mahony 2016, 9-57). While total emissions have fallen in the province, roughly 6% between 1990 and 2014, transportation-related emissions grew by 27% (Environment and Climate Change Canada 2016; cited in Government of Ontario 2017b). Passenger transportation emissions (cars, trucks, bus, rail, domestic aviation) accounted for roughly 66% of transportation-related emissions in 2014, growing 15% since 1990, due primarily to increased vehicle miles traveled (VMT) and an increase in fleet composition of larger vehicles like SUVs, minivans and pick-up trucks (Government of Ontario 2017b). Freight emissions are also significant, making up roughly 30% of transport-related emissions in 2014 (Government of Ontario 2017b). The road freight transportation sector has seen major increases (68%) in emissions since 1990, a product of shifts to just-in-time delivery in the manufacturing sector, and to warehousing, distribution and large-scale retail in the commercial sector.

There are many ways to classify measures to achieve emission reductions in the transportation sector, including by policy goal, by level of government, or by regulatory vs. market mechanisms. This research on road passenger transportation utilizes two broad categories to organize decarbonization efforts in the Province of Ontario: 1) cleaner vehicles and 2) transportation demand management. These categories represent the two key goals of policies and mechanisms aimed at developing a low carbon transportation system: 1) make passenger vehicles emit less GHGs, and 2) reduce the number of vehicles on the road. The establishment of an economy-wide carbon price acts to bolster these specific efforts.

Following a steadily-increasing intensity in efforts beginning in the early 2000s, the current legislative/climate change governance approach prior to the 2018 provincial election represented a peak in directly addressing GHG emission mitigation by the Ontario provincial government. The 2015 Climate Change Strategy, the *Climate Change Mitigation and Low Carbon Economy Act* (2016) and the 2016 five-year Climate Change Action Plan, represented critical pieces of the most recent climate change governance regime.

Ontario's Climate Change Strategy was released in November 2015, setting the Government's vision to 2050 for how it would grow a prosperous, low-carbon and resilient society and economy (Government of Ontario 2017a). Importantly, the Strategy contained a commitment to release a more detailed five-year climate change plan outlining specific commitments and initiatives to meet interim and long-term emission reduction targets (Wood 2017). On May 19, 2016 the *Climate Change Mitigation and Low Carbon*

*Economy Act* (2016) received Royal Assent. This landmark piece of legislation provided an overarching, long-term framework for tackling the issue of climate change in the Province of Ontario, including establishing targets for greenhouse gas (GHG) reductions in a legal statute for 2020, 2030 and 2050: 15% below 1990 levels for 2020, 37% below 1990 levels by 2030 and 80% below 1990 levels for 2050 (Government of Ontario 2016; Ontario Ministry of Environment and Climate Change [OMECC] 2017; Osler 2018).

Central to the Government's approach to GHG emission mitigation was the introduction of a cap and trade system in the Province. The *Climate Change Mitigation and Low Carbon Economy Act*, (2016) laid the legal foundation for the cap and trade program to begin in 2017, the proceeds of which are directed to a new fund, the Greenhouse Gas Reduction Account, supporting activities and projects that will reduce GHG emissions in the Province (Government of Ontario 2018). The Act also required a comprehensive climate change action plan (CCAP), which was produced for the years 2016-2020, and provided a framework for reviewing and revising GHG reduction target stringency and the ability to introduce interim targets (OMECC 2017; Government of Ontario 2016a).

It is not surprising that as the largest source of emissions, transitioning to a low-carbon transportation system is a central focus of the plan. In addition to longer-term TDM strategies, such as land-use planning efforts, promoting active transportation and transit expansion, the plan contains ambitious initiatives to promote the diffusion of cleaner vehicles. A key critique of the plan has been that these emission reductions will come at a very high cost. In general the CCAP is very much a top-down government-led approach. Some economists argue that this will be less efficient than other approaches, for example, setting a broad carbon tax and letting the market determine which clean technologies will reach market maturity and commercialization. Other recent commentaries have highlighted the importance of strategies employing the full range of policy tools: regulatory; economic; and informational in achieving major reductions in GHG emissions (Jaccard, Hein and Vass 2016; Winfield 2016a).

It has only been over the past ten years that both federal and provincial efforts to lower emissions from the transportation sector have been framed in terms of climate change mitigation. Longer-standing approaches, such as transportation demand management, provision of enhanced transit services, vehicle emission standards and fuel taxes, were primarily aimed at reducing smog, traffic congestion and urban sprawl. In the case of fuel taxes, there were also a means of raising revenues for the Government. The phase out of coal-fired electricity in 2014, which a decade earlier had provided 25 per cent of the province's electricity supplies, has significantly decarbonized the electricity system. This has highlighted the importance of the transportation sector in terms of where further major emissions reductions might be achieved in pursuit of the province's overall GHG emission reduction target.

The province's now relatively low-carbon electricity system, which consistently produces surpluses overnight, has made the increased use of EVs in the Province a very attractive method for reducing transportation-related emissions, and using up surplus electricity supplies. The province had introduced a host of supply-push and demand-pull initiatives to promote the growth of the EV market in Ontario; these are necessary to compliment the economy-wide carbon price, which is said to have a relatively weak signal for transportation (Macedonia 2017). Not only had the number of government initiatives proliferated in recent years, the actual amount of dedicated funding for these programs was significant. For example, Ontario subsidies/incentives for purchasing cleaner vehicles were by far the highest in North America (Richardson and Lightstone 2018). It is important to note that there are concerns over the economic efficiency of these subsidies, which are estimated to cost \$523 CAD per every tonne of emissions reduced (Green 2017).

Land-use planning was emerging as a potential key lever for the Government to curb transportation-related GHG emissions. Although the connection between land-use planning, transit supportive development and

transportation demand management began to be made in the 1990s, specific references to the need to reduce GHG emissions and address climate change impacts were only incorporated into provincial planning policies on from 2014 onwards. Regional planning efforts, specifically in the Greater Toronto Hamilton Region (Canada's largest urban area), have become much more sophisticated and nuanced in integrating environmental objectives, with a particular focus on expanding transit. In order to support these objectives, the Government, particularly under recent Liberal Party administration (2003-2018), established various mechanisms for funding mass transit projects, sought money from the federal government, and ended a long period of transit underinvestment. However, specific major transit investments continued to be strongly influenced by political considerations, as opposed to rational planning or transportation emission reduction considerations.

Complimentary TDM measures, that are substantive and designed to work directly in concert with land-use planning and transit expansion efforts, have only been introduced in recent years, spurred on by a reinvigorated focus on addressing climate change issues beginning with Ontario's Climate Change Strategy in 2015. In particular, efforts to promote active transportation (especially cycling) in order to support a modal shift in commuting behaviours, as well as more nuanced approaches to differential road treatments, like HOV and HOT lanes, have formed a central part of recent TDM programs. Funding TDM projects like the expansion of cycling infrastructure also increased along this same time period.

On June 7, 2018 Ontarians elected a Progressive Conservative Party (PC) government, led by Doug Ford, with a majority of seats in the provincial legislature (Elections Ontario 2018). The new PC Government stands in stark contrast to the previous Liberal Government (2003-2018) on many issues. Some of the most dramatic departures have been on the issue of carbon pricing and aggressive action on climate change mitigation. The most clear example of this has been the government's withdrawal from the Western Climate Initiative and termination of Ontario's cap and trade program (Office of the Premier Designate 2018; Buchta, Corpuz and Coburn 2018).

Other early changes include renaming the Ministry of Environment and Climate Change to the Ministry of Environment, Conservation and Parks, eliminating the 'climate change' from the title (McGrath 2018). More substantively, a series of programs intended to be funded through cap and trade revenues including: subsidies for electric vehicles, subsidies for work and home EV charging installations, and the the Ontario Municipal Cycling Commuter Program (Blinch 2018) have been cancelled. Funding for home and business energy efficiency retrofits, renewable energy projects and other climate change related initiatives has also been terminated (Winfield 2018).

In addition to terminating the province's own climate change initiatives, the province has launched a legal challenge against the federal government's imposition of a carbon-backstop pricing regime for provinces who do not already have an equivalent pricing scheme. The challenges is unlikely to successful. (Sharp 2018; Buchta, Corpuz and Coburn 2018; Rolfe 2018). The fate of the province's has GHG emission reduction targets established through *Climate Change Mitigation and Low Carbon Economy Act* (2016) remains unclear.

## INTRODUCTION

There has been a growing interest and body of research on sustainable transportation systems; as the second largest producer of carbon emissions globally (Kivimaa and Virkamäki 2014), intensified focus on the transportation sector makes logical sense given the growing significance of transportation-related emissions and the pressing challenge of global climate change. Transportation systems are multifaceted and interlinked, requiring much more than the dominant focus on the technological efficiency of vehicles (Kivimaa and Virkamäki 2014), especially given the ambition of climate targets and the complexity involved in effectively promoting a socio-technical transition to a low-carbon transportation system. There are also diverse actor interests involved in the transportation system, all of which must be targeted through policy measures to ensure a comprehensive and effective approach. For example, the US Transportation Research Board (2011) classifies three major groups of actors:

- *Transportation consists of three broad groups of actors: (a) the suppliers of transportation vehicles, fuel, and infrastructure; (b) the owners and operators of the vehicles and providers of the transportation services; and (c) the users of transportation services. The composition, interests, and roles of each differ, and they can vary greatly by mode. Thus, strategies and policies to influence transportation energy use and emissions must take these decision makers and their differing incentives, interests, and capabilities into account. (pp. 99)*

Reflecting this need, there has been a growing interest and focus on demand side management and a broadening of scope in transport planning, witnessed by an increase in diverse short and long-term measures, such as: improved cycling and walking infrastructure, car-sharing, teleworking, pricing, increased supply of public transit and (critical for long-term change) strategic land-use planning geared at promoting sustainable transportation modes (Kivimaa and Virkamäki 2014). At a more macro level, transportation as a policy issue, like the environment, necessary entails policy integration across sectors. The challenge of difficult institutional conditions related to the highly siloed nature of governments poses, in some way, a double complication to the integration of climate change objectives into the transportation sector, as both of these areas are highly subject to what Banister (2002) calls ‘the institutional/political structure barrier’ to the implementation of sustainable transport policies (Hatzopoulou and Miller 2008).

Many of the mechanisms to reduce emissions from the transportation sector are not novel. For example, mechanisms for promoting a sustainable transportation system such as government support for electric vehicles, high-speed rail and alternative fuels are mentioned in articles that are over twenty years old (e.g. Rienstra, Vleugel and Nijkamp 1996). While Rienstra et al. (1996) mention ‘telematics’, arguably the biggest change in policy options has been the immense technological progression witnessed in the past two decades, which has provided a new set of opportunities to reduce emissions from the transportation sector via information and communications technology (ITC) (and its applications).

There are many ways to classify measures to achieve emission reductions in the transportation sector, including: by policy goal, by level of government, or by regulatory vs. market mechanisms. This research on road passenger transportation utilizes two broad categories to organize decarbonization efforts, 1) Cleaner vehicles, and 2) Transportation demand management. These categories represent the two key goals of policies and mechanisms aimed at developing a low carbon transportation system: 1) make passenger vehicles emit less GHGs, and 2) reduce the number of vehicles on the road. The table below provides a list of key existing policy mechanisms for emission reduction in the transportation sector drawn from a state-of-the-art review conducted for this research. A note on potential rebound effects can be found in Appendix

A. These instruments are classified by the two broad categories utilized in this research, cleaner vehicles and transportation demand management:

Cleaner Vehicles	Transportation Demand Management
Climate Change Commitments and Carbon Pricing	
<ul style="list-style-type: none"> <li>• Fuel standards</li> <li>• Vehicle standards</li> <li>• Mandated emissions testing (I &amp; M)</li> <li>• Alternative Vehicle Standards and Mandates</li> <li>• Alternative vehicle charging infrastructure development</li> <li>• Tax on transportation fuels</li> <li>• Tax on inefficient vehicles</li> <li>• Feebates</li> <li>• Subsidies for alternative vehicles</li> <li>• Non-financial clean vehicle incentives</li> <li>• Funding for research and development and industry partnerships</li> <li>• Government procurement</li> <li>• Information measures</li> </ul>	<ul style="list-style-type: none"> <li>• Transit-Integrated land-use planning, “smart growth” policies</li> <li>• Enhanced public transportation services</li> <li>• Policies aimed at making current public transit systems more effective (funding for R and D; implementing intelligent traffic control systems)</li> <li>• Policies encouraging the use of bicycles (bike lane infrastructure development, bike-sharing)</li> <li>• Policies aimed at increasing occupancy rate of vehicles (car sharing; car pooling; HOV lanes)</li> <li>• Tolls and congestion charges</li> <li>• Insurance schemes</li> <li>• Telework and other employee travel reduction programs</li> <li>• Information measures</li> </ul>

The following section will outline the Province of Ontario’s current policies in place to lower emissions for the road passenger transportation sector, organized using the broad categories introduced above: climate change commitments and carbon pricing, cleaner vehicles and transportation demand management. Policies to lower emissions from road freight transport will also be briefly discussed. Importantly, insights into potential changes in policies under the newly elected Progressive Conservative government, led by Premier Doug Ford, will be analyzed.

## ONTARIO: CLIMATE CHANGE POLICIES

### *Early Legislation Related to GHG emissions and Air Pollution*

Within the Canadian context, Ontario has had a relatively long history of air pollution regulation, with direct involvement through a formalized air pollution regime beginning in the late 1960s under the *Air Pollution Control Act* (1967) (Drowley 1965; Jephcott 1960; Powell and Wharton 1982; McKetta 1976). The principle environmental statute in the Province is the *Environmental Protection Act* (1971), originally enacted in 1971, which governs a broad range of environmental topics, including air pollution (Wood, Levy, Mitchell and Lax 2013; Mahony 2016 9-8, 9-9). The province’s air pollution regulatory review has traditionally focused on criteria air pollutants and smog precursors, acid rain control, and hazardous air pollutants.

The province’s first efforts to deal with industrial GHG emissions date from the 1990s, with the implementation of a Voluntary Challenge and Registry (VCR), which was a voluntary GHG reduction scheme for commercial businesses and other institutions, established under the federal National Action Program on Climate Change (Mahony 2016, 9-26). The provincial government first committed to the stabilization of the province’s GHG emissions in 1994, with a longer term goal of a 20 per cent reduction by 2005 relative to 1988 (Winfield 2012 p. 77-78). The VCR program was a widely acknowledged failure and it would not be until the mid-2000s, with the arrival of a Liberal government led by Dalton McGuinty in 2003, that climate change came back onto the provincial political agenda in a significant way.

The arrival of the new McGuinty Liberal government was followed by a series of initiatives with significant GHG emission-related initiatives, including a phase-out of coal-fired electricity, programs aimed at renewable energy development, major reforms to the land-use planning system and significant new investments in public transit. However these actions were motivated far more by concerns over air pollution, traffic congestion and urban sprawl than climate change per se.

The Liberal government succeeded a PC Government, first elected in 1995, that had paid little attention to environmental issues, implemented major cuts to environmental agencies budgets and dismantled significant parts of the existing environmental regulatory regime (Winfield 2012).

In 2006 the provincial Liberal government passed Bill 200, the *Ontario Climate Change Act* (2007), with the goal of reducing provincial emissions to reach the larger national emission reduction obligations under the Kyoto Protocol; the Executive Council was required to ensure emission reductions of 6% below 1990 levels by 2012 and 25% below 1990 levels by 2020. The Liberal government's engagement on the climate a change issue was motivated by a number of factors. A major consideration were concerns that if the Conservative federal government, elected in January 2006 and led by Stephen Harper, were to engage in federal action on climate change, it might do so in a way that strongly favoured oil and gas interests in western Canada, and harmful to manufacturing interests in Ontario and Quebec. These concerns led Ontario and Quebec to join the emerging Western Climate Initiative, with the intention of establishing an alternative, transnational policy framework around climate change (Winfield 2012).

The Act tasked the Minister of the Environment to prepare a plan with strategies for meeting emission reductions, set emission reduction targets annually between 2008-2020, and report annually on progress and future emission reduction strategies for the following year, which are to be reviewed by the Environmental Commissioner (*Ontario Climate Change Act, 2007*, "explanatory note", para. 1). The *Ontario Climate Change Act* (2007) also empowers the Lieutenant Governor in Council (i.e. provincial cabinet) to make broad regulations relating to reducing GHG emissions.

Following this Act, the government released its 2007 climate change plan, "Go Green: Ontario's Action Plan on Climate Change", which set ambitious targets for emission reductions in all sectors: a 6% reduction from 1990 levels by 2014, a 15% reduction from 1990 levels by 2020, a 80% reduction from 1990 levels by 2050 (Government of Ontario 2007). With regards to transport-related emissions, the "Go Green" Plan called for a 13% reduction from 1990 levels by 2020 for passenger transportation (Metrolinx 2008). While this plan was a positive step in organizing actions specifically meant to reduce GHG emissions, it did not contain a comprehensive long-term vision based on an analysis of climate change impacts in the province, and was instead very much an consolidation of existing initiatives (Winfield 2012).

A key measure in meeting the initial emission reduction target set out in "Go Green" was to eliminate coal-fired generation from Ontario's electricity supply. While contributing to meeting the province's GHG reduction targets, the decision to eliminate coal as a source of power generation, which made up 25% of the supply mix in 2007 (Kilpatrick 2017), was heavily motivated by concerns over poor air quality, evidenced by a peak in smog advisories, and associated significant health risks and costs at the turn of the millenium (Government of Ontario 2018c). The *Cessation of Coal Use Regulation* (2007), O. Reg. 496/07, set an end date for the ability to use coal for power generation in the province of Dec. 31, 2014 (Government of Ontario 2015). The last coal-fired power plant, all of which had been owned by the provincially owned utility Ontario Power Generation, was shut down in April 2014. The coal phase out has been described as the largest single emission reduction initiative taken by any government in North America to date (Kilpatrick 2017).

The replacement of coal in the provincial supply mix was facilitated in part by the passing of the *Green Energy and Economy Act* (GEEA) (2009), as well as a major construction program of gas-fired power plants

(>8000MW) and the refurbishment of nuclear power facilities (Winfield 2016). The 2009 *GEEA* introduced a feed-in-tariff system to bring more renewable energy projects online, which required only one environmental approval (the Renewable Energy Approval), in addition to requiring public sector agencies to develop and update every five years Energy and Conservation Demand Management plans (Government of Ontario 2017b; Harper et al. 2016; Osler, Hoskin & Harcourt LLP 2018).

Despite significant critiques over costs (McKittrick and Aliakbari 2017) and the approval process (McRobert and Tennent-Riddell) for green energy projects, the *GEEA* facilitated a large increase in renewable energy capacity in the province, including over 4000MW of wind power, and nearly 400MW of solar PV, between 2009 and 2018 (IESO 2018)

Critics argue that the initiative has caused only statistically insignificant improvements in air quality, and that the measure was economically inefficient, blaming the coal-shutdown for greatly contributing to rising electricity costs (McKittrick and Aliakbari 2017). Counter arguments state these critiques are simplistic and narrow (Kilpatrick 2017). In particular, increased electricity prices in the province is a result of a host of factors, especially deferred investments in the electricity grid infrastructure and nuclear refurbishments (Flanagan and Gass 2017).

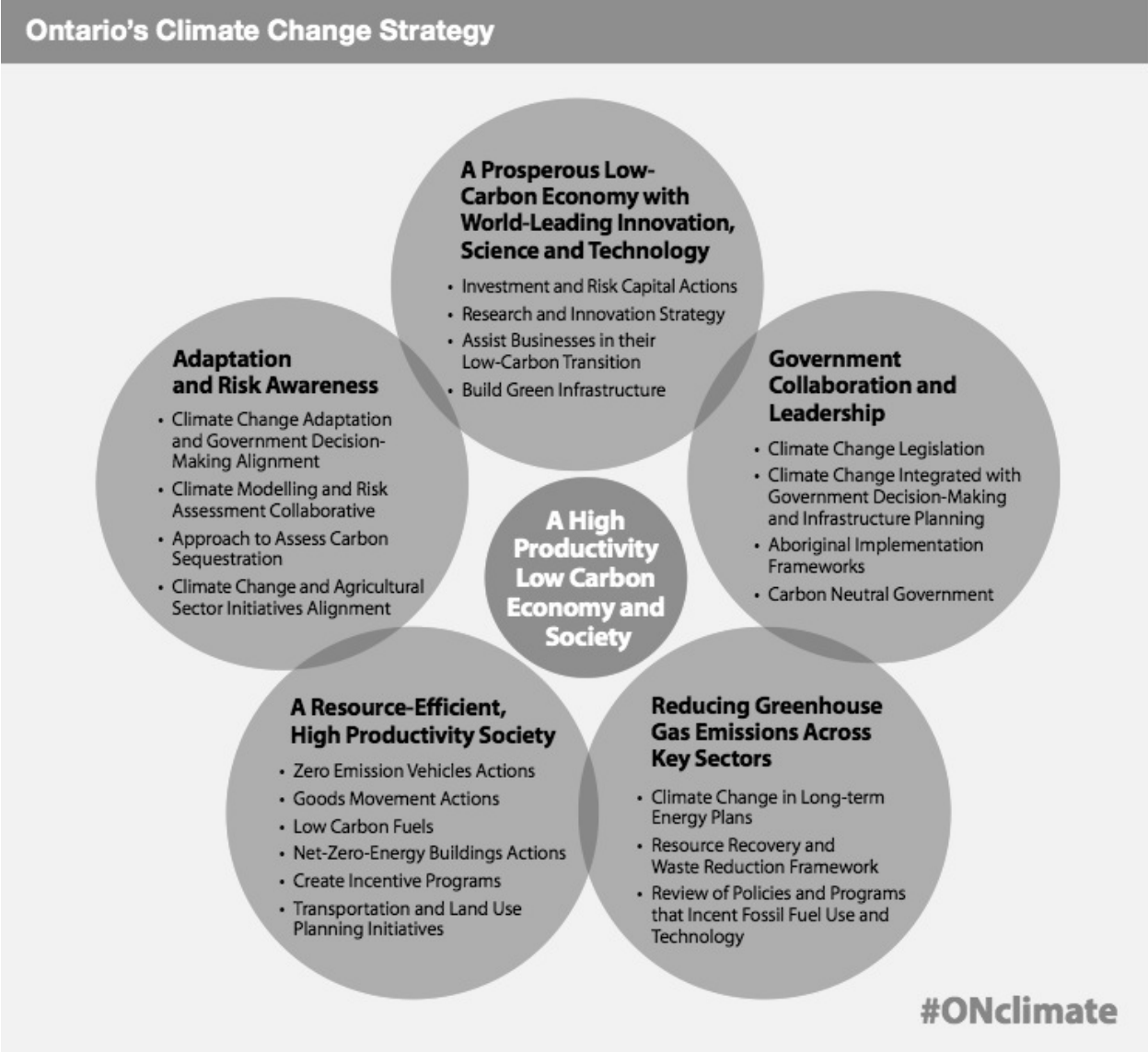
### *Ontario Climate Change Policy to June 2018*

In terms of the existing legislative framework around climate change, The 2015 Climate Change Strategy, the 2016 *Climate Change Mitigation and Low Carbon Economy Act* (2016) and the 2016 five-year Climate Change Action Plan, represented the critical pieces of the province's climate change governance regime.

