FACING CLIMATE CHANGE

Greenhouse Gas Progress Report 2016

Environmental Commissioner of Ontario

Preamble to Bill 172, *Climate Change Mitigation and Low-carbon Economy Act, 2016*

Human-induced climate change is real and impacts are being experienced around the globe. The Intergovernmental Panel on Climate Change has concluded that warming of the climate is unequivocal and that most of the observed increase in global average temperature is due to human activity.

To prevent dangerous climate change, the global community has identified the objectives of holding the increase in the global average temperature to well below 2 degrees Celsius above pre-industrial temperatures and pursuing efforts to limit the temperature increase to 1.5 degrees Celsius above pre-industrial temperatures. A rise beyond 2 degrees Celsius poses the very real risk that countries around the world will experience irreversible damage to their environment. Such a rise in temperature poses a risk of irreversible widespread impacts on human and natural systems and threatens Ontario's agricultural resources, natural areas and ecosystems, and economic well-being.

This risk justifies action to mitigate climate change, including reducing greenhouse gas that causes climate change. The global community is mobilizing around this goal through the United Nations Framework Convention on Climate Change and its related agreements, and Ontario is committed to playing its part.

By taking action now, Ontario's households and communities, infrastructure, agricultural resources, natural areas and ecosystems, including the Great Lakes and the boreal forest, will be better protected for the benefit and enjoyment of all. Ontario will also be well positioned to take advantage of the low-carbon economy through local job creation, an expanding low-carbon technology sector and other global economic opportunities.

All Ontarians have a role to play in addressing climate change, including understanding how Ontarians contribute to greenhouse gas emissions and changing their behaviour to reduce those emissions.

The Government of Ontario believes that the public interest requires a broad effort to reduce greenhouse gas and to build a cleaner and more prosperous Province. The Government will continue to involve and engage individuals, businesses, communities, municipalities, non-governmental organizations and First Nation and Métis communities in the ultimate goal of fostering a high-productivity low-carbon economy and society in Ontario.

First Nation and Métis communities have a special relationship with the environment and are deeply connected spiritually and culturally to the land, water, air and animals. They may offer their traditional ecological knowledge as the Government of Ontario develops specific actions.

The Government of Ontario cannot address this challenge alone. Collective action is required. As a leading sub-national jurisdiction, Ontario will participate in the international response to reduce greenhouse gas by establishing a carbon price. A key purpose of this Act is to establish a broad carbon price through a cap and trade program that will change the behaviour of everyone across the Province, including spurring low-carbon innovation. A cap and trade program in Ontario will allow Ontario to link to other regional cap and trade markets as part of the international, national and interprovincial responses to reduce greenhouse gas.

In addition to the carbon price signal and to further support the reduction of greenhouse gas, the Government of Ontario will pursue complementary actions to support and promote the transition to a low-carbon economy.

Enabled and supported by the cap and trade program and related actions, the Government of Ontario envisions, by 2050, a thriving society generating fewer or zero greenhouse gas emissions. Businesses and innovators will be creating world-leading low-carbon technologies and products that drive new economic growth, productivity and job creation. Ontarians will live, work and travel in sustainable ways in healthier and more liveable communities.

November 2016

The Honourable Dave Levac
Speaker of the Legislative Assembly of Ontario

Room 180, Legislative Building
Legislative Assembly of Ontario
Queen's Park
Province of Ontario

Dear Speaker:

In accordance with Section 58.2 of the *Environmental Bill of Rights, 1993*, I am pleased to present the Greenhouse Gas Progress Report 2016 of the Environmental Commissioner of Ontario for your submission to the Legislative Assembly of Ontario. This Annual Report is my independent review of the Ontario government's progress in reducing greenhouse gas emissions for 2015-2016.

Sincerely,

Dianne Saxe
Environmental Commissioner of Ontario

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ONLINE APPENDICES

All appendices are available online only at eco.on.ca/reports/2016-facing-climate-change

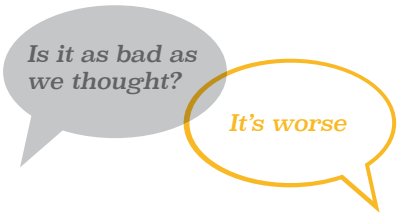
Greenhouse gas (GHG) emissions by humans are changing the climate.