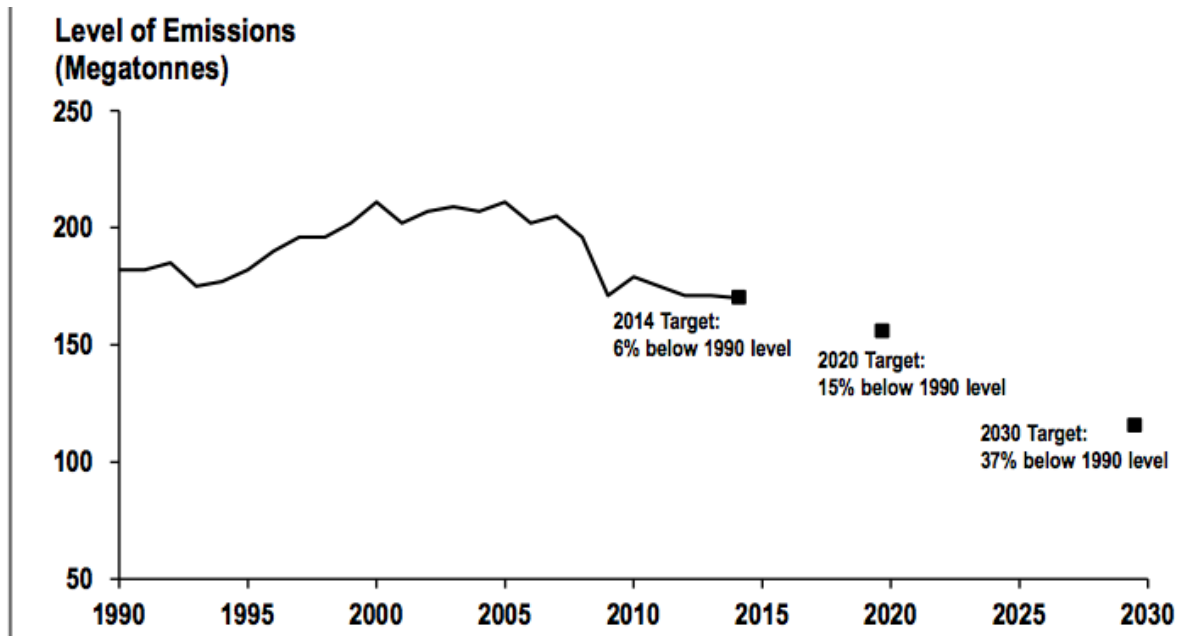
Ontario's Climate Change Strategy was released in November 2015, setting the government's vision to 2050 for how it would grow a prosperous, low-carbon and resilient society and economy (Government of Ontario 2017a). The Strategy justified the case for climate action and proposed actions that were wide in scope, with carbon pricing making up the cornerstone of the plan (Government of Ontario 2016). Five areas were highlighted as key pillars of the Strategy: A prosperous low-carbon economy with world-leading innovation, science and technology; government collaboration and leadership; reducing GHG emissions across key sectors; a resource-efficient, high productivity society; adaptation and risk awareness (Government of Ontario 2016) (see Figure 1). High level measures were outlined under each key area of transformation.

Importantly, the Strategy contained a commitment to release a more detailed five-year climate change plan outlining specific commitments and initiatives to meet interim and long term emission reduction targets (Wood 2017).

On May 19, 2016 Bill 172, the *Climate Change Mitigation and Low Carbon Economy Act* (2016) received Royal Assent. This landmark piece of legislation provides an overarching, long-term framework for tackling the issue of climate change in the province of Ontario, including establishing targets for greenhouse gas (GHG) reductions in a legal statute for 2020, 2030 and 2050: 15% below 1990 levels for 2020, 37% below 1990 levels by 2030 and 80% below 1990 levels for 2050 (see Figure 2) (Government of Ontario 2016; Ontario Ministry of Environment and Climate Change [OMECC] 2017; Osler 2018).



**FIGURE 1: KEY PILLARS OF ONTARIO'S CLIMATE CHANGE STRATEGY (GOVERNMENT OF ONTARIO 2016)**



**FIGURE 2: ONTARIO'S GREENHOUSE GAS EMISSIONS AND TARGET (ENVIRONMENT AND CLIMATE CHANGE CANADA; CITED IN ONTARIO MINISTRY OF FINANCE 2017C)**

Central to the government's approach to GHG emission mitigation was the introduction of a cap and trade system in the province. The *Climate Change Mitigation and Low Carbon Economy Act* (2016) laid the legal foundation for the cap and trade program to begin in 2017, the proceeds of which are directed to a new fund, the Greenhouse Gas Reduction Account, supporting activities and projects that will reduce GHG emissions in the province (Government of Ontario 2018). The Act also required a comprehensive climate change action plan, which was produced for the years 2016-2020, and provided a framework for reviewing and revising GHG reduction target stringency and the ability to introduce interim targets (OMECC 2017; Government of Ontario 2016a). In addition the *Climate Change Mitigation and Low Carbon Economy Act* (2016):

- *Embeds government action and accountability in a statute to ensure participants and the public are fully informed through the development of an action plan.*
- *Prescribes content that must be included in each action plan including:*
  - *Timetable for implementing each action;*
  - *Estimated reduction in greenhouse gases resulting from each action;*
  - *Assessment of the cost per tonne of the potential reduction in greenhouse gases;*
  - *and If an action could be funded, in whole or in part, from cap and trade program proceeds, the estimated amount of any such funding. (OMECC 2017)*

Strong enforcement and compliance provisions for the cap and trade program were introduced by the Act, including extensive powers given to the Ministry of Environment and Climate Change to investigate and inspect potential non-compliance (Environmental Commissioner of Ontario [ECO] 2016; Government of Ontario 2018). A critical feature allowed for by the *Climate Change Mitigation and Low Carbon Economy Act* (2016) is the ability for the cap and trade system to be linked with other jurisdictions (Osler, Hoskin and Harcourt 2018; Government of Ontario 2018).

The *Climate Change Mitigation and Low Carbon Economy Act* (2016) must be understood in conjunction with related regulations and documents, the two key items introduced in 2016 under this legislation being: *The Cap and Trade Program* (2016), O Reg 144/16 and *Quantification, Reporting and Verification of Greenhouse Gas Emissions* (2016), O Reg 143/16 (Osler 2018). In 2017, two other regulations were passed under the Act that also set out important rules for offsets and penalties under the program: *Ontario Offset Credits* (2017), O. Reg. 539/17 and *Administrative Penalties* (2017), O. Reg. 540/17.

*The Cap and Trade Program* (2016), O. Reg. 144/16, (the program), outlines key elements of the cap and trade system, including: caps, auctions and sales rules, allowance reserves, allocations and market rules (OMECC 2017). Caps are established for emissions allowances for the first compliance period (2017-2020) and dates for subsequent three year compliance periods (Osler, Hoskin and Harcourt 2018). This regulation also provides detailed rules and requirements for participants under the program as well as enforcement and compliance mechanisms (Government of Ontario 2018). There are three types of participants under the program: 1) mandatory participants are those facilities emitting over 25,000 tonnes of CO<sub>2</sub> per year, a fuel supplier selling more than 200 litres of fuel per year, or an electricity importer, 2) voluntary participants are those who choose to opt-in to the program and emit between 10,000 - 25,000 tonnes of CO<sub>2</sub> per year, and 3) market participants who opt-in to trading in the carbon market (Government of Ontario 2018; Osler, Hoskin and Harcourt 2018; OMECC 2017; Government of Ontario 2018a). A November 2017 revision to this regulation allowed the province to link its carbon market with California and Quebec through the Western Climate Initiative, which held its first joint auction with Ontario in February 2018 (Government of Ontario 2018; Government of Ontario 2018a).

During the initial compliance period, eligible capped participants, besides fuel suppliers/distributors, electricity importers and most electricity generators, will be provided for free as a 'transitional measure' with a decreasing rate of 4.57% per year for combustion emissions starting in 2018 (Government of Ontario 2018). The regulation also sets out rules for how the proceeds from auctions will be governed and spent (Osler, Hoskin and Harcourt 2018). The revenues raised through the auctions are not insignificant and have been in line with forecasts predicting revenues of approximately 1.9 billion dollars CAD per year (Zizzo Strategy 2017). The settlement price from the most recent auction (May 2018) was \$18.72 CAD and to date, \$2,873,158,143.54 CAD in proceeds have been placed in the Greenhouse Gas Reduction Account (Government of Ontario 2018b).

The other key regulation, which must be read alongside the *Climate Change Mitigation and Low Carbon Economy Act* (2016) is *Quantification, Reporting and Verification of Greenhouse Gas Emissions* (2016), O. Reg. 143/16. This regulation provides details for how GHG emissions will be quantified, verified and reported, and which activities explicitly trigger the requirement to do so (Osler, Hoskin and Harcourt 2018). These rules became effective in November 2017 and offer opt-in provisions for voluntary participants and provide refinements to support implementation of the above mentioned Cap and Trade Regulation (2016), O. Reg. 144/16, for example, how energy use and process information is to be used to support calculations for free allowances (OMECC 2017; Government of Ontario 2017).

Two additional important regulations passed under the Act in late 2017 are regulations dealing with offsets and administrative penalties. *Ontario Offset Credits* (2017), O. Reg. 539/17 outlines the rules for how offset credits can be used to meet compliance obligations. Up to 8% of a facilities compliance obligations can be met through offset credits created through the program for initiatives with verified emission reductions (ECO 2016; Osler, Hoskin and Harcourt 2018). Part II and III of the regulation provide detailed rules including offset registration, eligibility, crediting periods and the creation and transfer of credits (*Ontario Offset Credits Reg* 2017). A distinct set of offsets under the Voluntary Carbon Offsets Program is being developed; importantly these will not be able to be used to meet compliance obligations (Osler, Hoskin and Harcourt 2018). The Administrative Penalties Regulation (2017), Reg. 540/17, provides

additional key information on penalties for non-compliance with the *Low Carbon Economy Act* (2016) or its regulations; at its core is a three-step process for calculating penalties, which fall between a written warning and prosecution measure with financial penalties, which max out at \$1 million CAD (Osler, Hoskin and Harcourt 2018; Kramer and Grochalova 2018). Calculations for penalties are based on a daily base penalty set out in section 4(1) of the regulation; they can be reduced if the non-compliant party is able to illustrate they are taking actions to return to compliance and prevent future non-compliance (*Administrative Penalties Reg* 2017, 2017; Osler 2018).

Overall the cap-and-trade system established through the *Climate Change Mitigation and Low Carbon Economy Act* (2016) and related regulations, imposes a modest carbon price on the province's largest emitting facilities. The system design is moderate in providing many of the initial allowances for free to industry, allowing ample time to adjust to the new system and imposing a feasible reduction in combustion allowances at a rate just under 5% per year. Recognizing the potential disadvantage to covered industries, and the potential for 'leakage', the government has consulted closely with large emitters on how to manage elements such as price volatility and are providing an assistance factor of 100% during the first compliance period, following California's method for calculating free allowance distribution (Madras 2015).

Given that large final emitters were initially given allowances for free, most of the early revenue generated from the system came from allowances purchased by transportation and heating fuel distributors. These revenues provide monetary assistance for industries to become cleaner through programs funded by the Greenhouse Gas Reduction Account (e.g. GreenON Industries program and GreenON Small and Medium Businesses program). Flexibility mechanisms alongside a combination of free and auctioned allowances, reflect a design intended to maximize emission reductions at the lowest cost. Implementation and transaction costs should also be reduced by the sharing of WCI infrastructure for market operations (But 2016). The system also has administrative capacity built in to ensure efficiency and transparency in the market and multi-year compliance periods provide sufficient opportunities "to assess how program participants will best respond to carbon prices, either through investments in long-term abatement technologies or purchases of allowances or credits" (But 2016, p. 69-70). That being said, it is still too early to determine if the system design is sufficient to deal with the administrative challenges that accompany operating an effective and transparent cap-and-trade system.

### Climate Change Action Plan

As required by the *Climate Change Mitigation and Low Carbon Economy Act* (2016), the provincial government released its Climate Change Action Plan in June 2016, forming the 'backbone' of its climate change mitigation strategy (Office of the Premier 2016). In addition to a broad scope of initiatives meant to ensure that the short term (2020) emission reduction target is met, the Plan also set a mid-term 2030 target and focuses on longer-term transformational areas, especially pursuing a shift to a lower-carbon transportation system (Government of Ontario 2016a).

It is not surprising that as the largest source of emissions, transitioning to a low-carbon transportation system is a central focus of the plan. In addition to longer-term TDM strategies, such as land-use planning efforts, promoting active transportation and transit expansion, the Plan contains ambitious initiatives to promote the diffusion of cleaner vehicles, with the objective that these vehicles make up 5% of sales by 2020:

- *Working with the federal government to eliminate HST on zero emission vehicles*
- *Free overnight EV charging*
- *Providing rebates to replace older less fuel efficient vehicles with new or used EVs*
- *EV-ready new homes and workplaces*
- *Electric and Hydrogen Advancement Program*

- *Work with Plug'n Drive to establish and operate a facility to showcase EVs*
- *EV charging stations at government properties*
- *Establish EV requirements for existing condominiums and apartment buildings (Ontario Ministry of Transportation 2017a)*

Outside of the transportation sector, initiatives to reduce emissions include: incentives to install and retrofit clean energy systems, new rules and regulations to increase the energy efficiency of new buildings, creating a 'green bank' to aid businesses and homeowners to pay for energy-efficient technologies, helping business adopt lower carbon technologies, and intensify efforts to support low-carbon innovation, research and development (Osler, Hoskin and Harcourt 2018; Government of Ontario 2016a). \$375 million is dedicated to cleantech research and development, including:

- *\$140 million for a Global Centre for Low Carbon Mobility (Morrow and Keenan 2016);*
- *the Municipal GHG Challenge Fund to aid municipalities in funding projects that will result in emission reductions, and;*
- *the Green Ontario Fund, which is established as a non-for-profit government agency to assist homeowners and businesses with the cost of making energy saving retrofits and installations (Government of Ontario 2016a; Osler, Hoskin and Harcourt 2018).*

From a governance perspective, the Plan begins to address the issue of limited capacity (e.g. expertise, money) at the local level in terms of being able to develop and implement climate change mitigation and adaptation strategies.

Funding is promised under the Plan to assist in what the government is calling 'Municipal Action Planning', where support is provided to municipalities to develop or update climate change inventories, targets and strategies, and promote the completion of Municipal Energy Plans (MEP) by making completed MEPs a requirement for the Municipal GHG Challenge Fund (Ontario Ministry of Environment and Climate Change 2018; Government of Ontario 2016a). To ensure effective monitoring and policy evaluation, progress against the Plan is to be reported annually and a comprehensive review is set for every five years (Office of the Premier 2016).

## REDUCING EMISSIONS FROM THE PASSENGER TRANSPORTATION SECTOR

Ontario's road passenger transportation system consists of road and public transit infrastructure which is valued at \$82 Billion and \$11 billion respectively (Office of the Auditor General of Ontario 2017). Ontario has a total of 250,000 km (155,342.8 miles) of roads and highways, including: 2,100 km (1,304.9 miles) of controlled multi-lane highways, 14,800 km (9,196.3 miles) of other highways in addition to municipal and other roads (Government of Ontario 2014). The province also administers over 100,000 km (62,137.1 miles) of roads on Crown land, including approximately 30,000 km of resource access roads (Government of Ontario 2014). Ontario, in particular Southwestern Ontario, has some of the heaviest road traffic in North America; the estimated cost of road congestion in the GTHA was \$6 billion CAD in 2006 (Government of Ontario 2014).

With regards to mass or public transit, Ontario transit systems serve more than 130 communities, although most of the trips take place in the 15 largest urban communities (Government of Ontario 2014). Metrolinx, an agency of the Ministry of Transportation, operates a regional transit network in the Greater Toronto and Hamilton Area (which accounts for 25% of Canada's population), consisting of trains and buses operating over 11,000 sq km (Wallace 2017; Office of the Auditor General of Ontario 2017). Metrolinx vehicles serve roughly 69 million passengers annually (Office of the Auditor General of Ontario 2017) and municipal

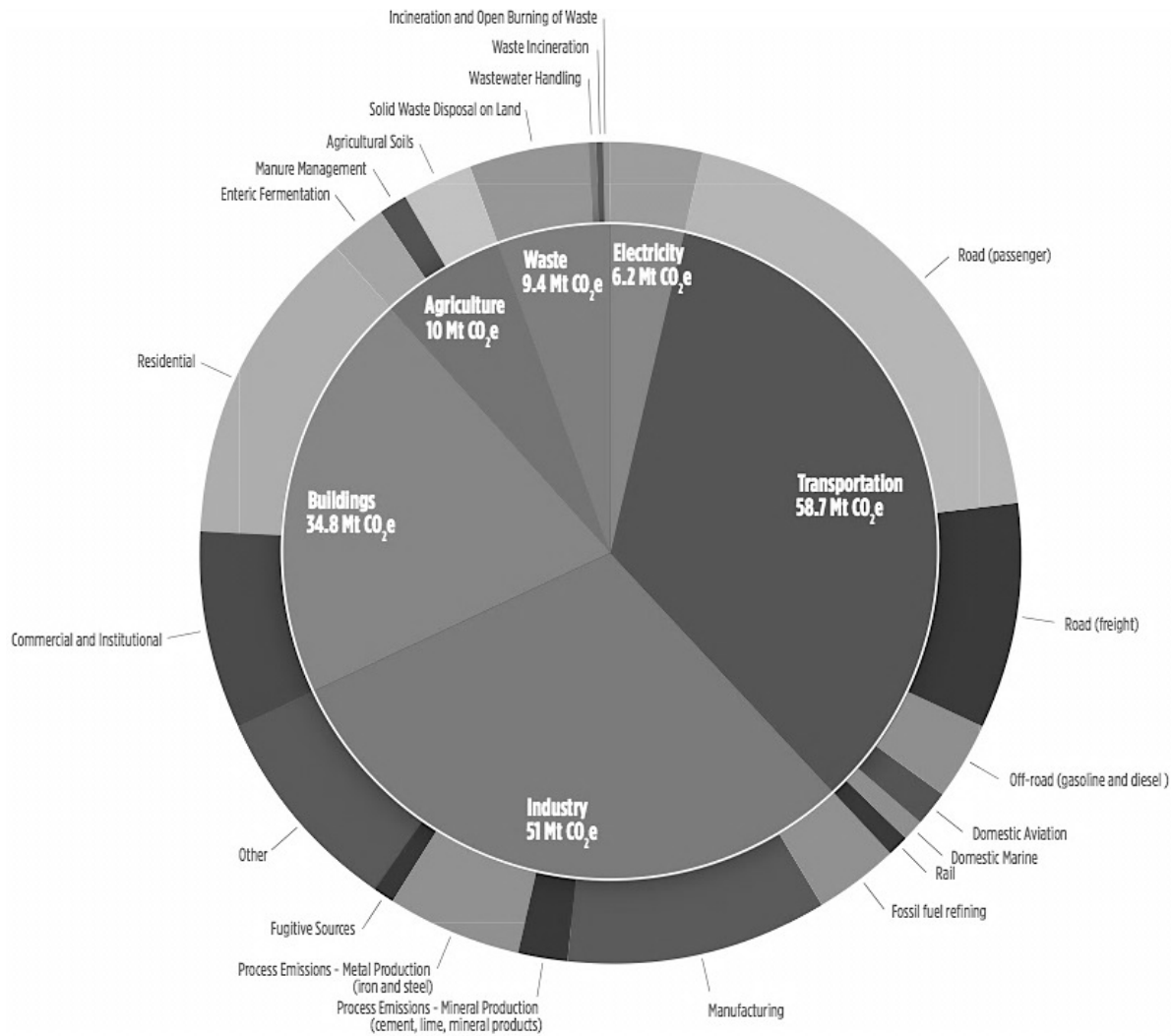
transit services in Ontario's 15 largest urban areas carry over 800 million passengers each year, with ridership expected to increase to 908 million trips annually by 2019 (Ontario Ministry of Transportation 2016c). Ontario municipalities operate 61 conventional public transit systems that vary widely in scope and complexity (Association of Municipalities Ontario [AMO] 2017). Local governments spend a substantial amount of money building and operating these systems.

The Toronto Transit Commission (TTC) is the largest municipal transit system in Ontario and the third largest in North America (Toronto Transit Commission [TTC] 2017). The subways, buses and streetcars that comprise the system served an annual ridership of just under 540 million passengers in 2017 (TTC 2017). Municipal transit systems in the GTHA, such as Zum (Brampton, ON), Transitway (Mississauga, ON) and VivaNext (York Region, ON), have seen higher growth rates than the TTC and are currently undergoing rapid expansion of their service networks (TTC 2017). In 2011, eight out of ten Ontarians drove to work, although carpooling rates were considerable (Ontario Ministry of Finance 2011). While Ontario has the largest number of light vehicle registrations in Canada at 7.9 million, it has one of the lowest ratios of these vehicle registrations in relation to the driving age population (Statistics Canada 2015).

Although total emissions have fallen in the province, roughly 6% between 1990 and 2014, transportation-related emissions grew by 27% and now make up 35% of the Province's total emissions (Environment and Climate Change Canada 2016; cited in Government of Ontario 2017b; ECO 2018). Transportation related emissions account for nearly one third of all the province's emissions, the largest of any share, making the reduction of these emissions "the biggest opportunity - and also the biggest challenge - to achieving Ontario's 2020 GHG reduction target." (Mahony 2016, 9-57) (see Figure 3). Passenger transportation emissions (cars, trucks, bus, rail, domestic aviation) accounted for roughly 66% of transportation-related emissions in 2014, growing 15% since 1990, due primarily to increased vehicle miles traveled (VMT) and an increase in fleet composition of larger vehicles like SUVs, minivans and pick-up trucks (Government of Ontario 2017b). Freight emissions are also significant, making up roughly 30% of transport-related emissions in 2014 (Government of Ontario 2017b). For roughly a decade Ontario Provincial governments have been planning and implementing measures to reduce GHG emissions. The province met its 6% reduction goal for 2014 (from 1990 levels) and is now pursuing reduction targets for 2020, 2030 and 2050: 15% below 1990 levels for 2020, 37% below 1990 levels by 2030 and 80% below 1990 levels for 2050 (Government of Ontario 2016).