In Ontario, climate change is already contributing to many impacts. Coldwater fish are losing habitat. Heat is stressing moose populations, which are already in decline. Invasive species are flourishing. Wildfire risk is increasing. Disease-carrying pests are spreading. Northern communities' ice roads are becoming less reliable. The season for ice fishing and snow sports is shrinking. Heat waves are posing health risks for vulnerable populations. Cities like Toronto, Burlington, Windsor, Thunder Bay and Sault Ste. Marie have suffered extreme storms and devastating floods. Severe heat and drought have crimped water supplies and damaged crops.

Why we must dramatically reduce our GHG emissions.

The Environmental Commissioner of Ontario (ECO) reports annually to the Legislature, and the public, on Ontario's progress reducing GHG emissions. In the first chapter of this year's report, the ECO reviews the science of climate change, its impacts on our planet and why Ontario must dramatically reduce its GHG emissions. The following chapters report on what Ontario's emissions are now, and what the government is doing to reduce them. **The government has taken great steps towards GHG reductions this year; the ECO's recommendations should help it avoid some major pitfalls.**

The focus of this report is on climate change mitigation, i.e., reducing GHG emissions. Ontario must also get ready to adapt to the impacts of climate change. The ECO will examine climate change adaptation in a future report.



Why Act Now? (Chapter 1)

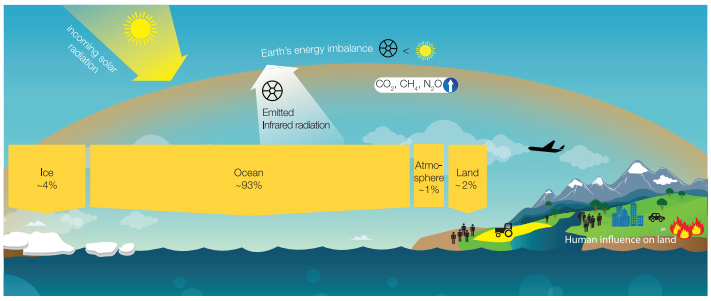
Climate change is one of the greatest threats of our generation.

Ontario's climate is changing because Earth's climate is changing. The **weather** has always fluctuated, and it will continue to do so. But the long-term average, the **climate**, is getting warmer and the weather is getting wilder. Effects on the natural environment, human health and the economy are accelerating.

Human activity is causing climate change (sometimes called *global warming*) by putting more GHGs into the atmosphere. As these gases accumulate, **GHGs form a powerful, invisible blanket around Earth**, trapping additional heat from the sun. This blanket is already dangerously thick and growing faster than ever. Past emissions will continue to trap heat for many years.

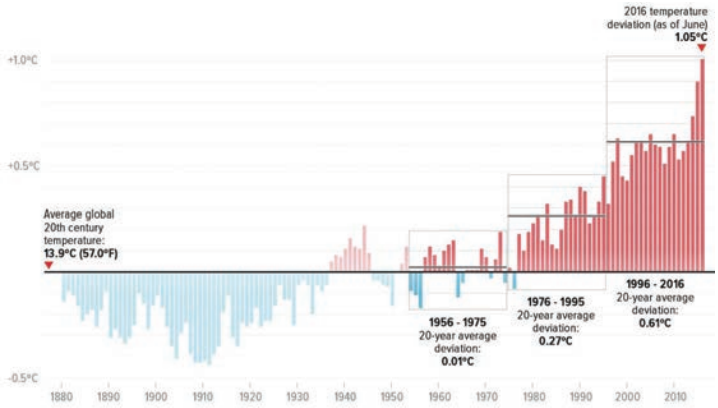
The most common GHG is carbon dioxide. In 2015, carbon dioxide levels in the atmosphere were the highest they have been for at least 800,000 years. Carbon dioxide also makes the oceans more acidic.

Where does the trapped heat go? Most of it (~93%) warms the oceans. Warmer water expands, raising sea levels, and fuels wilder storms. Some heat is melting ice and permafrost and warming land. About 1% of the extra heat has pushed up the world's average air temperature.



The flow and storage of energy in Earth's climate system. The global ocean is absorbing ~93 per cent of the additional heat.

Source: International Union for Conservation of Nature, *Explaining Ocean Warming: Causes, scale, effects and consequences*, 2016. From Laffoley and Baxter 2016, as redrawn and modified after Schuckmann et al. (2016).

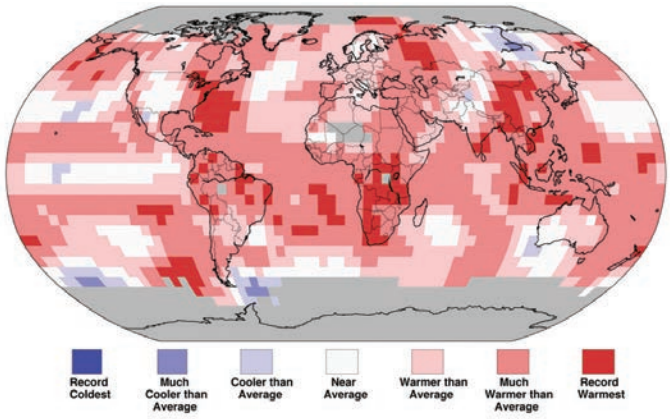


Annual temperature deviations. This chart indicates how average annual temperatures since 1880 compare to the average global temperature of the 20th century.

Source: Mashable (using data from the NOAA National Climatic Data Center), *Leaving the 20th century climate behind*, 2016.

What used to be "normal" weather is gone.

As a result, 2016 has continued to break all temperature records. January to August had the highest land and ocean temperatures ever recorded.



Blended Land and Sea Surface Ocean Temperature Percentiles January to August 2016. Note that blue (cool) areas near Greenland and Antarctica may represent meltwater and may indicate a slowing of ocean circulation currents.

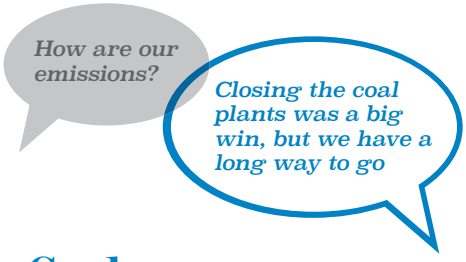
Source: National Aeronautics and Space Administration, *State of the Climate Global Analysis*, 2016.

Climate change does not mean that everywhere will be warmer all the time. Natural cycles, and disruption of those cycles, will sometimes make some places colder. But what used to be *normal* weather is gone, and not likely to return.

While not all impacts are harmful, on balance, climate change will bring more extreme weather, ecological damage, financial loss and human misery.

Ontario will not suffer as much from climate change as many other places. We are a relatively cold province, blessed with fresh water, and most of us live well above sea level. Still, warmer and wilder weather is already affecting the province, and much more lies ahead. Ontario is warming faster than the world average, especially in the north.

It is too late to avoid *some* disruptive and expensive changes to our environment and economy. But we still can influence how destructive those changes will be. **By working together, we can still protect much of what we love**, by reducing the GHGs that we emit, and by preparing for the changes ahead.



Ontario's Carbon Footprint – Where Are We Now? (Chapter 2)

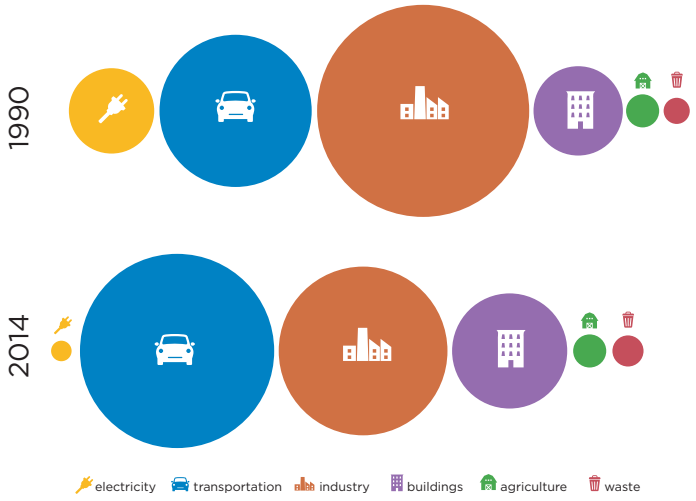
Ontario's targets are to reduce provincial GHG emissions (carbon footprint) by:

- 6% below 1990 levels by 2014;
- 15% below 1990 levels by 2020;
- 37% below 1990 levels by 2030; and,
- 80% below 1990 levels by 2050.

These targets, while ambitious, are consistent with those of other countries and are amply justified by climate science.

According to the official international method of calculation, Ontario met its 2014 target, mostly by closing coal-fired power generating stations. Meeting future targets will be harder. In four years, by 2020, Ontario has to reduce emissions a further 15 megatonne (Mt) (18.5 Mt compared to business as usual), a bigger and faster reduction than the 12 Mt reduced from 1990 to 2014.