### *Cleaner Vehicles*

It has only been over the past ten years that both federal and provincial efforts to lower emissions from the transportation sector have been framed in terms of climate change mitigation. Longer-standing approaches, such as vehicle emission standards, TDM and fuel taxes, were primarily aimed at reducing smog, congestion and sprawl. Significant decarbonization of the electricity system in Ontario, post the 2014 complete phase out of coal, has created a situation where the government must target emission reductions from the transportation sector in order to achieve overall GHG emission reduction targets. The relatively low-carbon electricity system, which also consistently produces surpluses overnight, makes the increased use of EVs in the province a very attractive method for reducing transportation-related emissions. Recognizing this, the government of Ontario introduced a host of initiatives to promote the growth of the EV market in Ontario, both supply-push and demand-pull, which are necessary to compliment the



**FIGURE 3: ONTARIO GHG EMISSIONS IN 2014 BY SECTOR (ENVIRONMENT AND CLIMATE CHANGE CANADA 2016; CITED IN ECO 2016)**

economy-wide carbon price, which is said to have a relatively weak signal for transportation (Macedonia 2017).

Not only has the number of government initiatives proliferated in recent years, the actual amount of dedicated funding for these programs is significant, which is particularly important for ensuring market instruments are sending a strong signal. Ontario subsidies/incentives for purchasing cleaner vehicles were the highest in North America, by far (Richardson and Lightstone 2018). The following section will discuss specific programs, first to reduce emissions from internal combustion engine (ICE) vehicles, and second, to promote the use of cleaner vehicles in the province.

### Reducing emissions from ICE vehicles

One of the most widely used and long-standing ways of reducing emissions from automobiles in Canada (and Ontario) has been for the government to set vehicle emission standards and tax vehicle fuels. Both tools were introduced in Canada, in part as a response to the energy crisis of the 1970s. Regulations for

both vehicle standards and vehicle fuel taxes have been amended over the decades in response to changing political motivations and technical objectives. Most recently requirements have been increasingly tailored to incorporate climate change mitigation objects. This follows the pattern more broadly for environmental policy, where environmental regulation previously enacted for the purposes of protecting lands and reducing pollution (usually talked about as smog), has followed a consistent arch but more recently been re-framed in terms of climate change mitigation and/or adaptation.

Vehicle emission standards or vehicle efficiency standards effectively put a limit on GHG emissions from vehicle tailpipes for every vehicle class (Yeh and Sperling 2013; Axsen, Goldberg and Melton 2016). This type of regulatory measure has been adopted widely around the world (Yeh and Sperling 2013) and has proven to be very effective in reducing energy consumption from passenger vehicles (Macadonia 2017).

In Canada, vehicle emissions standards are set at the Federal level; the first limits were set under the *Motor Vehicle and Safety Act*, (1969-70) (Anastakis 2013). The general approach for Canadian emission standards or fuel-efficiency standards has been to harmonize with U.S. regulations. In a move towards harmonizing with U.S. Corporate Average Fuel Economy (CAFE) standards, the Government of Canada established voluntary Company Average Fuel Consumption (CAFC) targets in agreement with the motor vehicle industry in 1976 (Government of Canada 2007). In 1982, the federal government passed the *Motor Vehicle Fuel Consumption Standards Act* (RSC 1985), which provided authority to move the effort to reduce vehicle emissions from a voluntary model to a regulatory one, empowering the government with the legal authority to regulate fuel consumption for specific vehicle classes (Government of Canada 2007); however, that authority would only be exercised after 2010.

Legislative authority to regulate vehicle emissions and fuel quality was transferred from the *Motor Vehicle Safety Act* (1969-70) to the country's primary legislative act protecting the environment and human health, the *Canadian Environmental Protection Act (CEPA)* (1999), effective one year after its passing in 2000 ("Canada: Regulatory Background" 2018). The *CEPA* (1999) expanded the range of ways vehicle emissions can be regulated, including the ability for the government to control multiple characteristics impacting fuel quality, the ability to use a performance-based approach to fuel standards, as well as the ability to regulate emissions for off-road engine applications (Mckitrick 2006). Subsequent regulations under *CEPA* (1999) have been passed over the years dealing with a variety of vehicle emissions issues, such as limiting specific compounds or tightening engine emission standards, for example, the *On-Road Vehicle Engine and Emission Regulations* (2003), SOR/2003-2, which tightened national emission standards for on road vehicles beginning in 2004 (New Climate Institute 2015).

In 2010, Transport Canada's Fuel Consumption Program (FCP)/CAFC was replaced by the *Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations* (2010), SOR/2010-201. This change was significant in that it marked the federal government's first ever GHG regulation and "was a major milestone for Environment and Climate Change Canada's transportation regulatory work", while continuing the trend of harmonizing with U.S. standards (Environment and Climate Change Canada 2017). It was, in fact, the changes to U.S. vehicle emission and performance standards by the Obama Administration that drove the then Conservative Federal government to change the (FCP)/CAFC program to align with U.S. EPA regulations (Winfield and Macdonald 2012).

Progressively more strict performance-based standards for light-duty vehicles (MY 2011-2025) were introduced based on a formula made up of the following variables: the model year's CO<sub>2</sub> equivalent target values, which are a function of the "footprint", and the number of vehicles models in the individual company fleet of light-duty vehicles (Environment and Climate Change Canada 2017). The regulations include flexibility mechanisms for compliance, for example vehicle manufactures can earn compliance credits through action such as selling extra zero-emission vehicles (Bérubé and Turcotte 2018).

In 2013 Environment Canada adopted GHG emission regulations for heavy-duty vehicles, which introduced performance-based emissions standards for model years 2014 and later, aligned with US EPA Phase 1 regulations (Government of Canada 2018). The following year, the government continued its light-duty emission regulation program by passing *Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations* (2014), SOR/2014-207, which extended the fuel economy program to align with US regulations for 2017 and beyond. On-road heavy-duty vehicles have also been regulated at the federal level in order to reduce GHG emissions. The most recent amendments to the *Heavy-duty Vehicle and Engines Greenhouse Gas Emissions Regulations* (2013), SOR/2013-24 were made in 2018. The government amended GHG emission standards for heavy-duty vehicles, increasing the stringency (beginning with model year 2021) for on-road heavy duty vehicles and engines (*Heavy-duty Vehicle Reg* (2013); Stevens 2018).

### Fuel Taxes

Another long-standing tool to promote the use of more efficient vehicles has been to tax motor vehicle fuels in the province. Fuel taxes are levied by the Federal and Provincial governments to raise money to pay for infrastructure, and more recently to incorporate the cost of driving on the environment. While taxing motor vehicle fuels may also discourage unnecessary driving, the price inelastic demand for filling up your existing car's gas tank for use means the impact on reducing VMTs is limited. Where motor vehicle fuel taxes can make a larger impact is with regards to a consumers purchase decision for their next car. According to Gallagher and Muehlegger (2011), for existing hybrid sales, 27% can be attributed to rising gas prices whereas only 6% can be attributed to tax incentive schemes (cited in Antweiler and Gulati 2013).

#### *Ontario Fuel Taxes*

Taxes on vehicle fuels were first introduced in Ontario under the 1925 *Gasoline Tax Act* (1925), which placed a tax directly on consumers for the consumption of gasoline (Ryan 1999). The next significant change with regards to vehicle fuel taxes was the passing of the 1965 Motor Vehicle *Fuel Tax Act* (RSO 1980), which for the first time differentiated gasoline and diesel fuels and raised the tax to 13 cents per gallon for gasoline and 20 cents per gallon for diesel fuel (Ryan 1999). Prior to this the tax rate was 11 cents/gallon for both fuels (Ryan 1999).

The tax of 14.3 cents per litre on all clear fuel required by the *Fuel Tax Act* is levied at the wholesale level, and passed on to the consumer by the retailer via incorporation in the pump price (Ontario Ministry of Finance 2017). The last change to the price of the provincial gas tax was made in 1992 (Zon 2015). The next major change to the Ontario gas tax regime came in 2004 when the Liberal McGuinty Government started Ontario's Dedicated Gas Tax Funds for Public Transportation, which provides long-term funding to Ontario municipalities for capital and operating expenditures on public transit (Ontario Community Transportation Network [OCTN] 2017). As of 2017, a cumulative \$3.8 billion in gas tax funding has been committed to Ontario municipalities (OCTN 2017).

In 2017, the *Fuel Tax Act* was amended to promote a lower-carbon transportation system, specifically to encourage the production of biodiesel, by exempting a newly created category of registered dyers from fuel transportation requirements, enabling more companies to offer coloured biodiesel products (Ontario Ministry of Finance 2017b). The *Gasoline Tax Act* is also levied the wholesale level and required all purchasers to pay a current tax rate of 14.7 cents per litre on unleaded gasoline and 17.7 cents per litre on leaded gasoline. To put these rates in perspective, in 1981 the tax rate for unleaded and leaded gasoline was 5.8 and 5.4 cents per litre respectively, meaning the rate has essentially remained the same when inflation is taken into account (Government of Ontario 2014).

#### *Federal Fuel Taxes*

The Federal government also taxes gasoline in two different ways: a flat rate excise tax and a sales tax. Since 1985 the federal government has charged a flat rate of 10 cents per litre on gasoline, and since 1987, 4 cents per litre on diesel fuel in accordance with the *Excise Tax Act* (Natural Resources Canada 2017). The federal government also imposes a sales tax on these fuels based on a percentage of the retail price; the 5% sales tax is combined with the Ontario sales tax (the Ontario portion of the HST) resulting in a 13% sales tax rate in the province (Natural Resources Canada 2017). Not only do fuel taxes work to discourage the demand for fuel consumption, they also are key sources for governments to generate revenues, sometimes dedicated for meeting environmental objectives. For example, in Ontario, a portion of the gasoline tax has been given to municipalities since 2004 in order to help them fund public transit projects (Ontario Ministry of Finance 2017). In addition to taxing vehicle fuels, fuels can also be regulated using standards or mandates aimed at reducing the emission profile of the fuel itself.

### *Regulation of Fuel Content – Ethanol*

Non-financial regulation of fuels, such as the use of fuel standards to reduce transportation-related emissions, is a much more recent strategy utilized in the province. Fuel standards were first taken up in Ontario in 2007, with the passing of the *Ethanol in Gasoline Regulation - Renewable Fuel Standard* (2007), O Reg 535/05. This was the first provincial attempt to increase the use of biofuels for powering vehicles. It is important to mention that there are concerns over the environmental impact of increasing biofuel use (from a life cycle perspective) as well as economic concerns about increasing food prices (resulting from less food supply) and questions about whether or not biofuel subsidies are really just subsidies to farmers (Runge 2010; National Research Council 2011; Wolf 2007).

This regulation required a minimum of 5% renewable content in gasoline, in particular incentivizing cellulosic ethanol, with the goal of increasing ethanol use in the province to 750 million litres (*Ethanol in Gasoline Reg* 2007; Environment and Climate Change Canada 2017a). Suppliers of gasoline in Ontario must comply with the standard and submit an annual compliance report confirming the amount of ethanol in gasoline supplied to the Ontario market (*Ethanol in Gasoline Reg* 2007, s.3(1); Government of Ontario 2018d). In addition to gasoline, regulations for renewable fuel requirements for diesel were also introduced. In 2014, the *Greener Diesel - Renewable Fuel Content Requirements For Petroleum Diesel Fuel* (2014), O. Reg. 97/14, introduced progressively more stringent requirements for the bio-based component of the fuel phased in over three years (2014-2017):

- *In 2014/15, 2% of the total volume of diesel fuel must be bio-based. The bio-based diesel component of this blend must have 30% lower greenhouse gas emissions than standard petroleum diesel*
- *In 2016, 3% of the total volume of diesel fuel must be bio-based. The bio-based diesel component of this blend must have 50% lower greenhouse gas emissions than standard petroleum diesel.*
- *In 2017, 4% of the total volume of diesel fuel must be bio-based. The bio-based diesel component of this blend must have 70% lower greenhouse gas emissions than standard petroleum diesel (Government of Ontario 2018e).*

Both the *Greener Diesel* (2014) and the *Ethanol in Gasoline* (2007) regulations were amended in 2018 in order to recognize emerging low-carbon fuels, increase blending requirements and improve the environmental performance of fuels (Government of Ontario 2018f). *The Greener Diesel - Renewable Fuel Content Requirements For Petroleum Diesel* (2018), O Reg 226/18 and the *Ethanol In Gasoline* (2018), O Reg 227/18 come into force in 2020. Each regulation incentivizes emerging renewable fuel technologies, for example biocrude, by introducing these technologies as compliance options. The *Ethanol in Gasoline* amendments increase the blending requirements to 10% ethanol in gasoline starting in 2020 and require ethanol used for compliance to emit much less GHG emissions (35%) on a lifecycle bases (determined

using a specified model) in comparison to petroleum gasoline (Government of Ontario 2018f). The amendments are aimed at advancing Ontario's Climate Change Action Plan and also to better align with the anticipated federal Clean Fuel Standard. The Federal Government also implemented a renewable fuels requirement, *Renewable Fuels Regulations* (2010), SOR/2010-189, under the *Canadian Environmental Protection Act* (1999) in 2010. Under this regulation fuel producers and importers are required to have a minimum renewable fuel content level of 5% for gasoline and 2% for deisel and heating oil (Neufeld and Massicotte 2017).

#### *Financial Incentives for low emission vehicles*

While standards have been the traditional method for ensuring vehicles meet or exceed specific emission profiles, the Government of Ontario has used financial incentives and disincentives to promote the purchase of vehicles with lower emitting internal combustion engines. In the early 1990s, Ontario became a pioneer with regards to innovative financial incentives and disincentives to promote the purchase and use of lower-carbon vehicles: the provincial government designed and implemented North America's first automobile feebate system, the *Tax and Credit for Fuel Conservation* in 1991 (Rivers and Schaufele 2014). This system, introduced under the *Retail Sales Tax Act* was born out of the 1989 *Tax on Fuel-inefficient Vehicles*, which was essentially a gas-guzzler type tax on all vehicles sold in the province with a highway fuel consumption rating over 9.5L/100km (Rivers and Schaufele 2014; Antweiler and Gulati 2013). Initially the tax covered only a narrow range of fuel economy ratings but in 1990 tax rates doubled and also were applied to a wider range of fuel economy ratings for passenger cars (Rivers and Schaufele 2014).

The feebate system evolved again in 1991 to incorporate SUVs and also introduce credits to highly fuel-efficient vehicles in order to encourage new car buyers to purchase them (Rivers and Schaufele 2014); A \$100 rebate was credited to purchasers of passenger cars with a fuel consumption of less than 6.0 litres/100km (Antweiler and Gulati 2013). Under pressure from the Canadian auto lobby, tax rates were reduced for cars with fuel economy ratings 8.0-8.9L/100km and 9.0-9.4L/100km (Rivers and Schaufele 2014) (see table 1 below). The program was eliminated in 2010 when the province underwent large-scale tax reform (Rivers and Schaufele 2014). While the introduction of this feebate system was a progressive action, its application was modest. This system was much more 'stick' than 'carrot' and price signals resulting from this 'tax' were much too low to make a difference in purchase behaviour. Roughly 90% of vehicles sold were taxed at a flat rate of \$75 (Bregha and Moffet 1995) and the inexpensive \$100 rebate for fuel-efficient meant neither the 'carrot' or the 'stick' embedded in this program had little impact on purchase behaviour (Antweiler and Gulati 2013). In a 2014 study of the program, Rivers and Schaufele found that while the feebate program did not reduce emissions, it was net revenue positive every year, even though over time the amount of rebates paid out increased while tax revenues collected decreased. While this government initiative attempted to influence emissions from new vehicles, during this time the government also started to turn its attention to managing emissions from existing vehicles, particularly older, higher-emitting ones.

Highway fuel efficiency rating (L/100km)	1989 Cars	1990 Cars	1991-2010 Cars	1991-2010 SUVs
less than 6.0	-	-	-100	-
6.0-7.9	-	-	75	-
8.0-8.9	-	200	75	75
9.0-9.4	-	700	250	200
9.5-12.0	600	1200	1200	400
12.1-15.0	1200	2400	2400	800
15.1-18.0	2200	4400	4400	1600
over 18.0	3500	7000	7000	3200

All fees and subsidies are in nominal Canadian dollars. Sources: Government of Ontario (1989), Government of Ontario (1991) and Government of Ontario (2010).

**FIGURE 4: SCHEDULE OF NEW VEHICLE FEES AND REBATES FOR THE ONTARIO FEEBATE PROGRAM (RIVERS AND SCHAUFLE 2014)**

In order to ensure that older vehicles in the province are meeting a certain standard with regards to emitting smog-causing pollutants, mandated inspection and maintenance (I and M) has been required since 1999 (Ontario Ministry of Environment and Climate Change 2017). In theory, enhancing I and M programs is a very cost effective way of reducing air pollution and emissions from cars because the reality is that a relatively small percentage of cars are often responsible for a disproportionate amount of emissions (Bryner and Duffy 2012). *Motor Vehicle* (1998), O Reg 361/98 requires all vehicles that are seven years or older be tested before vehicle license plates and registrations can be renewed (Ontario Ministry of Environment and Climate Change 2017). In 2017, the government eliminated the fee for the ‘Drive Clean’ program, established by O. Reg. 361/98, which has been an effective complimentary measure for reducing emissions from vehicles, especially light-duty vehicles (Ontario Ministry of Environment and Climate Change 2017; Office of the Auditor General of Ontario 2012, p. 113).

In addition to implementing measures to ensure traditional ICE vehicles are more environmentally friendly, the Ontario government has also encouraged the growth of the cleaner vehicle market (EVs, PHEVs, Hybrids etc.). Programs providing financial and nonfinancial incentives, as well as charging infrastructure development, make up the bulk of the new low-carbon transportation policies and regulations under the modern climate change governance regime.

#### Policies to Promote Alternative Clean Vehicles (EVs, ZEVs, Hybrids etc.)

The Ontario Provincial Government once again took a leadership role within Canada, designing and implementing the country’s first EV subsidy program in 2010, the Electric Vehicle Incentive Program (Axsen, Goldberg and Melton 2016). Initially a \$8,500 CAD subsidy was provided for the purchase or lease of new EVs based on their battery capacity but in 2016 the range and price of subsidies were increased (ranging from \$3,000 - \$14,000 CAD) and applied in a more nuanced manner based on battery capacity, seating and vehicle price (Ontario Ministry of Transportation 2017b; Axsen, Goldberg and Melton 2016).

The same year the government extended the program to 2020 and introduced a supply-side policy, a ZEV sales target, to compliment the significant demand-push subsidy policy (Clean Energy Canada et al. 2016).

The target, as opposed to a mandate, was aspirational, aiming to see 5% of all vehicle sales in the province be electric vehicles by 2020, a considerable leap from the .7% market share recorded in 2015 (Axsen, Goldberg and Melton 2016; Clean Energy Canada 2016). In 2018, the program was again updated to include a focus on hydrogen powered vehicles. The modernized Electric and Hydrogen Vehicle Incentive Program included the following key changes, making Ontario the most financially attractive jurisdiction in North America to buy an EV (DeRochie 2016):

- *Increased the current incentive range for EVs from \$5,000 - \$8,500 to \$6,000 - \$10,000*
- *Provided an opportunity to receive an additional \$3,000 incentive for vehicles with larger battery capacities*
- *Provided an additional \$1,000 incentive for vehicles with five or more seats*
- *In addition, the modernized EVIP included two caps: First the incentive amount was capped at \$3,000 if the MSRP of the vehicle was over \$75,000. Second, the incentive value was capped such that its value would not exceed 30% of the MSRP (Ontario Ministry of Transportation 2018b)*

It is important to note that these substantial subsidies for EVs are a very costly way to reduce emissions from the transportation sector. A recent estimate of the cost per tonne for emission reductions under Ontario's program was calculated at \$523/tonne (Green 2017).

Non-financial incentives to purchase or lease an EV were introduced alongside the start of the EVIP. The key incentive was the ability for drivers of EVs to use HOV and HOT lanes even if there is only one person in the car. This benefit was provided by the introduction in 2009 of the Ontario Green License Plate Program, whereby plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs) eligible for the EVIP, as well as used BEVs and PHEVs that are no older than model year 2010, receive 'green license plates' allowing single occupancy use of these lanes starting in 2010 (Ontario Ministry of Transportation 2017d). Both supply and demand side policies to encourage the uptake of cleaner vehicles make up the bulk of new efforts around low-carbon transportation, in comparison to older policies (emission standards etc.), and signify a clear government focus and aim to address transportation-related emissions for the purposes of mitigating climate change.

### *EV Charging Infrastructure*

Alongside subsidies and non-financial incentives for cleaner vehicles, the government also began building up a province-wide EV charging network and incentivizing homeowners and businesses to install charging stations. Ensuring there is sufficient electric vehicle supply equipment (EVSE), i.e. EV charging infrastructure, is crucial for supporting an increasing adoption rate of cleaner vehicles. This is another demand-focused policy that ensures those driving clean vehicles, which require charging, can easily recharge away from home (Axsen et al. 2016). By governments implementing policy measures aimed at developing a comprehensive charging infrastructure system, they are able to help mitigate issues around 'range anxiety', a common and powerful hindrance to ZEV uptake.

Recognizing this need, the provincial government launched the Electric Vehicle Charging Incentive Program (EVCIP) in 2013 to support and encourage homeowners and businesses to purchase and install EV charging stations for personal use by providing up to 50% of the purchase cost (up to \$500 CAD) and 50% of the installation cost (up to \$500) (Electric Mobility Canada 2016). Since its inception roughly \$2.2 million CAD has been provided to subsidize roughly 2,600 home charging stations (Ontario Ministry of Transportation 2018c). Beginning in 2015, the government has dedicated funds, first through a \$20 million endowment under the Green Investment Fund, and then through cap and trade revenues under the Greenhouse Gas Reduction Account, to build up a province-wide EV charging network (DeRochie 2016).

In order to meet the government goal of building roughly 500 charging stations in over 250 locations in the province, the Electric Vehicle Chargers Ontario (EVCO) program was established, which works with 24 public and private partners to facilitate the expansion of the provincial public EV charging network (Ontario Ministry of Transportation 2017c). As of 2018 it is estimated that there are now approximately 1,300 public EV charging stations installed under and outside of the EVCO program (Ontario Ministry of Transportation 2018c). Most recently, the government announced the creation of the The Workplace Electric Vehicle Charging Incentive Program, providing 80% of capital costs (up to \$7,500 CAD per level 2 charger) to employers and commercial building owners to further promote the uptake of EVs in the province (Ontario Ministry of Transportation 2018c). Taken together, these financial incentives for EVs and charging stations will continue to be funded by \$285 million CAD in cap-and-trade proceeds between 2017-2021 (Morrow and Keenan 2016).

### *Building Code and “EV Ready” Buildings.*

Complementary building code regulations to lower barriers for installing EV charging stations were passed in 2017 and 2018. In 2017, amendments to Ontario’s Building Code were made under *Building Code* (2017), O Reg 332/12 (filed under Building Code Act, 1992, S.O. 1992, c. 23) in order to ensure homes and workplaces are built to be “EV ready” (*Building Code*, 2007; ECO 2017). Specifically, all homes with parking must be built with a minimum 200 amp panel and a conduit to facilitate the potential future installation of a charging unit and all other buildings with parking (except multi-unit apartment buildings) need to be built with EV charging equipment covering at least 20% of parking spots, with the other 80% to be built “EV ready” (*Building Code* 2007, s 3.1.21.1). In 2018, *General* (2018), O Reg 114/18 was passed, which made amendments to the *Condominium Act* (SO 1998) to reduce the obstacles to installing an EV charger in condo buildings (O. Reg. 114/18; Thoms 2018). Taken together these measures illustrate a strong commitment to meet the 5% EV 2020 sales target, both in ambition and dedicated funding.

### Funding and Support for Research and Development, Industry Partnerships, and Local Industry Development

One critical way governments support low-carbon innovation through supply-side policies is by providing funds for research and development, which support collaboration and help new technologies reach commercialization. In the case of cleaner vehicles, government funding would be targeted at technologies related to ZEVs to encourage innovation that might not otherwise take place. While the rationale for government funded R & D is well known, the exact method or policy for delivering funding is still up for debate, therefore utilizing a mix of diverse policies is recommended (Bernanke 2011). Beginning in the mid-2000s the government of Ontario started focusing on funding low-carbon R & D, particularly money for industry to commercialize and adopt clean technology solutions.

Prior to the establishment of the modern climate change governance approach in 2015, two funds were established that included low-carbon transportation innovation objectives. In 2005, the Ontario Ethanol Growth Fund was established to support the production of ethanol fuel in Ontario by providing capital assistance to independent blenders and monies for pursuing research and innovation opportunities (Ontario Ministry of Agriculture, Food and Rural Affairs 2005). In 2008, the Next Generation Jobs Fund was introduced as an element of the province’s earlier climate change plan “Go Green” (Metrolinx 2008). The \$1.15 billion CAD fund’s goal is “to support research, development and commercialization in innovative industries and attract new investments in strategic areas of Ontario’s economy”, including the development of clean cars and fuels (Government of Ontario 2017c).

A large amount of money for funding for low-carbon research, development and technology commercialization was provided under various funds and programs post 2015; for the most part these programs remained very focused on industry. The 2016 Green Investment Fund (GIF) for Low-carbon

Technology for Industry works in a similar way as the GIF for homeowners and communities: enabling the adoption of low-carbon technologies to reduce GHG emissions (DeRochie 2016). The GIF for Low-carbon Technology for Industry provides \$74 million to large industrial facilities to adopt cleantech solutions and provides \$25 million to small and medium sized businesses for energy efficiency programs in order to reduce carbon pollution while stimulating local industry development (DeRochie 2016). Two programs, The Low Carbon Innovation Fund and Ontario's TargetGHG Collaborative Technology Development Program, were established the following year to provide funding more broadly for research, development and commercialization of GHG reduction technologies (ECO 2017; Sustainable Technology Development Canada 2017).

#### *Low Carbon Innovation Fund*

The Low Carbon Innovation Fund was established as a part of the province's Climate Change Action Plan and is aimed at providing funding to assist researchers, entrepreneurs and businesses to innovate and commercialize low carbon technologies; \$25.8 million in cap-and-trade proceeds were allocated to this program in 2017 (Government of Ontario 2017d; ECO 2017). The TargetGHG program similarly aims to accelerate commercialization of low-carbon technologies and stimulate local industry development, with a particular focus on small and medium size businesses, who apply for funds under this program to develop innovative technologies and execute demonstration projects (Sustainable Technology Development Canada 2017).

#### *Ontario Climate Change Solutions Deployment Corporation*

In 2017, the provincial government passed *Ontario Climate Change Solutions Deployment Corporation* (2017), O Reg 46/17 creating an organization, The Ontario Climate Change Solutions Deployment Corporation (OCCSDC), to help facilitate local cleantech industry development, reducing some of the transaction costs and barriers associated with this kind of activity. The following strategies are employed to meet the above-stated objective: providing information; engaging in marketing; providing services and arranging for others to be provided with services; providing incentives and engaging in financing activities, including providing incentives to individuals; stimulating private sector financing; and researching market barriers inhibiting the deployment of that technology and addressing those market barriers (Timmins 2017). It is important to point out that the OCCSDC does not support early stage research and development, but focuses on bringing commercially viable low-carbon technologies to market (Timmins 2017), which is a critical focus and important area to fund in order to meet near-term climate change policy objectives.

#### *R&D under the CCAP*

Funding has also been allocated specifically for reducing transportation-related emissions in the province. Under the research and development element of the Climate Change Action Plan, \$375 million has been allocated to cleantech R and D broadly, \$140 million CAD of which has been provided to set up a Global Centre for Low Carbon Mobility at an Ontario university or college to develop electric and other low-carbon vehicle technology (Morrow and Keenan 2016). In 2017, the government also brought together industry, environmentalists and academics, under the newly formed Electric and Hydrogen Vehicle Advancement Partnership, in order to work with government to advance low-carbon vehicle technologies; the Partnership received \$.09 million in cap-and-trade proceeds in 2017 (ECO 2017; Government of Ontario 2017e).

#### *Climate Change and Cleantech Strategy*

In order to organize a more comprehensive and coordinated approach to support low-carbon technologies, industries and development, the Ontario Government released its Cleantech Strategy in 2018, with the overall goal to leverage the province's position as having the fastest growing cleantech sector in Canada

and to become a leading cleantech hub in North America (Ontario Ministry of Research and Innovation and Science 2018; Ontario Ministry of Economic Development, Job Creation and Trade 2017). Under this strategy the province has allocated an initial ‘anchor commitment’ of \$55 million CAD to develop new ways to make equity investments in cleantech businesses under the Cleantech Equity Fund Initiative, \$27 million CAD to help mitigate the risks of expansion for cleantech firms under the Global Market Acceleration Fund, and \$10 million CAD to the GreenFIT fund for low-carbon technology demonstration projects (Ontario Ministry of Research and Innovation and Science 2018; Ontario Ministry of Economic Development, Job Creation and Trade 2017; Ontario Ministry of Economic Development, Job Creation and Trade 2018). Four pillars have been outlined under the Cleantech Strategy to help the expansion of this sector in the province: Venture and scale readiness support, such as improving access to global market intelligence; access to capital, including providing guidance on available provincial and federal cleantech funding and simplifying access; regulatory modernization, such as reducing barriers for cleantech market entry; adoption and procurement, by increasing demonstration and pilot opportunities (Ontario Ministry of Economic Development, Job Creation and Trade 2018).

### Government Procurement and Pilot Projects

A demand-pull policy, government procurement and pilot projects for cleaner vehicles, includes the government investing in demonstration projects like purchasing and using electric vehicles for public fleets (Gouldson et al. 2008; cited in Taylor et al. 2012; Axsen et al. 2016). When governments purchase and use a significant amount of a new low-carbon technology (e.g. ZEVs), they are aiming to impact demand through the use of ‘demonstration effects’. While the GreenFIT Procurement Strategy, introduced in 2010, is by no means limited to the transportation sector, it is an early example of contributing to the broader ‘greening’ of government by helping the Ontario Public Service, schools, hospitals and municipalities find green solutions to meet their purchasing needs (Ontario Ministry of Government and Consumer Services 2017).

With the release of the 2016 Climate Change Action Plan, funding for pilot and demonstration projects specific to low-carbon transport were established in the province. In 2017, the provincial government established a pilot program in order to study the electrification of school buses (and chargers), whereby eligible school bus operators apply for funding to add 100% BEV school buses to their fleet (ECO 2017; Ontario Ministry of Transportation 2017e). To date, the scope of the program remains limited and there are questions about the feasibility of a province-wide roll-out of the program (ECO 2017).

The same year the government passed *Pilot Project - Low Speed Vehicles* (2017), O Reg 215/17 launching a 10-year pilot program to study the use of low-speed vehicles on Ontario roads (Ontario Ministry of Transportation 2017f). The low-speed vehicles pilot program is aimed at better understanding how people can be moved safely and efficiently with limited environmental impacts, including a reduced reliance on conventional fuels, and to determine if existing road rules in Ontario are appropriate for the use of these kinds of vehicles (Ontario Ministry of Transportation 2017f). At the federal level, the 2016 budget also supported climate action, specifically lower carbon transportation, by allocating \$46.1 million CAD over two years to fund EV infrastructure demonstration projects under the broader Energy Innovation Program (Natural Resources Canada 2017a). The goal of these demonstration projects is to better understand how costs can be reduced and barriers to deploy next-generation EV charging infrastructure can be mitigated (Natural Resources Canada 2017a). In order to support all of the above mentioned programs, the provincial government has taken seriously the need to mitigate information failures in the market.

### Information Measures

Information campaigns are information-based policy measures aimed at combating information failures in the market. The goal is to educate the public through information provision with the goal of helping

“households and businesses identify economically sensible choices that reduce GHG emissions” (Ecofiscal Commission 2017, p. 4). Information campaigns can take many forms, including: websites providing information, labeling for vehicles, consumer outreach and government-funded advertising (Axsen et al. 2016). A novel approach to educating consumers about electric vehicles was recently pioneered and funded by the Ontario Government. In May of 2017, the government supported the opening of the Plug’n Drive Electric Vehicle Discovery Centre to combat information failures hindering the uptake of cleaner vehicles (The Canadian Press 2017). According to the Centre’s website, the facility is “focused entirely on providing an experiential learning environment for electric vehicles”, where visitors can:

- *Discover Ontario's Climate Change Action Plan and the role electric vehicles play in reducing greenhouse gas emissions*
- *Discover the environmental and economic benefits of driving an electric vehicle*
- *Discover Ontario's electricity system*
- *Discover and test drive the latest electric vehicle models from leading manufacturers*

...all without the pressure of being in a sales environment (Plug’n Drive 2017).

## *Transportation Demand Management*

Besides making passenger vehicles ‘cleaner’, the other major aim in developing a low-carbon road passenger transportation system is to try and reduce the use and number of personal vehicles on the road. As Lawless (2018) reminds us, “the only true zero-emission vehicle is one that is not driving”. Burda, Bailie and Haines (2010) explain that land-use and transit policies can be effective at reducing vehicle kilometers travelled (VKT) by enhancing transit systems and improving urban form in order to influence how far and by what method people travel. Policies that aim to meet these goals can be categorized as Transportation Demand Management (TDM) efforts. The impacts of these kinds of policies are diverse, including: “incentives for users to reduce driving, changing the frequency, mode, distribution, route or timing of their travel...reduc[ing] the need for physical travel through mobility substitutes or more efficient land use” and reforming policy to correct distortions in transport planning customs (Gwilliam et al. 2004; cited in Khan et al. 2007, p. 374).

### Transit-Integrated Land-Use Planning, Smart-Growth Measures

Land-use planning has been and continues to be a key lever for the Government to curb transportation-related GHG emissions. Since the original *Planning Act* (RSO 1950) was passed in 1946, foundational rules for land use planning processes in the province have been set out; at the most basic level rules dictate how land uses can be controlled and who is able to control them. Critically, the Act allowed for municipalities to develop formal, binding official plans for their area (White 2007). The legislation permitted the province to provide policy guidance to municipalities regarding their planning decisions through Provincial Policy Statements. However these tools were not fully developed until the early 1990s. The province can influence municipal land-use planning decisions in other ways, including the provision of capital funding for large-scale transportation infrastructure (e.g. transit and roads). Although implicit linkages existed between land-use, transportation and climate change, explicit references to climate change issues did not appear until 2014.

Formal linkages between the province’s land-use planning policies and transportation demand management first emerged in the early 1990s through the work of the Commission on Planning and Development Reform. The work of the Commission led to the adoption of a comprehensive set of Provincial Policy Statements (PPS) under the Planning Act in 1994. These reflected what would later be referred to as “smart growth” principles, including an emphasis on transit supportive densities and development, mixing of

residential and employment land uses to facilitate active transportation, and curbing urban sprawl (Winfield 2012).

These reforms were substantially weakened by the Progressive Conservative Government of Mike Harris, who was elected in 1995. The same government also withdrew provincial capital and operating support for transit projects, while placing a strong emphasis on highway construction. However, by the early 2000s a combination of concerns over rampant urban sprawl, traffic congestion and poor air quality compelled the Harris government to re-engage around transit infrastructure funding and land-use planning (Winfield 2012). As the problem of smog increasingly moved higher on the political agenda in the late 1990s, the Harris Government started to realize it needed to re-engage at some level in transit planning and funding; they also began discussing the concept of ‘smart growth’ in a formalized manner, launching a formal initiative in 2001, which in part led to the establishment of the Oak Ridges Moraine Conservation Plan and a five-year review of the Provincial Policy Statement (White 2007; Winfield 2012). The momentum around ‘smart growth’ was picked up by the next big change in government, the election of the Liberal Party, led by Dalton McGuinty, in 2003.

Building on some initial “smart growth” initiatives launched in the late stages of the Progressive Conservative government, the succeeding Liberal government under Dalton McGuinty undertook a major overhaul of the province’s land-use planning system between 2003 and 2006. The province’s initiatives included a significant strengthening of the *Planning Act*, the adoption of a revised PPS placing a strong emphasis on “smart growth” themes (including transit supportive development patterns), the creation of a “Greenbelt” within the Greater Toronto Area to contain urban sprawl, and the development of a “Growth Plan” for the region, intended to integrate land use and infrastructure planning (including transportation infrastructure). Although these planning and infrastructure development reforms were generally supportive of TDM and urban forms likely to reduce transportation related GHG emissions, they were not conceived of as climate change mitigation or adaptation strategies. Rather the underlying drivers remained sprawl, congestion and transportation-related air pollution.

It was only in 2014, under the Wynn Liberal Government (2013-2018), that climate change was integrated into land-use planning as a consideration in decision-making in earnest. In particular, the 2014 Provincial Policy Statement mentions climate change alongside longer-standing themes of transit-supportive, compact development; although, there was no formal mandate included *requiring* municipalities to plan to reduce emissions or adapt to the impacts of climate change (Ontario Ministry of Municipal Affairs and Housing 2014). These references were expanded in the 2017 update to the Growth Plan for the Greater Golden Horseshoe, although it is important to note that the plan only applies to the City of Toronto and surrounding area.

The 2017 Plan explicitly calls for municipalities to take action on climate change, both in terms of mitigation and adaptation (sec. 4.2.10 Climate Change). For example, in order to aid in the Province meeting its own GHG reduction goals, Policy 4.2.10.2 encourages municipalities to inventory GHGs, create strategies for emission reductions through the development of GHG reduction plans which stipulate interim and long-term reduction targets and to monitor progress against individual targets (Murphey et al. 2017). Policies are to be developed in the Official Plans of Upper and Single-tier municipalities that align with the Provinces’ 2015 Climate Change Strategy and 2016 Climate Change Action Plan, including:

- *supporting the achievement of complete communities as well as the minimum intensification and density targets in this Plan;*
- *reducing dependence on the automobile and supporting existing and planned transit and active transportation;*
- *assessing infrastructure risks and vulnerabilities and identifying actions and investments to address these challenges;*

- *undertaking stormwater management planning in a manner that assesses the impacts of extreme weather events and incorporates appropriate green infrastructure and low impact development;*
- *recognizing the importance of watershed planning for the protection of the quality and quantity of water and the identification and protection of hydrologic features and areas;*
- *protecting the Natural Heritage System and water resource systems;*
- *promoting local food, food security, and soil health and protecting the agricultural land base;*
- *providing direction that supports a culture of conservation in accordance with the policies in subsection 4.2.9; and*
- *any additional policies to reduce greenhouse gas emissions and build resilience, as appropriate, provided they do not conflict with this Plan. (Ontario Ministry of Municipal Affairs 2017, sec. 4.2.10)*

In addition, the 2017 Plan more aggressively directs growth to priority transit corridors:

*This Plan recognizes transit as a first priority for major transportation investments. It sets out a regional vision for transit, and seeks to align transit with growth by directing growth to major transit station areas and other strategic growth areas, including urban growth centres, and promoting transit investments in these areas. To optimize provincial investments in higher order transit, this Plan also identifies priority transit corridors and the Province expects municipalities to complete detailed planning for major transit station areas on these corridors to support planned service levels. (Ontario Ministry of Municipal Affairs 2017, p. 11)*

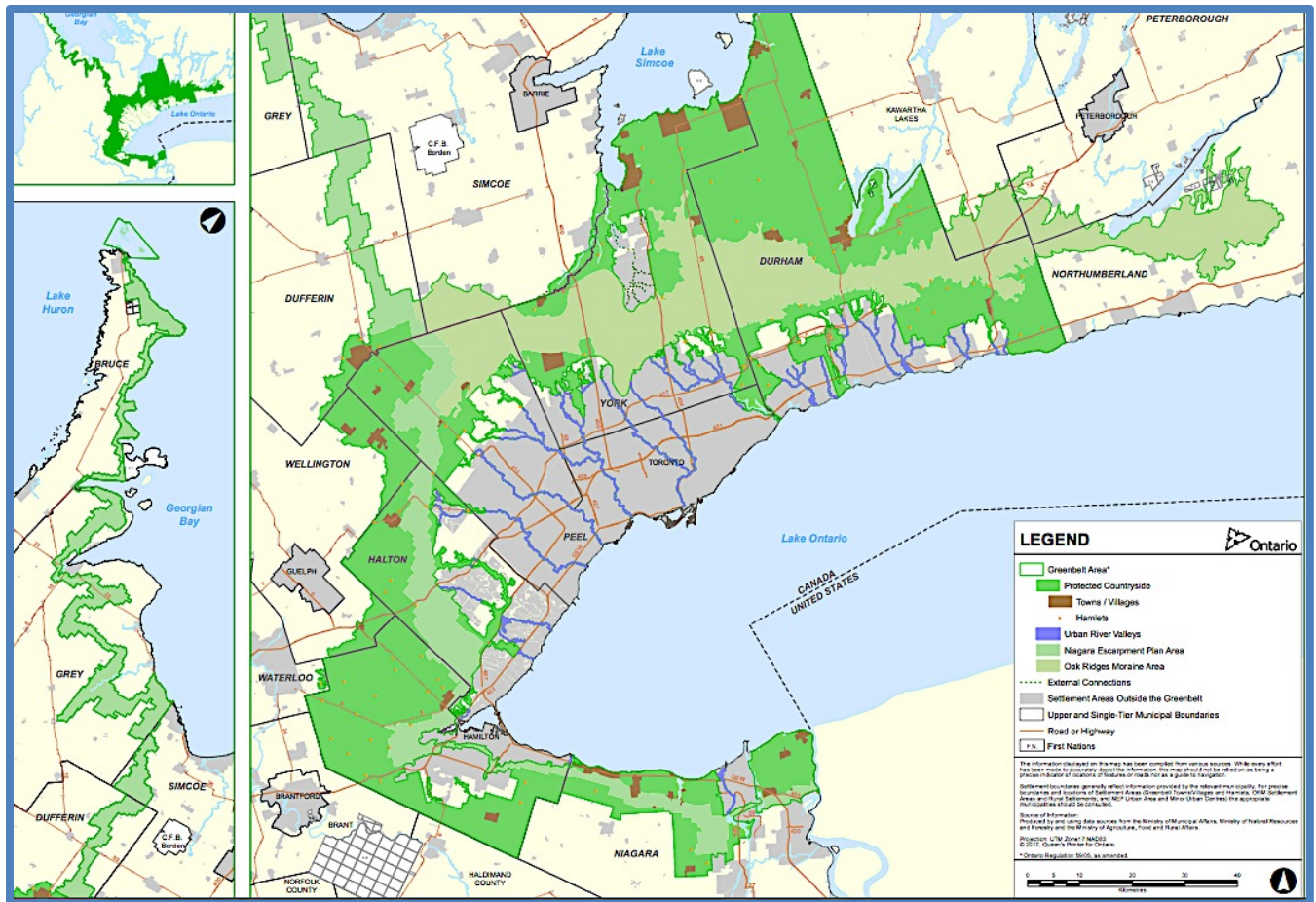
In addition to these key pieces of legislation, plans and many amendments to the *Planning Act*, guidance documents, such as the Ministry of Transportation’s Transit Supportive Guidelines (2012), have aided in producing positive environmental outcomes stemming from land-use and transportation planning and development. Subsequent Provincial Policy Statements (2005 and 2014) have also prioritized the need for ‘smart growth’ development and transit-integrated planning. These statements can be seen as another key crossover mechanism for the integration of transit and climate change objectives in land-use planning; unlike the Growth Plan for the GGH, the PPS integrates these objectives province-wide. For example, the most recent Statement (2014) for the first time discussed the concept of ‘active transportation’. Strong language (“shall”) is used around the need to incorporate active transportation in land-use planning decisions, as well as efficient resource use, intensification, freight and transit-supportive land-use patterns with the objective of minimizing negative impacts to air quality and climate change:

*Land use patterns within settlement areas shall be based on:*

- a) *densities and a mix of land uses which:*
  1. *efficiently use land and resources;*
  2. *are appropriate for, and efficiently use, the infrastructure and public service facilities which are planned or available, and avoid the need for their unjustified and/or uneconomical expansion;*
  3. *minimize negative impacts to air quality and climate change, and promote energy efficiency;*
  4. *support active transportation;*
  5. *are transit-supportive, where transit is planned, exists or may be developed; and*
  6. *are freight-supportive; and*
- b) *a range of uses and opportunities for intensification and redevelopment in accordance with the criteria in policy 1.1.3.3, where this can be accommodated.*  
(Ministry of Municipal Affairs and Housing 2014, sec. 1.1.3.2)

While the 2014 PPS certainly provides a step in the right direction with regards to prioritizing transit-integrated planning and climate change adaptation and mitigation, the Statement is not without critiques. The term ‘sustainable’ and ‘resilience’ are found throughout the 2014 PPS with regards to development. For example, Policies 1.1.4.1(f), 1.1.6.1 and 1.1.6.4 explicitly promote sustainable management and resource use of rural lands and Policies 1.2.3 and 1.3.1(c) each promote the notion of ‘resilient communities’ (Ontario Ministry of Municipal Affairs and Housing 2014; Flynn-guglietti and Forristal 2014). Importantly, as Flynn-guglietti and Forristal (2014) point out, neither of the terms ‘sustainable’ or ‘resilient’ are defined in the document. With regards to climate change, planning authorities are directed in Policy 1.8.1 to mitigate and adapt to climate change through land-use development; however, exactly what compliance with this policy would look like remains uncertain (Flynn-guglietti and Forristal 2014). As noted above, the introduction of the term ‘active transportation’ is an improvement on the previous PPS, but strong language (i.e. ‘shall’ vs. ‘should’) is missing with regards to incorporating the promotion of active transportation and a ‘complete streets’ approach in planning decision-making (Toronto Center for Active Transportation 2014). The pattern of somewhat vague language around climate change and sustainable development used in the 2014 PPS gives rise to concerns that any real impact will be limited.