Ontario still depends on fossil fuels for 80% of its energy. **Transportation is our biggest challenge**: Ontario's largest and fastest growing share of GHG emissions. Industry, homes and commercial buildings are other major emitters.

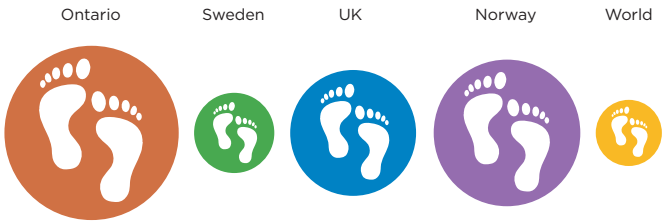


Ontario's Greenhouse Gas Emissions by Sector

Source: Environment and Climate Change Canada, National Inventory Report 1990-2014: GHG Sources and Sinks in Canada, Part 3, Table A11-12, (2016), p.55.

Ontario's Carbon Footprint – Beyond the Reported Numbers (Chapter 3)

Ontarians have high emissions per person, compared to most people around the world, even those in other rich northern countries.



Ontario's per capita GHG emission footprint (12.6 tonnes) compared to Sweden (5.8 tonnes), the UK (9.1 tonnes), Norway (10.6) and worldwide (4.9 tonnes).

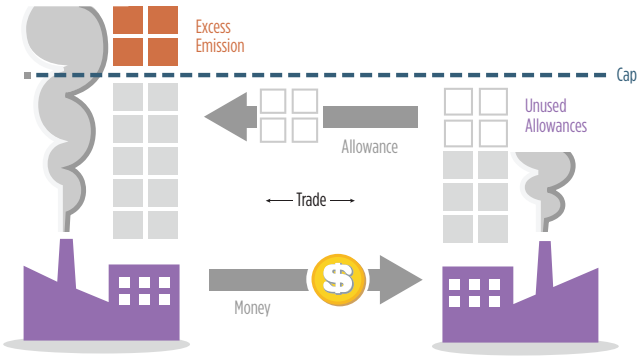
Source: Figure created by the ECO using information from the Conference Board of Canada and the World Bank.

Ontarians have high emissions per person.

And these emission numbers underestimate our true carbon footprint, because they leave out:

- the full impact of some emissions, such as methane and black carbon (soot);
- the emissions we cause by consuming things grown or made outside the province; and
- the emissions we cause through international aviation and shipping.

If these additional emissions were reflected in Ontario's annual GHG totals, our reported emissions would be much higher. We have lots of room to improve, and many opportunities to do so.



Schematic of how cap and trade works

Source: Adapted from Ontario's Climate Change Strategy (2015).

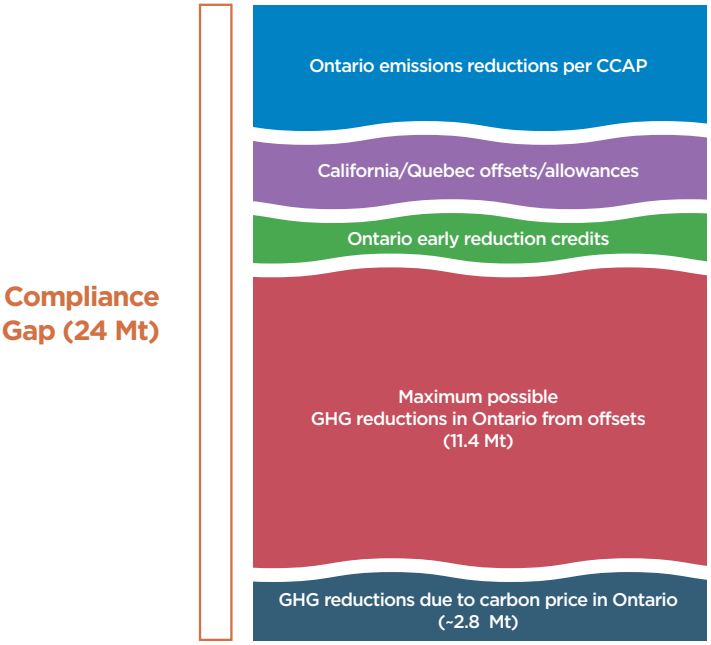
Chapter 4 focuses on the key design choices that Ontario has made, and how these choices may affect the success of the program in reducing emissions. In general, the cap and trade program is reasonable and well-designed, balancing the urgent need for GHG reductions with the cost to Ontario citizens and businesses, and the need to build public and non-partisan support. The types of changes that will reduce GHG emissions can also have many benefits for Ontario's environment and economy.