In 2017, the Province’s three major plans with regards to conserving lands, the Niagara Escarpment Plan, The Oak Ridges Moraine Conservation Plan, and the Greenbelt Plan were all updated. These plans build on the latest Provincial Policy Statement and work in concert with the Province’s climate change strategy, acting as a barrier to sprawl while protecting ecologically important land and water, as well as providing carbon sinks where emissions can be effectively sequestered (Ontario Ministry of Municipal Affairs and Housing 2017a). In particular the Greenbelt is significant due to the vast amount of land it protects, nearly 2 million acres, and the location surrounding the province’s largest urban areas, the Golden Horseshoe (Ontario Ministry of Municipal Affairs and Housing 2005). The Provincial government announced the expansion of the Greenbelt in 2013 (the first expansion since the 2005 Plan) and after much consultation, the updated 2017 Greenbelt Plan explicitly linked the protection of these lands to climate change action and expanded the Greenbelt to link key hydrological features (21 urban river valleys and 7 coastal wetlands) from the Greenbelt to Lake Ontario (The Friends of the Greenbelt Foundation n.d.) (see Figure 3).



**FIGURE 5: THE 2017 GREENBELT PLAN MAP. THE VARIOUS SHADES OF GREEN DEPICT THE PROTECTED LAND, WHICH ENCOMPASSES THE COUNTRY’S MOST POPULOUS URBAN AREA, THE GTHA. (FRIENDS OF THE GREENBELT 2017)**

In 2017, Bill 139, the *Building Better Communities and Conserving Watersheds Act*, (2017), provided a boost to the institutionalization of climate change adaptation and mitigation planning at lower levels of government. The Act highlights the role of land-use planning as a mechanism for protecting the environment and empowers Conservation Authorities with increased flexibility to deal with climate change and other environmental threats (Ontario Ministry of Municipal Affairs and Housing 2017). The *Building Better Communities Act* (2017) adds a new clause to sec. 16 of the *Planning Act* (which governs the content of Official Plans), requiring that municipal Official Plans, for the first time, contain climate change policies where objectives are set and strategies and actions delineated that will reduce emissions and increase community resilience through adaptation strategies (Murphy et al. 2017; Environmental Commissioner of Ontario 2017). In the same section, an additional amendment allows the inclusion of policies relating to development around transit stations and stops (*Building Better Communities and Conserving Watersheds Act* 2017, Explanatory note). One key outcome of the changes this Act makes is that municipalities should, in theory, be able to develop transit projects with fewer barriers (ECO 2017).

In addition to the updates to environmental protection plans (e.g. the Greenbelt Plan) and the passing of the *Building Better Communities Act*, 2017 also saw the passing of Bill 68, the *Modernizing Ontario’s*

*Municipal Legislation Act*, (2017). This Act amended the *Planning Act* by incorporating “the mitigation of greenhouse gas emissions and adaptation to a changing climate” as a matter of provincial interest. The Act also clarified that municipalities are able to pass climate change by-laws and participate in long-term energy planning as a means of mitigating the negative impacts of climate change in their communities (Murphy et al. 2017; Ontario Ministry of Municipal Affairs and Housing 2017b).

Changes to land-use planning in the province, especially new policy frameworks, over the past 25 years reflect the emergence of ideas around ‘smart growth’ and transit-supportive community building and the incorporation of best-practices in the field. The policy changes also reflect the province’s significant population growth, especially the growth of the urban mega-region of the GTHA, and the need to take aggressive action on minimizing urban sprawl. In addition to land-use planning taking on a ‘smart growth’ or a sustainable development orientation under the past Liberal governments, efforts to promote transit-integrated planning in the province also became more comprehensive during this time.

### *Transit Specific Planning or Investments*

The provincial government passed the *Metrolinx Act*, (2006) creating an agency (Metrolinx) tasked to deal with coordinating and integrating transit planning, design, construction, with a particular focus on the largest urban region in the country, Greater Toronto Hamilton Area (GTHA) (Metrolinx 2018). Modern, comprehensive, transit-specific planning has since been formalized in the province, first in 2007 with the announcement of the “MoveOntario 2020” plan, which represents the largest transit investment in Canadian history at an estimated \$17.5 billion CAD (Government of Ontario 2007). The plan includes 52 rapid transit projects in the GTHA, representing 902 kilometres of new rapid transit, with an estimated 175,000 associated construction jobs (Government of Ontario 2007). With regards to the environmental impact from this plan, the Province estimates 10 megatonnes of CO<sub>2</sub> reductions by 2020 and associated smog reductions (Office of the Premier 2007).

Although this was a positive step in the sense that serious funding was committed to transit, it is important to note that the decision-making process for what projects would be funded was and remains largely political, as opposed to being based on an analysis or modelling of resulting GHG reductions or planning rationales (Pagliaro and Spurr 2017).

The following year transit expansion planning continued with the announcement of “The Big Move”, the first long-range regional transportation expansion plan for the GTHA (Metrolinx 2013). The plan was adopted by Metrolinx in 2008 and provides an ambitious 25-year plan to plan, design and build an extensive regional transportation system in this rapidly expanding urban area (Metrolinx 2013). MoveOntario 2020 was incorporated in this first comprehensive regional transportation plan, which has now been updated and led to the second draft regional transportation plan for the GTHA, The 2041 Regional Transportation Plan, which works together with the previously mentioned Growth Plans (Metrolinx 2017; Metrolinx 2018). The 2041 Regional Transportation Plan builds on past progress and continues aggressive expansion of rapid transit in the GTHA, which will see its population increase to roughly 10 million people by 2041:

- *More than \$30 billion is being invested in rapid transit infrastructure over the next eight years*
- *An extension of the Yonge-University Subway to Vaughan Metropolitan Centre opened in late 2017*
- *Led by Metrolinx, the Eglinton Crosstown light rail transit (LRT) line is under construction in Toronto, and more Viva/YRT bus rapid transit (BRT) is being built in York Region*
- *UP Express has answered the decades-long call for a fast, permanent rail link between downtown Toronto and Lester B. Pearson International Airport*
- *Planning and engineering design is underway for 14 projects including expansions of LRT, BRT and subway services*

- *The Regional Express Rail program, our most ambitious program yet, will transform the region with frequent, two-way all-day rail service, more than doubling the number of GO Transit riders by 2031*
- *Union Station—the hub of the regional transit network—is expanding to meet the needs of 300,000 people who use it every weekday, and even more who will use it in the future*
- *Across the GTHA and Ottawa, fare payment has been modernized with the PRESTO fare card (Metrolinx 2018)*

The expansion of rapid transit in the GTHA is currently the largest in North America, therefore it is not surprising that the government has increased methods and sources for funding transit planning, design and construction along the same time period. The first major fund to assist cities with projects to improve air, soil and water quality, including transit building, was set up in the year 2000 by the Federal government. The Green Municipal Fund was established to provide low-interest loans for municipal projects directly or indirectly addressing climate change challenges. Initially \$550 million was endowed to the Federation of Canadian Municipalities, with an additional \$125 million in 2016 and \$72 million announced in 2017 (Federation of Canadian Municipalities 2017; Federation of Canadian Municipalities 2017a).

In the same year the Ontario Ministry of Transportation established a voluntary, competitive grant program for municipal governments wishing to implement TDM projects (Ontario Ministry of Transportation 2011). Finally in 2008, the government passed *Transit Projects And Metrolinx Undertakings* (2008), O Reg 231/08 aimed at expediting all public transit projects by exempting them from environmental assessment requirements under the *Environmental Assessment Act* (R.S.O. 1990), so long as they go through an alternative expedited review process (Mahony 2016, 9-55).

The past five years have seen much more significant funding efforts by the government to expand and upgrade regional transportation networks, following the trend of significant increased funding for climate change projects more broadly. In 2014 the province established a Green Bond Program to fund projects with environmental benefits, including transit projects like the Toronto Eglinton Crosstown Light Rail Project, which received the first round of funds raised. The program is currently funding 12 projects with the most recent round of funding of \$800 million (Ontario Financial Authority 2014; Government of Ontario 2016; ECO 2017). In another effort to fund mass transit and infrastructure projects, the Provincial government passed the *Trillium Trust Act* (2014), establishing a separate account funded by the sale of particular provincial assets (i.e. Hydro One), specifically dedicated to funding modern infrastructure and transportation networks (Ontario Ministry of Finance 2015).

As of 2017, the government was on track to meet its goal of reaching \$5.7 billion to the Trillium Trust, having already dedicated \$5.3 billion (Ontario Minister of Finance 2017a, p. 160). The money from the Trust will go towards the larger Moving Ontario Forward plan, which will invest \$130 billion over 10 years in transit, transportation and other priority infrastructure. (Ontario Minister of Finance 2017a, p. 160; Ontario Ministry of Finance 2015). It is important to emphasize again that the nature of transit investment decision-making remains largely political; the process lacks sophisticated formalized and standardized modelling requirements in order to ensure investments are optimized by directing funding to projects with maximum GHG reductions. As Professor Haider from Ryerson University in Toronto explains, politicians view building transit in part as a way to get elected, therefore political as opposed to evidence-based rationales dictate decisions:

The public transit infrastructure investment is a taxpayer subsidy to politicians' political ambitions because there's no rationale for it most of the time. What gets built and what should have been built are completely two different things. (Pagliaro and Spurr 2017)

In 2017, significant additional funding for public transit projects and service improvements were announced by the government in the annual budget. The Budget dedicated \$56 billion over the next ten years for rapid transit projects in Southwestern Ontario, as well as a transformation for the GO rail system under the GO Regional Express Initiative aimed at quadrupling the number of weekly trips to 6,000 by 2024-25 (Ontario Minister of Finance 2017a, p. 150). In addition, the 2017 Budget increased the share of the provincial gas tax that municipalities will receive from \$334 million in 2016–17, to roughly \$642 million by 2021–22 (Ontario Minister of Finance 2017a, p. 154). The amount of increased funding to municipalities is based 70% on ridership and 30% on population and will be dedicated towards local transit priorities (Ontario Minister of Finance 2017a, p. 154). With regards to making existing transit systems more efficient, the 2017 Budget also announced a \$50 million investment over 11 years “to establish a Trade and Transportation Information System to fill significant information, data and analytical gaps in strategic elements of the transportation system” (Transport Canada 2016, p. 29).

The effort to increase delivery of expanded funding for transit, efforts to ensure timely completion of projects, and efforts to improve transit system efficiency with data and information systems illustrates that the prioritization of creating a regional rapid transit network in key provincial locations goes much further than rhetoric or plans on paper.

### Other TDM Measures

Complimentary TDM measures that are substantive and designed to work directly in concert with land-use planning and transit expansion efforts have only been introduced in recent years, spurred on by a reinvigorated focus on addressing climate change issues beginning with Ontario’s Climate Change Strategy in 2015. In particular, efforts to promote active transportation (especially cycling) in order to support a modal shift in commuting behaviours, as well as more nuanced approaches to differential road treatments, like HOV and HOT lanes, have formed a central part of recent TDM programs. Funding TDM projects like the expansion of cycling infrastructure has also increased along this same time period.

### Active Transportation

Encouraging active transportation, such as the use of bicycles for transportation purposes, by increasing the supply of alternative transportation infrastructure such as bike lanes and bike-parking, can enable modal shift and reduce VMTs (Cairns and Arros 2014). While increasing bike infrastructure is not a very cost effective way to reduce GHG emissions, there are many co-benefits outside of emission mitigation that make these programs attractive enough to realize widespread implementation; these programs can “improve health, fitness, and safety for cyclists, reduce transportation costs for people who cycle instead of drive, reduce the costs associated with traffic congestion, and increase the overall efficiency of the transportation network” (Litman, 2017; cited in EcoFiscal Commission 2017).

The beginnings of a shift in policy to encourage the use of bicycles started with small changes, such as allowing public transit vehicles to be equipped to carry bicycles in 2008 (*Public Vehicles Amendment Act* 2008). A much more comprehensive approach to encouraging commuter cycling in the Province began in 2014 with the “CycleON” Ontario Cycling Strategy, followed by the 2015 Ontario Municipal Cycling Infrastructure plan (Ontario Ministry of Transportation 2016; 2016a). The Ontario Cycling Strategy consists of multi-year action plans to make the province more cycling-friendly over a 20 year horizon; the first plan #CycleON Action Plan 1.0 was an intergovernmental approach being implemented by twelve different ministries and the second plan, Action Plan 2.0, will continue this work over its implementation between 2018-2023 (Ontario Ministry of Transportation 2016; Ontario Ministry of Transportation 2018).

As a part of the first “CycleON” Action plan, the Ministry of Transportation established a \$10 million Ontario Municipal Cycling Infrastructure Program to encourage growth in cycling over the next 20 years (Ontario Ministry of Transportation 2016). The Ministry also released guidelines and manuals to aid in the

design and development of cycling facilities, including” the Ontario Traffic Manual Book 18: Cycling Facilities and the Bikeways Design Manual (Ontario Ministry of Transportation 2018). Legislative and regulatory amendments were also passed in 2015 to encourage more people to cycle by promoting cycling safety, including: a requirement for drivers to maintain a minimum distance of one metre when passing cyclists, allowing contra-flow bike lanes on on-way highways, and increasing the range for fines for “dooring” from \$60-\$500 to \$300-\$1000 with and associated increase in lost demerit points from 2 to 3 points (Ontario Ministry of Transportation 2018).

The new plan includes a host of initiatives to continue progress made in Action Plan 1.0. Some of these include: ensuring active transportation is built into official municipal plans and implemented in the 2041 Regional Transportation Plan for the GTHA, promoting and expanding active commuting to school, expanding provincial cycling infrastructure, continuing to promote cycling safety and awareness of cycling rules, and increasing cycling tourism opportunities (Ontario Ministry of Transportation 2018). As a part of Ontario’s Climate Change Action Plan, \$150-\$225 million has been dedicated from cap and trade proceeds to accelerate the implementation of the Ontario Cycling Action Plan, including the construction of curb-separated bike lanes and bike parking at GO stations (Morrow and Keenan 2016; Ontario Ministry of Transportation 2018). Further to these efforts, in 2017, the Ontario Municipal Commuter Cycling Program was established, which directs \$94 million over four years to municipalities to invest in commuter cycling infrastructure (Ontario Ministry of Transportation 2018; ECO 2017).

### Car sharing/pooling

Car sharing/car-pooling programs are a more cost-effective way to attempt to reduce personal trip distance and vehicle ownership as compared to traditional public transit and promoting cycling commuting, and have also been proven to reduce GHG emissions (Cairns and Arros 2014; Clean Energy Canada et al. 2016). These programs can be operated as government-owned, private, not-for-profit or hybrid operations (Clean Energy Canada et al. 2016). Car-sharing/pooling programs lead to a reduction of fuel consumption and GHG emissions by supplementing transit and active transportation, filling gaps for trips where destinations are not easily or well served by transit, or in the case that cargo is needed to be transported (Elzen et al. 2004).

Governments may also facilitate car-sharing, for example through setting up organizations that facilitate information provision and sharing and reduce the transaction costs associated with organizing car-pooling. A good example of this in Ontario is the Greater Toronto-Hamilton region ‘Smart Commute’ program (Metrolinx 2017). The Ontario Ministry of Transportation also provides 6000 parking spaces specifically for park & ride or carpooling vehicles located in 80 lots (Ferguson, Harrison, Pang, Higgins, & Kanaroglou 2016). Although millions have flowed into the Smart Commute program, this government effort has had a negligible impact on reducing VMT (Yauch 2013). Anecdotal evidence would suggest that various technological applications have produced a much more widespread user base for car-sharing and carpooling in comparison to government directed programs like Smart Commute. Car-sharing and pooling applications like Lyft and Uberpool, as well as more informal Facebook groups for carpooling over longer distances (e.g. Waterloo to Toronto), have proliferated since the advent of the modern smartphone and social media websites and applications.

### HOV and HOT lanes

Generally speaking, Ontario highway travel “is largely general purpose in its implementation and orientation”; there are only four highways with High Occupancy Vehicle (HOV) lanes in the province and

one pilot project for High Occupancy Toll (HOT) lanes (Ferguson et al. 2016; Ontario Ministry of Transportation 2018a). Differential treatment of traffic flows, like increased use of HOV and HOT lanes, is required in order to optimize travel along key highway corridors, for example innovation corridors like Toronto-Waterloo (Ferguson et al. 2016). The *Highway Traffic Act* (R.S.O. 1990) is the primary piece of legislation regulating HOV lanes and road pricing in the province. Simply, road pricing means that vehicles are charged for access to certain roads with the aim of decreasing road use and/or shifting the time that roads are used (Cairns and Arros 2014).

These schemes can take many forms, including: congestion charges, cordon schemes, road tolls, distance-based fees and High Occupancy Tolls (HOTs) (Transportation Research Board 2011; Heptonstall et al. 2009). Toll roads and lanes are a scarcely used tool in Canada, which has only three significant highway stretches that are tolled, two of which (Highway 407 and 412) are in Ontario (Ferguson et al. 2016; Ontario Ministry of Transportation 2017). Currently, the Ministry of Transportation has converted HOV lanes on the Queen Elizabeth Way to HOT lanes as a first-ever pilot project with the aim of testing new ways to improve traffic flow and increase carpooling (Ontario Ministry of Transportation 2018a). Within the Canadian context, Duff and Irvine (2005) suggest road pricing is underutilized. This would especially seem to be the case in Southwestern Ontario where congestion and traffic delays have been stated to cause billions of dollars per year (Duff and Irvine 2005).

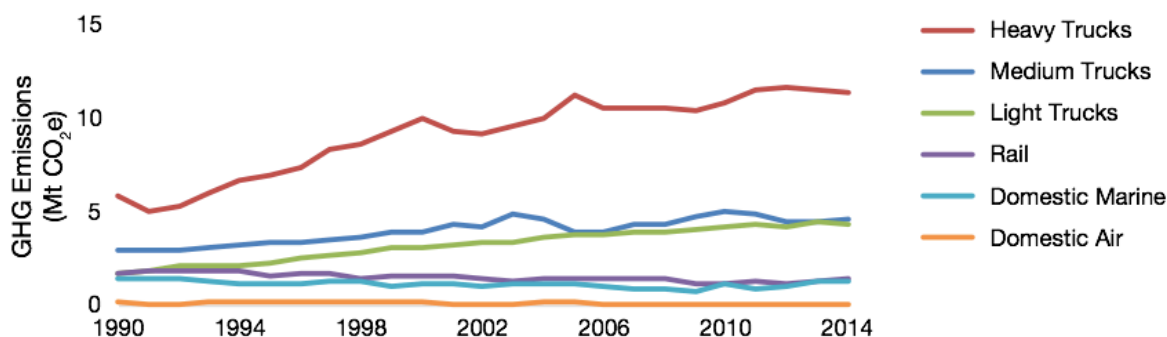
As mentioned above, a first-ever pilot project for testing the impact of HOT lanes was rolled out in 2016, covering 16.5 km of the QEW highway (Ontario Ministry of Transportation 2016b); a positive sign for this underutilized method of managing traffic flows and raising revenues. Further use of HOT lanes are planned in the next few years, for example, a 15.5 km stretch of Highway 427 will be outfitting with electronic tolling in both directions starting in 2021 (Ontario Ministry of Transportation 2016b). The cost of using the HOT lane is a key consideration, and potential issue for the design of this project in Ontario. The cost of a permit to use the HOT pilot lane is \$60/month (Ontario MTO 2018a), or less than \$3 per day for someone commuting five days per week. If the goal is to create a modal shift in commuting behaviour, this price signal is far too weak. The price must at least equal the cost of regional public transit, the GO Presto fare, if any considerable results in commuting behaviour and environmental benefits are to be realized.

HOV lanes are, in comparison, a more commonly used and accepted mode of manipulating traffic flows in the province, which is seeing an expansion of a planned HOV lane network. In 2005, the *Transportation Statute Law Amendment Act* (2005) introduced a new section (154.1) allowing the Minister of Transportation to designate any lane a HOV lane and to regulate what kind of vehicle type or class, and number of occupants, were able to use the lane. This is important not only to provide for the expanded use of HOV lanes, but as previously mentioned, allowed for ‘cleaner vehicles’ to use the lane even with single occupancy. An important concern arises with the promotion of HOV lanes in the province. A key critique from experts like Dr. Barry Wellar (Professor Emeritus, University of Ottawa) is that the Ministry of Transportation is “attempt[ing] to pass off HOV lanes as a sustainable transport practice, even though they have been panned in the literature, at public meetings, and in governmental correspondence as a gimmick to expand the highway network and add to the amount of private motor vehicle traffic on Ontario’s highways, thereby creating the demand for more highways...” (Wellar 2010, p. 19).

## REDUCING EMISSIONS FROM THE FREIGHT TRANSPORTATION SECTOR

In comparison to efforts to reduce GHG emissions from the passenger transportation sector, parallel efforts for freight transportation are extremely limited. This can be understood in part due to the unique technological challenges associated with pursuing low-carbon freight transportation, which are very significant. The importance of taking action to promote low-carbon freight transportation cannot be

understated. Since 1990, freight emissions have grown 205% and are on pace to outnumber passenger transportation emissions by 2030 in Canada (Wiginton 2018). This mirrors the situation in Ontario where freight emissions have also more than doubled since 1990 and are projected to continue to rise (ECO 2017). The shift to just-in-time delivery business model and more recent rapid increase in online shopping has meant demand for trucking has risen, alongside fuels allowing trucks to travel longer distances (ECO 2017). As Figure 6 illustrates, the increase in freight emissions in Ontario is primarily due to increased heavy trucking:



**FIGURE 6: THE GROWTH OF FREIGHT GHG EMISSIONS IN ONTARIO (1990-2014) (NATURAL RESOURCES CANADA 2016; CITED IN ECO 2017)**

While achieving a low-carbon freight transportation system remains a difficult challenge, rapid technological advances in key elements like batteries are making the possibility of electrified heavy-duty fleets a real possibility if governments provide the right mix of supportive policies (Wiginton 2018). Plans to reduce emissions from freight transportation have been initiated under the modern climate change governance approach at both the federal (The Pan-Canadian Framework on Climate Change, 2016) and provincial level (Ontario’s Climate Change Action Plan, 2016), although comparatively, less substantive action has taken place at the provincial level.

The Federal Pan-Canadian Framework sets out at least seven actions to directly and indirectly support a low-carbon freight industry in Canada (Government of Canada 2017; Wiginton 2018). Direct action to decarbonize the freight sector include: new heavy-duty emission standards for new vehicles, new rules for efficiency upgrades for existing trucks, partnerships for alternative fuel stations, investments in trade hubs, corridors and ports (Government of Canada 2017; Wiginton 2018). Indirect economy-wide measures like carbon pricing and a forthcoming federal low-carbon fuel standard will also aid in decarbonizing freight transport by making the direct actions more economically attractive (Government of Canada 2017; Wiginton 2018).

While trucks have become more efficient (i.e. less emission intensive), these gains have been greatly offset by the rapid increase in demand for trucking in the province and to a lesser extent that most trucks still run on carbon-intensive diesel fuel (ECO 2017). The provincial government has only a few policies in place to encourage trucks to be less emission intensive and more recently, that they utilize bio-blended fuels. Vehicle standards for trucks in the province are geared at higher efficiency outcomes, such as required speed limiters and revised truck dimension regulations to allow rear-aerodynamic devices (ECO 2017). The provincial government established a pilot Green Commercial Vehicle Program (GCVP) between 2008-2010 that was modernized using insights from the pilot and re-launched as a part of the Climate Change Action Plan in

2018 (Ontario Ministry of Transportation 2018c). The GCVP provides near-term emission reductions by subsidizing up to 50% of the cost to buy and install various technologies to reduce vehicle emissions such as anti-idling devices, aerodynamic devices and electric trailer refrigeration units (Ontario Ministry of Transportation 2018c). The program also subsidizes the purchase of electric and natural gas trucks as well as dual fuel and conversion kits (Ontario Trucking Association 2017).

Lower-carbon fuels are also being encouraged in the province. As explained previously, in 2014 the government introduced the *Greener Diesel - Renewable Fuel Content Requirements For Petroleum Diesel Fuel* (2014), O Reg 97/14, which established progressively stringent requirements for the bio-based component of the fuel phased in over three years (2014-2017). While the bio-based component for diesel is required to have a 70% lower GHG emission profile than petroleum diesel, the bio-based fuel quota is only 4% of the total fuel volume, meaning the emission reduction for the whole fuel blend is only reduced by 3% (ECO 2017). One misguided approach the provincial government is taking to reduce freight congestion on roads is to build new roads (e.g. Highway 412 and Highway 407 expansion) and expand truck capacity on existing roads, as suggested in the government's Freight Supportive Guidelines (ECO 2017). As many empirical studies have illustrated, this will only increase freight related emissions (ECO 2017). While most of these initiatives are a step in the right direction, their impact will be nowhere near enough to reduce provincial freight emissions, which "are on track to use up the 2050 emission-reduction target for the entire province" (ECO 2017, p. 194).

## POTENTIAL CHANGES UNDER THE NEW PROGRESSIVE CONSERVATIVE GOVERNMENT

On June 7, 2018 Ontarians elected a Progressive Conservative Party (PC) government, led by now Premier Doug Ford, who won a majority of seats (76), followed by the Ontario New Democratic Party (NDP) (40 seats), ending a 15-year rule by the Ontario Liberal Party who won only 7 seats, and as a result lost official party status (Elections Ontario 2018). In addition to the three major parties, for the first time an Ontario Green Party Member of Provincial Parliament (MPP) was elected (Elections Ontario 2018). With regards to climate change and the importance of science and evidence in government decision-making, two recent changes under the new government provide signals that both are no longer top priorities.

First, the PC government has changed the name of the Ministry of Environment and Climate Change to the Ministry of Environment, Conservation and Parks, eliminating the 'climate change' from the title (McGrath 2018). In addition, early in July 2018, Premier Ford fired the province's first Chief Scientist, who was appointed to the newly created position in November of 2017 (Maloney 2018). While the exact meaning of these changes is not completely clear, the general orientation of the new government with regards to environmental issues has been illustrated very clearly via early actions. For example, Premier Ford recently announced the cancelation of 758 renewable energy installations, representing the latest round of planned renewable energy project procurements in the province (Winfield 2018). A particular hostility towards climate change action has been evidenced, in particular by early action to follow through on dismantling the provincial cap and trade system, a central feature of the new government's election platform and now government mandate.

The new PC government stands in stark contrast to the past Liberal Party on many issues, but perhaps most dramatically on the issue of carbon pricing and aggressive action on climate change mitigation. As mentioned, the most clear example of this is province's withdrawal from the Western Climate Initiative and cancel Ontario's cap and trade program (Office of the Premier Designate 2018; Buchta, Corpuz and Coburn 2018). In addition to the lost revenue from cap and trade, roughly \$2 billion CAD per year, Lisa DeMarco of the Toronto law firm DeMarco Allan, estimates the cost of canceling the program, including buying back

allowances already sold to companies covering emissions expected and beyond 2020, would cost the province between \$2-4 billion CAD (Sharp 2018).

The cost also includes the price of potential litigation, estimated to be upwards of \$100 million CAD, which will likely be result from this action (Sharp 2018). According to DeMarco, a full cancelation of the program may not occur and instead existing legislation may be tweaked and repackaged: “I think once they discuss with industry what’s working, they will likely keep a price on carbon but determine how best to use the proceeds,” she said, with such options as returning the revenues directly to ratepayers or taxpayers (Sharp 2018). As of early July, Ford has revoked the regulations outlining the carbon pricing system in the province and has begun the process of deciding how to revoke funding for projects paid for by carbon pricing proceeds (Loriggio 2018).

The new government’s disdain for carbon pricing also goes beyond provincial borders. The *Greenhouse Gas Pollution Pricing Act* (2018), which legally established the federal carbon backstop price, has recently received Royal Assent. Premier Ford has stated continually that he will launch a legal challenge against the federal government’s imposition of a carbon-backstop pricing regime for provinces who do not already have an equivalent pricing scheme, a legal battle he is unlikely to win according to constitutional and environmental law experts (Sharp 2018; Buchta, Corpuz and Coburn 2018; Rolfe 2018).

In addition to lost revenue from cap and trade and significant costs associated with pulling out of the system, the province may also not receive its \$420 million share of the federal Low Carbon Economy Fund as a result of cancelling carbon pricing in the province, effectively pulling out of the national climate change plan without any alternative plan to address climate change issues (Wechsler 2018). Finally, the province has GHG reduction targets enshrined in law as per the *Climate Change Mitigation and Low Carbon Economy Act* (2016). The fate of these targets and framework legislation under the new government is unclear.

With regards to policies impacting transportation-related emissions, the new PC government has canceled many of the ‘cleaner vehicle’ programs and policies, which made up the bulk of new environmentally-oriented policies in the transportation sector. The Electric and Hydrogen Vehicle Incentive Program and the Electric Vehicle Charging Incentive Program were both cancelled, effective July 11, 2018 (Ontario Ministry of Transportation 2018d; Blinch 2018). The PC government has also committed to reducing the provincial gasoline tax by 10 cents/litre (Winfield 2018).

In terms of public transit projects, Premier Ford has a strong preference for subways and underground transit, committing \$5 billion for subways in Toronto and support for other regional rapid transit projects (Canadian Press 2018). It is highly problematic that there is no clear strategy for how these would be funded (Canadian Pres 2018), especially with funds not being continued through cap and trade, in addition to the fact that subways tend to only be financially feasible to construct and maintain in areas with significant population density, potentially leaving out much of the province. Also problematic is the continuation of political decision-making around transit priorities as opposed to more evidence-based decision-making. On the whole, the funding announced by Premier Ford for transit is less than the previous Liberal Government (Canadian Press 2018). Finally, the promotion of active transportation has been impacted by the cancelling of the Ontario Municipal Commuter Cycling Program (Stuckless 2018).

## CONCLUSION

Ontario has relatively well developed governance structures and regulatory regimes around air pollution, infrastructure and land-use planning. Although some of these regimes date back to the 1940s and 1950s, linkages between land-use planning and transportation only began to be made in a formal sense in the early

1990s. Although many of the resulting policies were potentially strongly supportive of transportation related GHG emission reduction strategies, explicit references to climate change mitigation only began to emerge very recently under the Wynne government from 2014 onwards, and the province's carbon pricing system, a cap and trade structure flowing from the original Western Climate Initiative, only began to be implemented in 2017.

In particular, land-use planning laws and regulations, especially in the GTHA, have been critical for ensuring Ontario's passenger transportation emissions don't grow exponentially as a result of continued sprawl. Much of this emergent policy infrastructure is now dismantled or being dismantled by the new Ford government. The new government claims to recognize the reality of climate change, and has committed to the development of a new climate change strategy. However the contents of that strategy are completely unknown at this stage. In the words of the Environmental Commissioner of Ontario, the June 2018 election of the Ford Government has resulted in "an abrupt halt" of climate change efforts and the passing of legislation to repeal the Green Energy and Economy Act and the province's cap and trade system will "leave Ontario with no statutory emission targets, no pathway to achieve targets, weak reporting, no carbon price, and no stream of revenue to invest in solutions" (ECO 2018, p. 66).

In the case of Ontario, as with many other jurisdictions, the challenge to reduce emissions in general, and from the transportation sector, remains largely a political one. Better understanding how the political acceptability of mitigation policies can be increased through strategic communication efforts will be a key step in ensuring a sufficient level of social consensus upon which policies can be justified. In addition, ensuring climate policies are designed in a robust and resilient manner, so that they may continue to exist effectively through shocks, changing governments, policy paradigms and swings in issue-salience, is necessary to create the policy stability required for meeting long-term objectives around reducing emissions.

## REFERENCES

- Administrative penalties, O Reg 540/17, <<http://canlii.ca/t/532hd>>
- Air Pollution - Local Air Quality, O Reg 419/05, <<http://canlii.ca/t/536gm>>
- Air Pollution Control Act, RSO 1970, c 16
- Association of Municipalities Ontario. (2017). Ontario Municipal Transit. Retrieved from <https://www.amo.on.ca/AMO-Content/Backgrounders/2017/OntarioMunicipalTransit>
- Anastakis, D. (2013). *Autonomous state: The struggle for a Canadian car industry from OPEC to free trade*. University of Toronto Press.
- Antweiler, W., & Gulati, S. (2013). Market-based policies for green motoring in Canada. *Canadian Public Policy*, 39(SUPPL.2). <http://doi.org/10.3138/CP.39.Supplement2.S81>
- Axsen, Jonn, Suzanne Goldberg, & Noel Melton. (2016). *Canada's electric vehicle policy report card*. Vancouver. <https://sfustart.files.wordpress.com/2016/11/canadas-electric-vehicle-policy-report-card.pdf>.
- Berube, A. & Turcotte, I. (2018, April 27). The US wants to weaken vehicle emissions standards. As Canada's standards incorporate the US's, to keep ours strong we need to split from the US. *Policy Options*. Retrieved from <http://policyoptions.irpp.org/magazines/april-2018/on-vehicle-emissions-standards-its-time-canada-divorced-the-us/>
- Bill 137, An Act to amend the Income Tax Act to provide for a tax credit for expenses incurred in using public transit, 2004, 1st Sess, 38th Leg, 2004 < <https://www.ola.org/sites/default/files/node-files/bill/document/pdf/2004/2004-10/bill---text-38-2-en-b137.pdf>>
- Bill 200, The Ontario Climate Change Act, 2007, 2nd Sess, 38th Leg, 2007 < <https://www.ola.org/sites/default/files/node-files/bill/document/pdf/2007/2007-04/bill---text-38-2-en-b200.pdf>>
- Blinch, M. (2018, June 28). Doug Ford Year One: What's happened so far in the new Ontario. *The Globe and Mail*. Retrieved from <https://www.theglobeandmail.com/canada/article-doug-ford-year-one-ontario-premier-explainer/>
- Bregha, F., & Moffet, J. (1995). The tax for fuel conservation in Ontario. In R. Gale, S. Barg, & A. Gillies (Eds.), *Green budget reform: an international casebook of leading practices*. Routledge. Earthscan Publications Ltd.
- Buchta, J. Corpuz, B. & Coburn, R. (2018, June 20). *Canada: An End To Ontario's Cap-And-Trade Program*. Mondaq. Retrieved from [http://www.mondaq.com/article.asp?articleid=712278&email\\_access=on&chk=1722308&q=1010030](http://www.mondaq.com/article.asp?articleid=712278&email_access=on&chk=1722308&q=1010030)
- Bueckert, K. (2018, April 30). Doug Ford plans to open up 'big chunk' of Greenbelt for development. *CBC news online*. Retrieved from <https://www.cbc.ca/news/canada/kitchener-waterloo/doug-ford-pc-greenbelt-open-developers-mike-schreiner-1.4641575>
- Building Better Communities and Conserving Watersheds Act, S.O. 2017, c. 23, <<https://www.ontario.ca/laws/statute/S17023>>
- Building Better Communities and Conserving Watersheds Act, SO 2017, c. 23 <<https://www.ola.org/en/legislative-business/bills/parliament-41/session-2/bill-139>>
- Building Code, O Reg 332/12, <<http://canlii.ca/t/5389b>>
- Burda, Cherise, Alison Bailie, & Graham Haines. (2010). *Driving Down Carbon: Reducing GHG Emissions from the Personal Transportation Sector in Ontario*. Retrieved from <http://www.pembina.org/pub/1993>.
- But, J. (2016). *Evaluation of Ontario's Cap and Trade Regulation (Master's Thesis)*. Retrieved from York University <https://yorkspace.library.yorku.ca/xmlui/bitstream/handle/10315/34677/MESMP02370.pdf?sequence=2&isAllowed=y>
- Canada: Regulatory Background. (2018). Retrieved from <https://www.transportpolicy.net/standard/canada-regulatory-background/>
- Canadian Environmental Protection Act, 1999, SC 1999, c 33, <<http://canlii.ca/t/534sg>>
- Cessation of Coal use - Atikokan, Lambton, Nanticoke and Thunder Bay Generating Stations, O Reg 496/07, <<http://canlii.ca/t/1npv>>
- Climate Change Mitigation and Low-carbon Economy Act, SO 2016, c 7, <<http://canlii.ca/t/53549>>
- Condominium Act, S.O. 1998, c. 19 <<https://www.ontario.ca/laws/statute/98c19>>

- Cooper, K. (1996). Submissions of the Canadian Environmental Law Association to the Standing Committee on Resources Development Reviewing Bill 20 , the “ Land Use Planning and Protection Act .” Retrieved from <http://www.cela.ca/sites/cela.ca/files/uploads/bill20.pdf>
- Cowan, J. (2018, May 29). Here is the Ontario election beer promise politicians should be making. Maclean's. Retrieved from <https://www.macleans.ca/politics/a-simple-no-fuss-promise-for-ontario-politicians-to-help-beer-drinkers/>
- DeRochie, P. (2016). Ontario's Green Investment Fund: A Down Payment On Climate Action. Retrieved from <http://environmentaldefence.ca/2016/03/29/ontarios-green-investment-fund-payment-climate-action/>
- Development Charges Act, 1997, SO 1997, c 27, <<http://canlii.ca/t/533k7>>
- Drowley, W. B. (1965). The Province of Ontario's Air Pollution Control Program. *Journal of the Air Pollution Control Association*, 15(9). <http://doi.org/10.1080/00022470.1965.10468400>
- Duff, D. & Irvine, C. (2005). Road Pricing in Theory and Practice: A Canadian Perspective. *U Toronto, Legal Studies Research Paper No. 05-07*. Retrieved from [https://commons.allard.ubc.ca/cgi/viewcontent.cgi?article=1105&context=fac\\_pubs](https://commons.allard.ubc.ca/cgi/viewcontent.cgi?article=1105&context=fac_pubs)
- Ecofiscal Commission. (2017). Supporting Carbon Pricing: How To Identify Policies That Genuinely Complement An Economy-Wide Carbon Price. Retrieved from <http://ecofiscal.ca/wp-content/uploads/2017/06/Ecofiscal-Commission-Report-Supporting-Carbon-Pricing-June-2017.pdf>.
- Elections Ontario. (2018). Province-Wide Election Night Results /Résultats du soir de l'élection à l'échelle provinciale. Retrieved from <https://www.elections.on.ca/en/election-results/provincial-results.html>
- Electric Mobility Canada. (2016). List of Electric Vehicle Funding Programs and Pilot Projects - A Canadian Overview. Retrieved from [https://emc-mec.ca/wp-content/uploads/Canadian\\_Funding\\_Program\\_for\\_EVs\\_updated\\_2016\\_04\\_20.pdf](https://emc-mec.ca/wp-content/uploads/Canadian_Funding_Program_for_EVs_updated_2016_04_20.pdf)
- Environment and Climate Change Canada. (2017). Greenhouse Gas Emissions Performance for the 2011 to 2015 Model Year Light-Duty Vehicle Fleet, (June), 13. Retrieved from [http://www.ec.gc.ca/lcpe-cepa/4665B128-1889-4563-9677-AD913A8CCF7C/GHG\\_Emissions2015-EmissionsGES\\_eng.pdf](http://www.ec.gc.ca/lcpe-cepa/4665B128-1889-4563-9677-AD913A8CCF7C/GHG_Emissions2015-EmissionsGES_eng.pdf)
- Environment and Climate Change Canada. 2017a. Clean Fuel Standard: Discussion Paper. Retrieved from [http://ec.gc.ca/lcpe-cepa/D7C913BB-13D0-42AF-9BC7-FBC1580C2F4B/CFS\\_discussion\\_paper\\_2017-02-24-eng.pdf](http://ec.gc.ca/lcpe-cepa/D7C913BB-13D0-42AF-9BC7-FBC1580C2F4B/CFS_discussion_paper_2017-02-24-eng.pdf).
- Environmental Assessment Act, RSO 1990, c E.18, <<http://canlii.ca/t/kxbr>>
- Environmental Commissioner of Ontario [ECO]. (2016). Facing Climate Change. Retrieved from <http://docs.assets.eco.on.ca/reports/climate-change/2016/2016-Annual-GHG-Report-EN.pdf>
- Environmental Commissioner of Ontario. (2017). Ontario's Climate Act From Plan to Progress Annual Greenhouse Gas Progress Report 2017. Toronto. <http://docs.assets.eco.on.ca/reports/climate-change/2017/From-Plan-to-Progress.pdf>.
- Environmental Commissioner of Ontario. (2018). Climate Action in Ontario: What's Next? Retrieved from <https://docs.assets.eco.on.ca/reports/climate-change/2018/Climate-Action-in-Ontario.pdf>
- Environmental Protection Act, RSO 1990, c E.19, <<http://canlii.ca/t/5323x>>
- Ethanol In Gasoline, O Reg 227/18, < <https://www.ontario.ca/laws/regulation/r18227>>
- Ethanol in Gasoline, O Reg 535/05, <<http://canlii.ca/t/52vgz>>
- Federation of Canadian Municipalities. (2017, June 23). Government of Canada and FCM announce \$72 million for municipal projects demonstrating strong actions on climate change. Retrieved from <https://fcm.ca/home/programs/green-municipal-fund/gmf-news/2017/government-of-canada-and-fcm-invest-72-million-dollars-for-municipal-projects-on-climate-change.htm>
- Federation of Canadian Municipalities. (2017a). About GMF. Retrieved from <https://fcm.ca/home/programs/green-municipal-fund/about-gmf.htm>
- Ferguson, M., Harrison, C., Pang, J., Higgins, C. & Kanaroglou, P. (2016). Enhancing Transportation Corridors
- Flanagan, E. & Gass, P. (2017, February 28). Canadians need to choose between providing international leadership on coal or continuing to endure the health problems from air pollution. *Policy Options*. Retrieved from <http://policyoptions.irpp.org/magazines/february-2017/coal-phase-out-improved-ontarios-air-quality/>
- Flynn-guglietti, M. L., & Forristal, A. (2014). Land Development And Planning Forum 2014 The 2014: Provincial Policy Statement And Environmental Protection. Retrieved from [https://mcmillan.ca/Files/174002\\_The\\_2014\\_Provincial\\_Policy\\_Statement\\_Environmental\\_Protection.pdf](https://mcmillan.ca/Files/174002_The_2014_Provincial_Policy_Statement_Environmental_Protection.pdf)