Cap and Trade (Chapter 4)

To do our fair share, Ontario is joining a worldwide movement to put a price on GHG pollution. Ontario's new *Climate Change Mitigation and Low-carbon Economy Act, 2016*, creates a cap and trade program that covers 82 per cent of Ontario's direct emissions. The first compliance period begins January 1, 2017, and is to be linked with California and Quebec in 2018. For the basics of cap and trade, see Appendix A to this report, online at eco.on.ca.

The cap and trade program is reasonable and well-designed.

In 2020, Ontario's capped emitters (i.e., those covered under the cap and trade program) will have a 24 Mt gap between their projected business as usual emissions and the allowances (i.e., permits to pollute) that the government will distribute (for free or by auction). Emitters have several options for filling that gap, such as reducing their emissions further, perhaps as the result of the Climate Change Action Plan (CCAP), or buying allowances from California (see figure below).



How emitters can meet the compliance gap (2020). See Chapter 4.5 for a full explanation of this figure.

Source: Adapted from: Dave Sawyer, Jotham Peters, and Seton Stiebert, EnviroEconomics, summary report, *Impact Modelling and Analysis of Ontario's Proposed Cap and Trade Program*, p.10, May 27, 2016.

Linking Ontario's cap and trade program with California and Quebec will reduce costs for Ontario GHG emitters, and has other important benefits. But if Ontario emitters buy allowances from outside the province, Ontario emissions may not go down much. Also, the California cap and trade program faces legal problems. A timely supply of high-quality Ontario offset credits (i.e., voluntary GHG reductions outside the capped sectors, which can be purchased by emitters) may be key to keeping investment and GHG reductions in Ontario.

Buying California allowances could send some emitters' capital to California for several years. However, the cap and trade program plus the Climate Change Action Plan should also reduce Ontario's multi-billion-dollar imports of petroleum and natural gas. The balance could be in Ontario's favour.

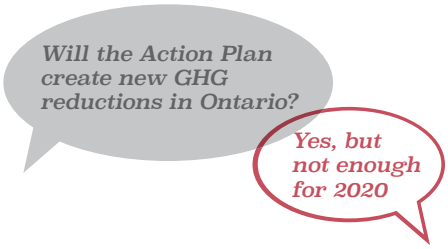
What are proper uses for cap and trade money?

New GHG reductions

Spending the Money Well (Chapter 5)

Ontario has chosen a ***cap and invest*** approach to carbon pricing. The government will put the proceeds from its quarterly cap and trade allowance auctions into a Greenhouse Gas Reduction Account (GGRA) that it controls. Its justification: it needs the money to drive emissions reductions that would not otherwise occur.

The ECO agrees that putting a price on carbon, by itself, would not be enough to achieve Ontario's reduction targets, unless the price were very high. But will the GGRA fund (up to $2 billion per year) be genuinely used to reduce Ontario's GHG emissions, or will it leak away into other government priorities? The government should build public confidence by ensuring that the money is being spent only on new GHG reductions, with clear spending rules and transparent, timely reporting.



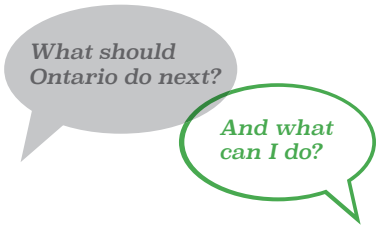
Climate Change Action Plan (Chapter 6)

The cap and trade program alone is predicted to provide only 2.8 Mt of the 18.5 GHG reductions needed to meet Ontario's 2020 GHG target. The government estimates that 9.8 Mt of additional reductions will come from its Climate Change Action Plan, to be funded from the GGRA.

> Subsidizing electricity rates is not an acceptable use of GGRA funds.

The Action Plan contains some excellent proposals, which should, over time, reduce Ontario's emissions. For example, the ECO supports the Action Plan's proposed investments in low-carbon transportation and in clean technology innovations. The proposed green bank could improve energy efficiency in buildings, and be a helpful intermediary between building owners/operators and energy efficiency service providers.

However, the Action Plan is not likely to produce 9.8 Mt in new reductions by 2020. The ECO found no evidence to support emission reduction claims for the key proposal to subsidize electricity prices, or the claim that technology adoption by industry can produce 2.5 Mt in additional reductions by 2020. This means that subsidizing electricity rates is not an acceptable use of GGRA funds. It also means that, for the 2017-2020 compliance period, the gap to be filled by offset credits and/or California allowances may be larger than the government predicts.