- Fox, J., Axsen, J., & Jaccard, M. (2017). Picking Winners: Modelling the Costs of Technology-specific Climate Policy in the U.S. Passenger Vehicle Sector. *Ecological Economics*, 137, 133–147. <http://doi.org/10.1016/j.ecolecon.2017.03.002>
- Friends of the Greenbelt Foundation. (2017). Maps: 2017 Greenbelt Plan Map. Retrieved from <http://www.greenbelt.ca/maps>
- Friends of the Greenbelt Foundation. (n.d.). Coordinated Land-Use Planning Review. Retrieved from <http://www.greenbelt.ca/landuseplanningreview>
- Fuel Tax Act, RSO 1990, c F.35, <<http://canlii.ca/t/52xr1>>
- Garmestani, A. S., & Allen, C. R. (Eds.). (2014). *Social-ecological resilience and law*. Columbia University Press.
- Gasoline Tax Act, RSO 1990, c G.5, <<http://canlii.ca/t/52b3j>>
- General, O Reg 114/18, < <https://www.ontario.ca/laws/regulation/R18114>>
- GO Transit. (n.d.). What is GO? Retrieved from <https://www.gotransit.com/en/about-us/what-is-go/about-go-transit>
- Government of Canada. (2007). Motor Vehicle Fuel Consumption Standards Act Proclaimed. <https://www.canada.ca/en/news/archive/2007/11/motor-vehicle-fuel-consumption-standards-act-proclaimed.html>
- Government of Canada. (2017). Pan-canadian Framework on Clean Growth and Climate Change. Ottawa, Ontario. Retrieved from <https://www.canada.ca/content/dam/themes/environment/documents/weather1/20170125-en.pdf>
- Government of Canada. (2018). Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations (SOR/2013-24). Retrieved from <https://pollution-waste.canada.ca/environmental-protection-registry/regulations/view?Id=119>
- Government of Ontario. (2007). Go Green: Ontario's Action Plan On Climate Change. Retrieved from <http://www.climateontario.ca/doc/workshop/2011LakeSimcoe/Ontarios%20Go%20Green%20Action%20Plan%20on%20Climate%20Change.pdf>
- Government of Ontario. (2014). Gasoline tax rates: Data tracking the current and historical gasoline tax rates. Retrieved from [https://www.ontario.ca/data/gasoline-tax-rates?\\_ga=2.28882740.927880254.1531939917-1541597776.1527197467](https://www.ontario.ca/data/gasoline-tax-rates?_ga=2.28882740.927880254.1531939917-1541597776.1527197467)
- Government of Ontario. (2016). Ontario's Climate Change Strategy. Retrieved from <https://dr6j45jk9xcmk.cloudfront.net/documents/4928/climate-change-strategy-en.pdf>
- Government of Ontario. (2016a). Ontario's Five Year Climate Change Action Plan: 2016 - 2020. Retrieved from [http://www.applications.ene.gov.on.ca/ccap/products/CCAP\\_ENGLISH.pdf](http://www.applications.ene.gov.on.ca/ccap/products/CCAP_ENGLISH.pdf)
- Government of Ontario. (2017). Developing a modern renewable fuel standard for gasoline in Ontario. Retrieved from [http://www.downloads.ene.gov.on.ca/envision/env\\_reg/er/documents/2017/012-7923.pdf](http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2017/012-7923.pdf)
- Government of Ontario. (2017). Guideline for Quantification, Reporting and Verification of Greenhouse Gas Emissions. Retrieved from [http://www.downloads.ene.gov.on.ca/envision/env\\_reg/er/documents/2017/013-1457\\_d\\_Guide.pdf](http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2017/013-1457_d_Guide.pdf)
- Government of Ontario. (2017a). Minister's Climate Change Action Plan progress report 2017. Retrieved from <https://www.ontario.ca/page/ministers-climate-change-action-plan-progress-report-2017#section-1>
- Government of Ontario. (2017b). Climate Change. Retrieved Aug. 2 from <https://www.ontario.ca/page/climate-change>
- Government of Ontario. (2017c). Next Generation Of Jobs Fund (NGOJF) grant recipients. Retrieved from <https://www.ontario.ca/data/next-generation-jobs-fund-ngojf-recipients>
- Government of Ontario. (2017d). "Low Carbon Innovation fund." Retrieved from <https://www.ontario.ca/page/low-carbon-innovation-fund>
- Government of Ontario. (2017e). "Electric and Hydrogen Vehicle Advancement Partnership." Retrieved from <https://www.ontario.ca/page/electric-and-hydrogen-vehicle-advancement-partnership>
- Government of Ontario. (2018). Cap and trade: program overview. Retrieved from <https://www.ontario.ca/page/cap-and-trade-program-overviewed>
- Government of Ontario. (2018a). Cap and trade. Retrieved from <https://www.ontario.ca/page/cap-and-trade>
- Government of Ontario. (2018b). Ontario Post-Joint Auction Public Proceeds Report: Ontario Cap-and-Trade Program: May 2018 Joint Auction #15. Retrieved from [https://files.ontario.ca/post-auction\\_public\\_proceeds\\_report\\_en\\_2018-05-15.pdf](https://files.ontario.ca/post-auction_public_proceeds_report_en_2018-05-15.pdf)
- Government of Ontario. (2018c). The End of Coal. Retrieved from <https://www.ontario.ca/page/end-coal>
- Government of Ontario. (2018d). Ethanol in gasoline. Retrieved from <https://www.ontario.ca/page/ethanol-gasoline>

- Government of Ontario. (2018e). Greener diesel regulation. Retrieved from <https://www.ontario.ca/page/greener-diesel-regulation>
- Government of Ontario. (2018f). Low Carbon Transportation Fuels in Ontario: Amendments to Ethanol in Gasoline (O. Reg. 535/05) and Greener Diesel - Renewable Fuel Content Requirements for Petroleum Diesel Fuel (O. Reg. 97/14) Regulations. Ontario's Regulatory Registry. Retrieved from [https://www.ontariocanada.com/registry/view\\_posting.jsp;jsessionid=JGVEM098J6XGQha22fiKIJQ?language=en&postingId=25687](https://www.ontariocanada.com/registry/view_posting.jsp;jsessionid=JGVEM098J6XGQha22fiKIJQ?language=en&postingId=25687)
- Green Energy and Economy Act, SO 2009, c 12 <<http://canlii.ca/t/5320t>>
- Green, K. P. (2017). Canada's Climate Action Plans: Are they cost-effective? Retrieved from [https://www.fraserinstitute.org/sites/default/files/canadas-climate-action-plans-are-they-cost-effective\\_0.pdf](https://www.fraserinstitute.org/sites/default/files/canadas-climate-action-plans-are-they-cost-effective_0.pdf)
- Greener Diesel - Renewable Fuel Content Requirements for Petroleum Diesel Fuel, O Reg 97/14, <<http://canlii.ca/t/527k2>>
- Greener Diesel - Renewable Fuel Content Requirements For Petroleum Diesel, O Reg 226/18 <<https://www.ontario.ca/laws/regulation/r18226>>
- Greenhouse Gas Pollution Pricing Act, SC 2018, c 12, s 186, <<http://canlii.ca/t/53920>>
- Growth Plan Areas, O Reg 416/05, <<http://canlii.ca/t/km55>>
- Hamilton Area. Retrieved from [http://www.metrolinx.com/en/docs/pdf/board\\_agenda/20170914/20170914\\_BoardMtg\\_RTP\\_Report\\_EN.pdf](http://www.metrolinx.com/en/docs/pdf/board_agenda/20170914/20170914_BoardMtg_RTP_Report_EN.pdf)
- Harper, D., Wong, S., Drost, A., Crossman, T., Taylor, D., Bakker, N., Chernawsky, N. & M. Nolin. (2016). An Overview Of Various Provincial Climate Change Policies Across Canada And Their Impact On Renewable Energy Generation. *Energy Regulation Quarterly* 4(4). <http://www.energyregulationquarterly.ca/articles/an-overview-of-various-provincial-climate-change-policies-across-canada-and-their-impact-on-renewable-energy-generation#sthash.q2gW7icl.dpbs>
- Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations, SOR/2013-24, <<http://canlii.ca/t/52hmt>>
- Heery, E., & Noon, M. (2008). perverse effect. In (Ed.), *A Dictionary of Human Resource Management*. : Oxford University Press,. Retrieved 17 Jul. 2018, from <http://www.oxfordreference.com/view/10.1093/acref/9780199298761.001.0001/acref-9780199298761-e-935>.
- Highway Traffic Act, RSO 1990, c H.8, <<http://canlii.ca/t/536dw>>
- Independent Energy System Operator [IESO]. (2018). Ontario's supply mix. Retrieved from <http://www.ieso.ca/learn/ontario-supply-mix/ontario-energy-capacity>
- Jaccard, M., Hein, M., & Vass, T. (2016). Is Win-Win Possible? Can Canada's Government Achieve Its Paris Commitment...and Get Re-Elected? Retrieved from [http://rem-main.rem.sfu.ca/papers/jaccard/Jaccard-Hein-Vass\\_CdnClimatePol\\_EMRG-REM-SFU\\_Sep\\_20\\_2016.pdf](http://rem-main.rem.sfu.ca/papers/jaccard/Jaccard-Hein-Vass_CdnClimatePol_EMRG-REM-SFU_Sep_20_2016.pdf)
- Jephcott, C. (1960). Air Pollution Activities in Ontario. *Canadian Journal of Public Health / Revue Canadienne De Sante'e Publique*, 51(6), 235-239. Retrieved from <http://www.jstor.org.ezproxy.library.yorku.ca/stable/41981730>
- Kahn Ribeiro, S., S. Kobayashi, M. Beuthe, J. Gasca, D. Greene, D. S. Lee, Y. Muromachi, P. J. Newton, S. Plotkin, D. Sperling, R. Wit, P. J. Zhou. (2007). "Transport and its infrastructure." In *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Kilpatrick, J. (2017). Ontario's coal phaseout in perspective. Clean Energy Canada. Retrieved from <http://cleanenergycanada.org/ontarios-coal-phaseout-perspective/>
- Kramer, G. & Grochalova, B. (2018, January 11). Administrative Monetary Penalties In Force For Ontario Cap And Trade Program [Blog Post]. [http://blg.com/en/News-And-Publications/Publication\\_5176](http://blg.com/en/News-And-Publications/Publication_5176)
- Kyoto Protocol Implementation Act, SC 2007, c 30, <<http://canlii.ca/t/52lvw>>
- Lawless, David. (2018). Canada Needs a Comprehensive Zero-Emissions Vehicle Strategy. *Policy Options*, April. Retrieved from <http://policyoptions.irpp.org/magazines/april-2018/canada-needs-a-comprehensive-zero-emissions-vehicle-strategy/>.
- Local Planning Appeal Support Centre Act, S.O. 2017, c. 23, <<https://www.ontario.ca/laws/statute/17I23b>>
- Local Planning Appeal Tribunal Act, S.O. 2017, c. 23, <<https://www.ontario.ca/laws/statute/17I23a>>

- Loriggio, P. (2018, July 3). Doug Ford starts to dismantle Ontario's cap-and-trade program. Macleans. Retrieved from <https://www.macleans.ca/politics/doug-ford-starts-to-dismantle-ontarios-cap-and-trade-program/>
- Macedonia, Jennifer. (2017). Policies to Decarbonize Transportation. Center for American Progress. Retrieved from <https://www.americanprogress.org/issues/green/reports/2017/01/20/296906/policies-to-decarbonize-transportation/>.
- Madras, M. (2015, November 1). Ontario's Proposed Cap And Trade Program. Retrieved from <https://gowlingwlg.com/fr/insights-resources/articles/2015/ontario-s-proposed-cap-and-trade-program>
- Mahony, D. (2016). The law of climate change in Canada (2017 student edition.). Thomson Reuters.
- Maloney, R. (2018, July 4). Doug Ford Fires Ontario's 1st Chief Scientist Dr. Molly Shoichet. Retrieved from [https://www.huffingtonpost.ca/2018/07/04/doug-ford-ontario-chief-scientist\\_a\\_23474870/?utm\\_hp\\_ref=ca-politics](https://www.huffingtonpost.ca/2018/07/04/doug-ford-ontario-chief-scientist_a_23474870/?utm_hp_ref=ca-politics)
- McGrath, J. M. (2018, June 29). Meet the Progressive Conservatives' new cabinet. Retrieved from <https://tvo.org/article/current-affairs/meet-the-progressive-conservatives-new-cabinet>
- McKittrick, R. (2006). Air pollution policy in Canada: improving on success. Fraser Institute. Retrieved from <https://www.fraserinstitute.org/sites/default/files/AirPollutionPolicyinCanada.pdf>
- McKittrick, R., & Aliakbari, E. (2017). Did the Coal Phase-out Reduce Ontario Air Pollution? Retrieved from <https://www.fraserinstitute.org/sites/default/files/did-the-coal-phase-out-reduce-ontario-air-pollution.pdf>
- McRobert, D., & Tennent-Riddell, J. (2016). Ontario's Green Economy and Green Energy Act: Why a Well-Intentioned Law is Mired in Controversy and Opposed by Rural Communities. Renewable Energy Law. Retrieved from <http://search.proquest.com/openview/32cf0ff12ef10523894b2cbc81c5bd8e/1?pq-origsite=gscholar&cbl=136205>
- Metrolinx Act, SO 2006, c 16, <<http://canlii.ca/t/532f5>>
- Metrolinx. (2008). Background, The Big Move: Climate Change and Energy Conservation. Retrieved from [http://www.metrolinx.com/thebigmove/Docs/big\\_move/RTP\\_Background\\_Clim\\_Change\\_Energy\\_Conservation.pdf](http://www.metrolinx.com/thebigmove/Docs/big_move/RTP_Background_Clim_Change_Energy_Conservation.pdf)
- Metrolinx. (2013). The Big Move: Baseline Monitoring Report. Retrieved from [http://www.metrolinx.com/en/regionalplanning/bigmove/The\\_Big\\_Move\\_Baseline\\_Monitoring\\_Full\\_Report\\_EN.pdf](http://www.metrolinx.com/en/regionalplanning/bigmove/The_Big_Move_Baseline_Monitoring_Full_Report_EN.pdf)
- Metrolinx. (2017). Memorandum Re: Draft 2041 Regional Transportation Plan for the Greater Toronto and
- Metrolinx. (2018). The 2041 Regional Transportation Plan. Retrieved from <http://www.metrolinx.com/en/regionalplanning/rtp/Metrolinx%20-%202041%20Regional%20Transportation%20Plan%20%E2%80%93%20Print.pdf>
- Ministry of Economic Development, Job Creation and Trade. (2017). Helping Clean Tech Companies Grow and Compete Globally. Retrieved from <https://news.ontario.ca/medg/en/2017/01/helping-clean-tech-companies-grow-and-compete-globally.html>
- Modernizing Ontario's Municipal Legislation Act, S.O. 2017, c. 10, < <https://www.ontario.ca/laws/statute/S17010>>
- Morrow, A. and Keenan, G. (2016, May 16). Ontario to spend \$7-billion on sweeping climate change plan. The Globe and Mail Online. Retrieved from <https://beta.theglobeandmail.com/news/national/ontario-to-spend-7-billion-in-sweeping-climate-change-plan/article30029081/?ref=http://www.theglobeandmail.com>
- Motor Vehicle Fuel Consumption Standards Act, RSC 1985, c M-9, <<http://canlii.ca/t/j5p6>>
- Motor Vehicle Fuel Tax Act, RSO 1980, c 300
- Motor Vehicle Safety Act, (1969-1970). Canada 18-19 Elizabeth II, 28th Parliament, 2nd Session 1969, 397-408.
- Motor Vehicles, O Reg 361/98, <<http://canlii.ca/t/530fk>>
- Murphy, J., Meyer-MacLeod, J., Jager, M. de, Sullivan, M., Devine, N., Torrie, R., ... Herbert, Y. (2017). DRAFT Community Emissions Reduction Planning: A Guide for Municipalities. Toronto, ON. Retrieved from [http://www.downloads.ene.gov.on.ca/envision/env\\_reg/er/documents/2018/013-2083.pdf](http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2018/013-2083.pdf)
- National Energy Board. (2017). Canada's Renewable Power Landscape 2017 – Energy Market Analysis. Retrieved from <https://www.neb-one.gc.ca/nrg/sttstc/lctrc/rprt/2017cndrnwblpwr/prvnc/on-eng.html>
- National Research Council. (2011). Environmental Effects and Tradeoffs of Biofuels in Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy (p. 181-262). Washington, DC: The National Academies Press. doi: 10.17226/13105
- Natural Resources Canada. (2017). Fuel Consumption Taxes in Canada. Retrieved from <https://www.nrcan.gc.ca/energy/fuel-prices/18885>

Natural Resources Canada. 2017a. “Electric Vehicle Infrastructure Demonstrations.” Retrieved from <http://www.nrcan.gc.ca/energy/funding/icg/18386>

New Climate Institute. (2015). New Climate Policy Database: Canada. Retrieved from <http://climatepolicydatabase.org/index.php?title=Country:Canada>

Neufeld, Richard, and Paul J. Massicotte. (2017). Decarbonizing Transportation in Canada. Ottawa, Ontario. Retrieved from [https://sencanada.ca/content/sen/committee/421/ENEV/reports/ENEV\\_TransportationReport\\_FINAL\\_e.pdf](https://sencanada.ca/content/sen/committee/421/ENEV/reports/ENEV_TransportationReport_FINAL_e.pdf)

Niagara Escarpment Planning and Development Act, RSO 1990, c N.2, <<http://canlii.ca/t/51tvk>>

O. Reg. 416/05: GROWTH PLAN AREAS. (2005). Retrieved from the Ontario e-laws website: <https://www.ontario.ca/laws/regulation/050416?search=growth+plan>

Oak Ridges Moraine Conservation Act, SO 2001, c 31, <<http://canlii.ca/t/hxh4>>

Oak Ridges Moraine Conservation Plan, O Reg 140/02, <<http://canlii.ca/t/532hc>>

Office of the Auditor General of Ontario. (2012). 2012 Annual Report of the Office of the Auditor General of Ontario. Retrieved from <http://www.auditor.on.ca/en/content/annualreports/arreports/en12/304en12.pdf>

Office of the Premier Designate. (2018, June 15). Premier-Designate Doug Ford Announces an End to Ontario's Cap-and-Trade Carbon Tax. Retrieved from <https://news.ontario.ca/opd/en/2018/06/premier-designate-doug-ford-announces-an-end-to-ontarios-cap-and-trade-carbon-tax.html>

Office of the Premier. (2007). MoveOntario 2020. Retrieved from <https://news.ontario.ca/opo/en/2007/06/moveontario-2020.html>

Office of the Premier. (2016, June 8). Ontario Releases New Climate Change Action Plan: Plan Charts Course to an Innovative, Low-Carbon Economy. Retrieved from <https://news.ontario.ca/opo/en/2016/06/ontario-releases-new-climate-change-action-plan.html>

On-Road Vehicle and Engine Emission Regulations, SOR/2003-2, <<http://canlii.ca/t/52hlp>>

Ontario Bar Association. (2017). Bill 139 , the Building Better Communities and Conserving Watersheds Act , 2017. Retrieved from <https://www.oba.org/CMSPages/GetFile.aspx?guid=280e0b78-56c5-41e7-b078-6b74e81c9852>

Ontario Climate Change Solutions Deployment Corporation, O Reg 46/17, <<http://canlii.ca/t/52wd4>>

Ontario Community Transportation Network. (2017). Ontario’s Gas Tax Program: Common Questions and Answers. Retrieved from <http://www.octn.ca/uploads/userfiles/files/Questions and Answers on the Provincial Gas Tax MTO March 2017.pdf>

Ontario Financing Authority. (2014). Ontario Green Bond Q&A’s. Retrieved from [http://www.ofina.on.ca/pdf/green\\_bond\\_qa.pdf](http://www.ofina.on.ca/pdf/green_bond_qa.pdf)

Ontario Ministry of Agriculture, Food and Rural Affairs. (2005). Ontario Ethanol Growth Fund: Invitation to Proponents. Retrieved from <http://www.ontla.on.ca/library/repository/mon/12000/256612.pdf>

Ontario Ministry of Economic Development, Job Creation and Trade. (2018). Ontario Supporting Technologies to Fight Climate Change. Retrieved from <https://news.ontario.ca/medg/en/2018/02/ontario-supporting-technologies-to-fight-climate.html>

Ontario Ministry of Environment and Climate Change. (2017). Drive Clean: mandatory emissions testing for older vehicles. Retrieved from <https://www.ontario.ca/page/drive-clean>

Ontario Ministry of Finance. (2015, April 16). The Trillium Trust and Moving Ontario Forward. Retrieved from <https://news.ontario.ca/mof/en/2015/04/the-trillium-trust-and-moving-ontario-forward.html>

Ontario Ministry of Finance. (2017). Gasoline Tax. Retrieved from <https://www.fin.gov.on.ca/en/tax/gt/index.html>

Ontario Ministry of Finance. (2017a). 2017 Ontario Budget: A Stronger, Healthier Ontario. Retrieved from <https://www.fin.gov.on.ca/en/budget/ontariobudgets/2017/budget2017.pdf>

Ontario Ministry of Finance. (2017b). Fuel Tax. Retrieved from <https://www.fin.gov.on.ca/en/tax/ft/index.html>

Ontario Ministry of Finance. (2017c). Ontario’s Long-Term Report On The Economy. Retrieved from <http://www.fin.gov.on.ca/en/economy/ltr/2017/ltr2017.pdf>

Ontario Ministry of Government and Consumer Services. (2017). What is the GreenFIT Procurement Strategy?. Retrieved from <https://www.doingbusiness.mgs.gov.on.ca/mbs/psb/psb.nsf/English/GreenFIT>

Ontario Ministry of Infrastructure. (2005, June 14). Historic Act Supports Planning For Economic Growth. Retrieved from <https://news.ontario.ca/archive/en/2005/06/14/Historic-Act-Supports-Planning-For-Economic-Growth.html>

- Ontario Ministry of Infrastructure. (2011). Growth Plan for Northern Ontario. Retrieved from <https://www.placestogrow.ca/images/pdfs/GPNO-final.pdf>
- Ontario Ministry of Municipal Affairs and Housing. (2002). Oak Ridges Moraine Conservation Plan. <http://www.mah.gov.on.ca/AssetFactory.aspx?did=11177>
- Ontario Ministry of Municipal Affairs and Housing. (2005). The Greenbelt Plan. Retrieved from <http://www.mah.gov.on.ca/AssetFactory.aspx?did=11171> doi:0-7794-7642-5.
- Ontario Ministry of Municipal Affairs and Housing. (2014). 2014 Provincial Policy Statement. Retrieved from <http://www.mah.gov.on.ca/AssetFactory.aspx?did=10463>
- Ontario Ministry of Municipal Affairs and Housing. (2014). 2014 Provincial Policy Statement. Retrieved from <http://www.mah.gov.on.ca/AssetFactory.aspx?did=10463>
- Ontario Ministry of Municipal Affairs and Housing. (2017, December 12). Ontario Passes Legislation to Build Better Communities and Conserve Watersheds: Ontario Overhauling the Land Use Planning Appeal System and Strengthening Conservation. Retrieved from <https://news.ontario.ca/mma/en/2017/12/ontario-passes-legislation-to-build-better-communities-and-serve-watersheds.html>
- Ontario Ministry of Public Infrastructure Renewal. (2006). Growth Plan for the Greater Golden Horseshoe. Retrieved from [https://www.placestogrow.ca/images/pdfs/ggh/en/2006\\_growth-plan-for-the-ggh-en.pdf](https://www.placestogrow.ca/images/pdfs/ggh/en/2006_growth-plan-for-the-ggh-en.pdf)
- Ontario Ministry of Research and Innovation and Science. (2018). "Ontario's Cleantech Strategy." Retrieved from <https://www.ontario.ca/page/ontarios-cleantech-strategy>
- Ontario Ministry of the Environment and Climate Change [OMECC]. (2017). Ontario's Action on Climate Change. Retrieved from <http://www.ieso.ca/-/media/files/ieso/document-library/sac/2017/sac-20170201-ontario-climate-change-action-plan.pdf?la=en>
- Ontario Ministry of Transportation. (2011). Sustainability inSight. Retrieved from [http://www.mto.gov.on.ca/english/sustainability/strategy/MTO\\_sustainabilityreport-en.pdf](http://www.mto.gov.on.ca/english/sustainability/strategy/MTO_sustainabilityreport-en.pdf).
- Ontario Ministry of Transportation. (2012). Transit- Supportive Guidelines. Queen's Printer for Ontario. Retrieved from <http://www.mto.gov.on.ca/english/transit/pdfs/transit-supportive-guidelines.pdf>
- Ontario Ministry of Transportation. (2016). #CycleON: Ontario's Cycling Strategy. Retrieved from <http://www.mto.gov.on.ca/english/publications/ontario-cycling-strategy.shtml>
- Ontario Ministry of Transportation. (2016a). Ontario Municipal Cycling Infrastructure Program. Retrieved from <http://www.mto.gov.on.ca/english/safety/ontario-municipal-cycling-infrastructure-program.shtml>
- Ontario Ministry of Transportation. (2016b). Canada's First High Occupancy Toll Lanes Open September 15. Retrieved from <https://news.ontario.ca/mto/en/2016/09/canadas-first-high-occupancy-toll-lanes-open-september-15.html>
- Ontario Ministry of Transportation. (2016c). Estimates Briefing Book. <http://www.mto.gov.on.ca/english/publications/pdfs/estimates-briefing-book-2016-17.pdf>.
- Ontario Ministry of Transportation. (2017). News Release: Major New Investment to Make Cycling Safer and More Convenient. Retrieved from <https://news.ontario.ca/mto/en/2017/12/major-new-investment-to-make-cycling-safer-and-more-convenient.html>
- Ontario Ministry of Transportation. (2017). Tolling Set to Begin on Highway 407 and Highway 412. Retrieved from <https://news.ontario.ca/mto/en/2017/01/tolling-set-to-begin-on-highway-407-and-highway-412.html>
- Ontario Ministry of Transportation. (2017a). Climate Change Action Plan: Transportation Sector Discussion Paper: Electric Vehicle Incentives, Infrastructure and Awareness. Retrieved from [http://www.raqsa.mto.gov.on.ca/techpubs/eps.nsf/0/7cb1ff72c8743be28525804c004c3ab5/\\$FI](http://www.raqsa.mto.gov.on.ca/techpubs/eps.nsf/0/7cb1ff72c8743be28525804c004c3ab5/$FI)
- Ontario Ministry of Transportation. (2017b). Electric Vehicle Incentive Program ( EVIP ). Retrieved from [http://www.forms.ssb.gov.on.ca/mbs/ssb/forms/ssbforms.nsf/GetFileAttach/023-2096E~3/\\$File/2096E\\_guide.pdf](http://www.forms.ssb.gov.on.ca/mbs/ssb/forms/ssbforms.nsf/GetFileAttach/023-2096E~3/$File/2096E_guide.pdf)
- Ontario Ministry of Transportation. (2017c). Making it Easier for Electric Vehicle Owners to Charge Up in Peterborough. Retrieved from <https://news.ontario.ca/mto/en/2017/02/making-it-easier-for-electric-vehicle-owners-to-charge-up-in-peterborough.html>
- Ontario Ministry of Transportation. (2017d). Ontario's Green Licence Plate Program. Retrieved May 31, 2017 from <http://www.mto.gov.on.ca/english/vehicles/electric/green-licence-plate.shtml>
- Ontario Ministry of Transportation. (2017e). Electric School Bus Pilot Program. Retrieved from <http://www.mto.gov.on.ca/english/vehicles/electric-school-bus-pilot.shtml>
- Ontario Ministry of Transportation. (2017e). Low Speed Vehicles. Retrieved from <http://www.mto.gov.on.ca/english/vehicles/low-speed-vehicles.shtml>

Ontario Ministry of Transportation. (2018). Action Plan 2.0. Retrieved from <http://www.mto.gov.on.ca/english/publications/cycle-action-plan.shtml>

Ontario Ministry of Transportation. (2018a). High Occupancy Toll (HOT) Lanes. Retrieved from <https://www.ontario.ca/page/high-occupancy-toll-hot-lanes>

Ontario Ministry of Transportation. (2018b). “Electric and Hydrogen Vehicle Incentive Program (EVHIP).” Retrieved from <http://www.mto.gov.on.ca/english/vehicles/electric/electric-vehicle-incentive-program.shtml>

Ontario Ministry of Transportation. (2018c). Green Commercial Vehicle Program. Retrieved from [https://www.grants.gov.on.ca/prodconsum/groups/grants\\_web\\_contents/documents/grants\\_web\\_contents/prdr018055.pdf](https://www.grants.gov.on.ca/prodconsum/groups/grants_web_contents/documents/grants_web_contents/prdr018055.pdf)

Ontario Ministry of Transportation. (2018d). About electric and hydrogen vehicles. Retrieved from <http://www.mto.gov.on.ca/english/vehicles/electric/about-electric-vehicle.shtml>

Ontario Municipal Board Act, RSO 1990, c O.28, <<http://canlii.ca/t/532d9>>

Ontario Offset Credits, O Reg 539/17, <<http://canlii.ca/t/532hl>>

Ontario Planning and Development Act, 1994, S.O. 1994, c. 23, Sched. A. (1994). Retrieved from the Ontario e-laws website: <https://www.ontario.ca/laws/statute/94o23>

Ontario Trucking Association. (2017, Dec. 14). MTO Announces Final Details of Green Commercial Vehicle Program. Retrieved from <http://ontruck.org/mto-announces-final-details-of-green-commercial-vehicle-program/>

Osler Hoskin & Harcourt LLP. (2018, April). Carbon and Greenhouse Gas Legislation in Ontario. Retrieved from <https://www.osler.com/en/resources/regulations/2015/carbon-ghg/carbon-and-greenhouse-gas-legislation-in-ontario>.

Pagliaro, J., & Spurr, B. (2017, September 18). How politics, not evidence, drives transit planning in Toronto. The Toronto Star. Retrieved from [https://www.thestar.com/news/city\\_hall/2017/09/18/how-politics-not-evidence-drives-transit-planning-in-toronto.html](https://www.thestar.com/news/city_hall/2017/09/18/how-politics-not-evidence-drives-transit-planning-in-toronto.html)

Parker, B. (2017, April 6). Review Of Bill 73 Smart Growth For Our Communities Act, 2015. Retrieved from <https://gowlingslg.com/en/insights-resources/articles/2017/review-of-bill-73-smart-growth-for-our-communities>

Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations, SOR/2010-201, <<http://canlii.ca/t/52hms>>

Pilot Project - Low-Speed Vehicles, O Reg 215/17, <<http://canlii.ca/t/52zjf>>

Places to Grow Act, 2005, SO 2005, c 13, <<http://canlii.ca/t/51ttj>>

Places to Grow Act, SO 2005, c. 13 <<https://www.ontario.ca/laws/statute/05p13?search=places+to+grow>>

Planning Act, RSO 1950, c 277, <<https://digitalcommons.osgoode.yorku.ca/rso/vol1950/iss3/62>>

Planning Act, RSO 1990, c P.13, <<http://canlii.ca/t/534jl>>

Planning Amendment Act, SO 1989, c 5 <[http://digitalcommons.osgoode.yorku.ca/ontario\\_statutes/vol1989/iss1/7/](http://digitalcommons.osgoode.yorku.ca/ontario_statutes/vol1989/iss1/7/)>

Plug’n Drive. (2017). Electric Vehicle Discovery Centre. Retrieved Aug. 16, 2017 from <https://plugndrive.ca/electric-vehicle-discovery-centre>

Public Transportation and Highway Improvement Act, R.S.O. 1990, c. P.50, <<https://www.ontario.ca/laws/statute/90p50>>

Public Transportation and Highway Improvement Amendment Act (Assistance to Municipalities), SO 2008, <https://www.ola.org/en/legislative-business/bills/parliament-39/session-1/bill-38>

Public Vehicles Act, R.S.O. 1990, c. P.54 < <https://www.ontario.ca/laws/statute/90p54>>

Quantification, Reporting and Verification of Greenhouse Gas Emissions, O Reg 143/16, <<http://canlii.ca/t/5327x>>

Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations, SOR/2014-207, <<http://canadagazette.gc.ca/rp-pr/p2/2014/2014-10-08/pdf/g2-14821.pdf>>

Renewable Fuels Regulations, SOR/2010-189, <<http://canlii.ca/t/524k9>>

Richardson, M. & Lightstone, M. (2018, May 6). What’s an inexpensive electric vehicle that can handle Canadian winters? The Globe and Mail. Retrieved from <https://www.theglobeandmail.com/drive/culture/article-whats-an-inexpensive-electric-vehicle-that-can-handle-canadian/>

Rolfe, K. (2018, June 1). Doug Ford's fight against a federal carbon tax likely doomed, experts say. Canada’s National Observer. Retrieved from <https://www.nationalobserver.com/2018/06/01/analysis/doug-fords-fight-against-federal-carbon-tax-likely-doomed-experts-say>

Runge, F. (2010, March 11). The Case Against Biofuels: Probing Ethanol’s Hidden Costs. Yale Environment 360. Retrieved from [https://e360.yale.edu/features/the\\_case\\_against\\_biofuels\\_probing\\_ethanols\\_hidden\\_costs](https://e360.yale.edu/features/the_case_against_biofuels_probing_ethanols_hidden_costs)

- Sharp, A. (2018, June 2). Doug Ford's promise to repeal cap and trade could cost Ontario billions - lawyer. Canada's National Observer. Retrieved from <https://www.nationalobserver.com/2018/06/02/news/doug-fords-promise-repeal-cap-and-trade-could-cost-ontario-billions-lawyer>
- Smart Growth for Our Communities Act, S.O. 2015, c. 26, <<https://www.ontario.ca/laws/statute/S15026>>
- Smart Growth for Our Communities Act, SO 2015, c. 26 <<https://www.ola.org/sites/default/files/node-files/bill/document/pdf/2015/2015-12/bill---text-41-1-en-b073ra.pdf>>
- Statistics Canada. (2015). Vehicle Registrations, 2015. (catalogue no. 11-001-X). Ottawa, ON: Statistics Canada. Retrieved from [https://www150.statcan.gc.ca/n1/en/daily-quotidien/160628/dq160628b-eng.pdf?st=\\_wONUGSn](https://www150.statcan.gc.ca/n1/en/daily-quotidien/160628/dq160628b-eng.pdf?st=_wONUGSn)
- Stevens, D. (2018, June 12). Canada: What's Next Under Ontario's New Government? Mondaq, pp. 1–2. Retrieved from [http://www.mondaq.com/article.asp?articleid=709720&email\\_access=on&chk=1719750&q=1010030](http://www.mondaq.com/article.asp?articleid=709720&email_access=on&chk=1719750&q=1010030)
- Strong Communities (Planning Amendment) Act, S.O. 2004, c. 18, <<https://www.ontario.ca/laws/statute/s04018>>
- Strong Communities (Planning Amendment) Act, SO 2004 Retrieved from the Ontario e-laws website: <https://www.ontario.ca/laws/statute/s04018>
- Stuckless, J. (2018, July 5). Ontario Municipal Commuter Cycling Program Officially Cancelled. Retrieved from <https://medium.com/share-the-road-cycling-coalition/ontario-municipal-commuter-cycling-program-officially-cancelled-a01b7dea503a>
- Sustainable Prosperity. (2015). Ontario Standing Committee on Social Policy: Bill 73, Smart Growth for Our Communities Act, 2015. Retrieved from <http://institute.smartprosperity.ca/sites/default/files/publications/files/Sustainable Prosperity - Ontario Bill 73 Submission to Standing Committee on Social Policy.pdf>
- Sustainable Technology Development Canada. (2017). Ontario's TargetGHG Collaborative Technology Development Program. Retrieved from <https://www.sdtc.ca/en/apply/funds/ontarios-targetghg-collaborative-technology-development-program>
- Taylor, C., Pollard, S., Rocks, S., & Angus, A. (2012). Selecting Policy Instruments for Better Environmental Regulation: a Critique and Future Research Agenda. *Environmental Policy and Governance*, 22(4), 268–292. <http://doi.org/10.1002/et.1584>
- The Canadian Press. (2017, May 17). Ontario opens first ever electric vehicle education centre in Toronto. CBC News. Retrieved from <http://www.cbc.ca/news/canada/toronto/ontario-opens-first-ever-electric-vehicle-education-centre-in-toronto-1.4120469>
- The Canadian Press. (2018, May 9). Doug Ford's transit plan includes \$5B for Toronto subways, all-day GO service to Niagara. Retrieved from <https://globalnews.ca/news/4197177/doug-ford-election-transit-plan/>
- The Cap and Trade Program, O Reg. 144/16, <<http://canlii.ca/t/5327w>>
- The Cap and Trade Program, O Reg. 144/16, online: <https://www.ontario.ca/laws/regulation/160144>
- Thoms, Zoe. (2018, May 15). Canada: Rules Change To Make It Easier For Condo Residents To Charge Electric Vehicles. Retrieved from <http://www.mondaq.com/canada/x/700362/Rules+Change+to+Make+it+Easier+for+Condo+Residents+to+Charge+Electric+Vehicles>
- Timmins, T. (2017). This One's Got Legs: The Ontario Climate Change Solutions Deployment Corporation. Retrieved from <https://gowlingswlg.com/en/insights-resources/articles/2017/this-one-s-got-legs-the-ontario-climate-change-so>
- To Support Southern Ontario Innovation Ecosystems. Retrieved from <http://mitl.mcmaster.ca/sites/default/files/Enhancing%20Transportation%20Corridors%20to%20Support%20Southern%20Ontario%20Innovation%20Ecosystems.pdf>
- Toronto Center for Active Transportation. (2014). Ontario's New Provincial Policy Statement Prioritizes Active Transportation But Misses The Mark On Complete Streets. Retrieved from <http://www.tcat.ca/general-news/2172/>
- Transit Projects and Metrolinx Undertakings, O Reg 231/08, <<http://canlii.ca/t/52jmq>>
- Transitional matters — growth plans, O Reg 311/06, <<http://canlii.ca/t/536ln>>
- Transport Canada. (2016). Transportation in Canada 2016. Retrieved from [https://www.tc.gc.ca/media/documents/policy/comprehensive\\_report\\_2016.pdf](https://www.tc.gc.ca/media/documents/policy/comprehensive_report_2016.pdf)
- Transportation Statute Law Amendment Act, S.O. 2005, c. 26, <<https://www.ontario.ca/laws/statute/S05026>>
- Trillium Trust Act, SO 2014, c 7, Sch 32, <<http://canlii.ca/t/52kkt>>

- Wechsler, S. (2018, July 3). Trudeau government reviewing \$420 million in transfer payments to Ontario after Doug Ford begins 'orderly wind-down' of green programs. *Canada's National Observer*. Retrieved from <https://www.nationalobserver.com/2018/07/03/news/trudeau-government-reviewing-420-million-transfer-payments-ontario-after-doug-ford>
- Wellar, B. (2010). *Further Analysis of HOV Lane and Sustainable Transport Failures in Ontario : Ottawa Case Study*. Retrieved from [http://wellar.ca/wellarconsulting/Further Analysis of Ontario\\_FINAL.pdf](http://wellar.ca/wellarconsulting/Further Analysis of Ontario_FINAL.pdf)
- White, R. (2007). *The Growth Plan for the Greater Golden Horseshoe in Historical Perspective (Neptis Papers on Growth in the Toronto Metropolitan Region No. 4)*. Retrieved from [http://www.neptis.org/sites/default/files/historical\\_commentary/historicalcomm\\_web\\_200711291.pdf](http://www.neptis.org/sites/default/files/historical_commentary/historicalcomm_web_200711291.pdf)
- Wiginton, L. (2018, March 23). Five ideas for a competitive, low-carbon freight industry in Canada [Blog Post]. Retrieved from <http://www.pembina.org/blog/five-ideas-competitive-low-carbon-freight-industry-canada>
- Winfield, M. S. (2004). *Comments on Planning Act Reform and Implementation Tools And Ontario Municipal Board Reform*. Retrieved from [http://www.pembinafoundation.org/reports/26-08-04\\_OMB-Planning\\_Act\\_Reform\\_Final.pdf](http://www.pembinafoundation.org/reports/26-08-04_OMB-Planning_Act_Reform_Final.pdf)
- Winfield, M. & MacDonald, D. (2012). *Federalism and Canadian Climate Change Policy*. In G. Skogstad and H. Bakvis (Eds.), *Canadian Federalism: Performance, Effectiveness and Legitimacy* (3rd ed.). Toronto: Oxford University Press.
- Winfield, M. (2015). *Implementing Environmental Policy in Canada*. In D. VanNijnatten (Ed.), *Canadian Environmental Policy and Politics* (4th ed.). Toronto: Oxford University Press.
- Winfield, M. (2016). *Electricity Planning and Sustainability Assessment: The Ontario Experience*. In R.B. Gobson (Ed.), *Sustainability Assessment: Applications*. London: Earthscan.
- Winfield, M. S. (2016a). *Implementing Environmental Policy in Canada*. In D. Van Nijnatten (Ed.), *Canadian Environmental Policy and Politics: The Challenges of Austerity and Ambivalence* (4th ed., pp. 74–96). Don Mills: Oxford University Press.
- Winfield, M. S. (2018, July). *Ford's Hydro Moves Will Do Nothing To Reduce Rates* [Blog Post]. Retrieved from <http://marksw.blog.yorku.ca/2018/07/16/fords-hydro-moves-will-do-nothing-to-reduce-rates/>
- Wolf, M. (2007, October 31). *Biofuels: a tale of special interests and subsidies*. *The Financial Times*. Retrieved from <https://www.ft.com/content/40a71f96-8702-11dc-a3ff-0000779fd2ac>
- Wood, A. (2016). *Ontario's Climate Change Actions & Transportation*. Retrieved from <http://www.pollutionprobe.org/wp-content/uploads/Alex-Wood.pdf>
- Wood, B. D., Levy, A., Mitchell, H., & Lax, C. (2013). *Birth of a Practice: The Environmental Lawyer*. Retrieved August 5, 2018, from <http://www.woodbull.ca/docs/default-source/publications/birth-of-a-practice---the-environmental-lawyer>
- Yauch, B. (2013). *Smart Commute: Millions in spending and little to show for it*. *Consumer Policy Institute*. Retrieved from <https://cpi1.files.wordpress.com/2013/11/smart-commute-paper.pdf>
- Yeh, S., & Sperling, D. (2013). *Low carbon fuel policy and analysis*. *Energy Policy*, 56, 1–4. <http://doi.org/10.1016/j.enpol.2013.01.008>
- Zizzo Strategy. (2017, April 6). *ONTARIO'S FIRST CAP AND TRADE AUCTION BRINGS IN \$472M* [Blog Post]. Retrieved from <https://zizzstrategy.com/ontarios-first-cap-and-trade-auction-brings-in-472m->



## APPENDIX A: A NOTE ON ‘REBOUND EFFECTS’ AND PERVERSE INCENTIVES

Policies formulated to produce an intended effect, such as lowering carbon emissions from passenger transportation, do not always produce the desired impact when implemented. In some cases, policies may actually have the opposite effect. In these situations, a perverse incentive is said to have been created, resulting in a perverse effect: “An unforeseen negative consequence of an action or policy that produces exactly the opposite to the intended effect” (Heery and Noon 2008). A rebound effect is a particular kind of perverse effect that has been the subject of much discussion in the transportation field (Owens and Driffill 2008). Berkhout, Muskens and Velthuisen (2000, p. 426) define the rebound effect as follows:

Technological progress makes equipment more energy efficient. Less energy is needed to produce the same amount of product, using the same amount of equipment - *ceteris paribus*. However, not everything stays the same. Because the equipment has become more energy efficient, the cost per unit of services of the equipment falls...A price decrease normally leads to increased consumption. Part of the *ceteris paribus* gains is lost, because one tends to consume more productive services, and the extra demand for productive services from the equipment implies more energy consumption.

Within the context of reducing emissions from the passenger transportation sector, the impact of improving fuel efficiency from vehicles provides a clear illustration of a *direct* rebound effect and also highlights the influence of price elasticity of demand for fuel in modifying the overall magnitude of the rebound effect in the transport sector. If vehicle efficiency is improved for a given automobile, meaning less fuel is required to drive an additional distance, than the increase in fuel efficiency can lead a driver to drive more, therefore increasing overall fuel use. This means some of the gains in terms of reduced carbon emissions (from increased vehicle efficiency) is lost or offset by the choice to drive more (Owens and Driffill 2008; Farber and Carlarne 2018). This assumption that a person will make the choice to drive more is based on neo-classical principles of economics, where an actor is assumed to be rational and have certain and complete information, which they use to make optimal decisions that maximize their utility (Berkhout et al. 2000). The assumption of rationality is a necessary condition for the existence of the rebound effect (Berkhout et al. 2000).

There are also *indirect* rebound effects, where money saved from increased energy efficiency is re-spent elsewhere, or where demand is reduced for energy, lowering prices, and resulting in increased demand for the energy source (Nadel 2012). Using the same example of increased vehicle efficiency, if less fuel is required to drive a given distance, demand for fuel decreases, leading to a price reduction, which may cause other drivers to increase their demand for fuel (Farber and Carlarne 2018). The magnitude of the effect within the context of automobiles is not very large as it is modified by the fact that demand for gasoline is relatively inelastic (Farber and Carlarne 2018). Theoretically, an increase in energy efficiency could actually lead to a increase in total energy consumption, although study of empirical evidence of the rebound effect suggests the effect is limited (Farber and Carlarne 2018). Although an exact estimate of the magnitude of the rebound effect is difficult to determine, general, economy-wide (indirect) rebound effect for OECD countries is estimated to be around 10% (Farber and Carlarne 2018).