Knowledge + Action = Hope (Chapter 7)

This has been an important year, with much progress on climate action in Ontario and around the world. Ontario has punched above its weight, and deserves kudos for its active role in national and international co-operation. **Putting a price on GHG pollution is long overdue.**

But there remains a chasm between the facts and what the public understands, and between government rhetoric and action. If the government doesn't treat climate change as an emergency, then many people feel that they don't need to either. To earn public support for serious climate action, the whole government must consistently show that it takes climate change seriously.

At the same time, climate change action cannot be left entirely to governments. As proud Ontarians who care about each other and the beautiful province in which we live, there is much we can each do. No one can do everything, but everyone can do something. It's not too late.

> No one can do everything, but everyone can do something. It's not too late.

Chapter 1

Why Act Now?

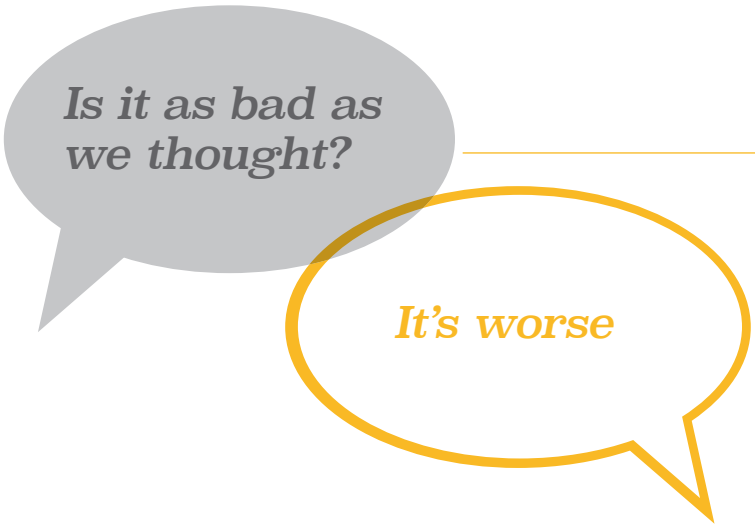
ABSTRACT

Since the ECO's 2015 climate report, the amount of carbon pollution in the atmosphere has continued to soar. Effects on the natural environment, human health and the economy are accelerating.

We cannot beat the laws of physics. It is too late to avoid some disruptive and expensive changes to our environment and economy. But we can influence how destructive these changes will be. By working together, we can still protect much of what we love, by reducing the greenhouse gases that we emit into the air, and by preparing for the changes that are coming. The transition to a low-emission future will take money, effort and political will, but inaction will cost far more - in money, in human misery and in ecological destruction. Ontario has a lot at stake.

Note to Reader

This chapter presents a simplified summary of the key scientific concepts about climate change. The ECO makes every effort to ensure that the facts in this report are credible, based on appropriate evidence, and free from fraud or bias. After decades of doubt and debate, extensive physical evidence about climate change has been collected, reviewed and accepted by virtually all the knowledgeable scientists, and bodies of science, in Ontario, Canada and the world. However, climate change is complex, the science and evidence are developing rapidly, and some uncertainty is inevitable about many details.



1.1 The Invisible Carbon Blanket Gets Thicker

Ontario's climate is changing, because Earth's climate is changing. The **weather** that we experience on a daily basis has always fluctuated, and it will continue to do so. But the underlying long-term average, the **climate**, is getting warmer, and weather fluctuations are getting wilder.

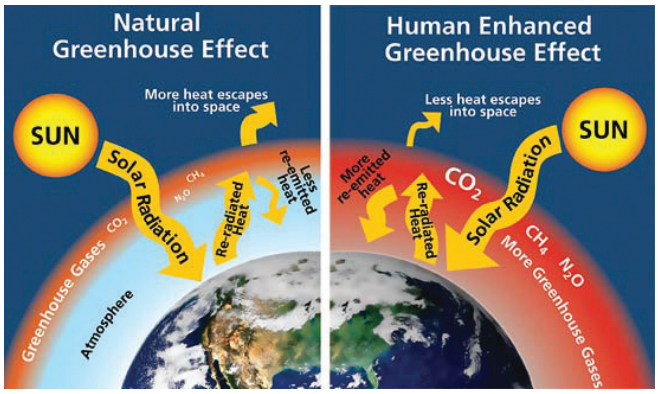


Figure 1: Natural versus human enhanced greenhouse effect.

Source: U.S. National Parks Service, Golden Gate National Recreation Area website, *What is Climate Change*.

Ontario's climate is changing, because Earth's climate is changing.

The key reason for climate change (sometimes called *global warming*) is that human activity has driven up the amount of greenhouse gases in the atmosphere, which trap additional heat from the sun.

1.2 What is a Greenhouse Gas?

Gases in the atmosphere are referred to as *greenhouse gases* if they let the sun's heat in, but then block it from escaping, much as glass does in a greenhouse. As shown in Figure 1, there is a natural greenhouse effect that has moderated temperatures on Earth for millennia. In the absence of these naturally occurring gases, Earth would be a much colder place.[1] Through human activity, however, large volumes of extra greenhouse gases have been released into the atmosphere. As these gases accumulate, they form a powerful, but invisible, blanket around Earth. Heat from the sun is absorbed by the atmosphere and some of this heat is radiated back out into space. Because of rising GHG levels in the atmosphere due to human activity, less of this radiated heat can escape than previously.

The international system of greenhouse gas reporting, under the Framework Convention on Climate Change, focusses on seven of the most common greenhouse gases released by humans. These greenhouse gases are powerful heat trappers even at very small concentrations, which is why they are usually measured in parts per million of air (ppm). In order of atmospheric volume, the gases are **carbon dioxide** (CO_2), **methane** (CH_4), **nitrous oxide** (N_2O), **hydrofluorocarbons** (HFCs), **perfluorocarbons** (PFCs), **sulphur hexafluoride** (SF_6), and **nitrogen trifluoride** (NF_3). These are the same seven gases controlled under Ontario's new *Climate Change Mitigation and Low-carbon Economy Act, 2016* (the "Climate Act"). Some long-lived gases formerly used as refrigerants, especially chlorofluorocarbon 12 and 11 (CFC-12 and CFC-11), are also part of the current carbon blanket.

Table 1: Greenhouse Gases (symbol, name, and common sources)

Symbol	Name	Common Sources
CO_2	Carbon Dioxide	Fossil fuel combustion (i.e., using gasoline for driving and natural gas for heating), forest clearing, cement production
CH_4	Methane	Garbage decomposition in landfills, production and distribution of natural gas and petroleum, fermentation from the digestive system of livestock, rice cultivation, incomplete fossil fuel combustion
N_2O	Nitrous Oxide	Fossil fuel combustion, fertilizers, nylon production, soil cultivation practices, manure
HFCs	Hydrofluorocarbons	Refrigeration gases, fire-extinguishing, aluminum smelting, semiconductor manufacturing, foam blowing
PFCs	Perfluorocarbons	Aluminum production, semiconductor industry, solvents in electronics industry, refrigerants
SF_6	Sulfur Hexafluoride	Electrical transmissions and distribution systems, circuit breakers, magnesium production
NF_3	Nitrogen Trifluoride	Thin-film solar cells, manufacture of semi-conductors, liquid crystal display (LCD) panels, photovoltaics

Source: Environment and Climate Change Canada, National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada, Part 3, 2016.

1.3 How Much Have Greenhouse Gases Gone Up?

Carbon Dioxide

Carbon dioxide is the most common greenhouse gas released by humans. Around 1750, when the industrial revolution began, the concentration of carbon dioxide in the atmosphere was about 278 ppm. It had been around that level or below, for all of human history,[2] and for hundreds of thousands of years before that. Then, humans began to burn fossil fuels (mostly coal) on a larger scale. By the middle of the 19th century, when the modern history of petroleum was about to begin, carbon dioxide concentration levels had crept up to 280 ppm. Since that time, humans have massively increased our use of fossil fuels (such as gasoline, diesel, and natural gas as well as coal), emitting huge amounts of greenhouse gases into the atmosphere every year.

This has made the carbon blanket thicker. How much thicker? In 2015, a significant threshold was breached: for the first time in at least 800,000 years,[3] the level of carbon dioxide in the atmosphere exceeded 400 ppm.[4] Levels below 400 ppm are not likely to occur again in our lifetimes, or in the foreseeable future.[5]

CO_2 for all of human history until 1750 = 180 to 280 ppm

CO_2 in 1750 = 278 ppm

CO_2 in 1860 = 280 ppm

CO_2 in 1988 = 350 ppm

CO_2 in June 2016 = 404 ppm

Here is how the current level of carbon dioxide in the atmosphere compares to the last 800,000 years:

Not only is the carbon blanket thickening, it is doing so faster than ever. 2015 was the fourth year in a row that

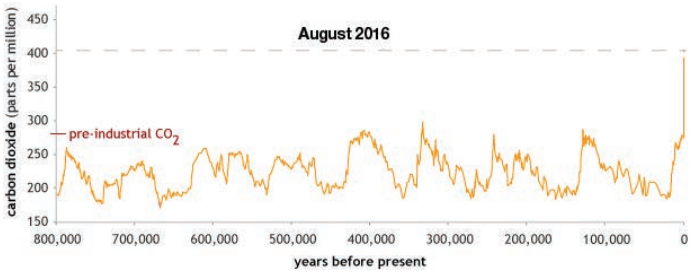


Figure 2: Historic atmospheric carbon dioxide concentrations in parts per million as reconstructed from ice cores.

Source: National Oceanic and Atmospheric Administration, 2013 *State of the Climate: Carbon dioxide tops 400 ppm*, 2014.

Not only is the carbon blanket thickening, it is doing so faster than ever.

atmospheric CO_2 levels increased by approximately 2 ppm annually,[6] and 2015 saw the largest year-over-year increase ever recorded.[7] Current annual emission growth rates (~2.5 per cent/ year) are twice as large as in the 1990s (average 1 per cent/ year).[8] Here is how fast carbon dioxide in the atmosphere has risen during the last 60 years:

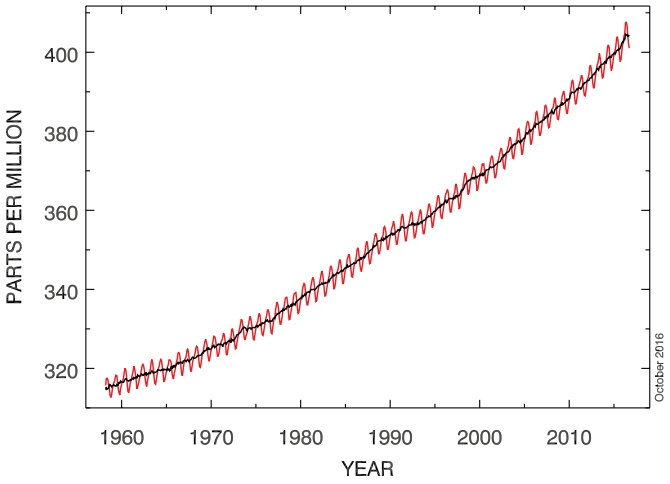


Figure 3: Atmospheric CO_2 levels (ppm), ~1960-Present as recorded at Mauna Loa Observatory.

Source: National Oceanic and Atmospheric Administration, *Trends in Atmospheric Carbon Dioxide at Mauna Loa Observatory (full record)*, 2016.

Another huge amount of carbon dioxide has dissolved into the oceans, making the upper layers about 30 per cent more acidic than before the industrial revolution.[9] This is harmful to a wide variety of ocean species.

We've known about the science underlying climate change for a generation, although the scientific evidence is now much stronger. *The United Nations Framework Convention on Climate Change* was adopted at the Rio Earth Summit in 1992, only four years after the world passed the key carbon dioxide threshold of 350 ppm.[10] Coral reefs, mountain glaciers and other sensitive ecosystems are not expected to survive long at carbon dioxide levels higher than 350 ppm, and they are now in serious decline.

Carbon Dioxide Plus the Other Greenhouse Gases

Carbon dioxide is not the only greenhouse gas that humans have been emitting. As explained in Chapter 3, each of the main greenhouse gases has its own heat-trapping effect, and together they have a cumulative impact much greater than that of carbon dioxide alone. The U.S. National Oceanic and Atmospheric Administration (NOAA) Annual Greenhouse Gas Index (AGGI) measures how much heat is trapped by all human-released greenhouse gases, based on the highest quality atmospheric observations from sites around the world.

As the NOAA puts it,

The AGGI is analogous to the dial on an electric blanket. Just as the dial does not tell you exactly how hot you will get, the AGGI does not predict how much Earth's climate will warm. You do know, however, that if the dial is turned up a little, the blanket will get warmer – and not immediately. If you turn it up a lot, you know the blanket will get a lot warmer – eventually... In essence, we continue to increase the setting on Earth's "thermostat" by a small amount every year...

Of course, the Earth System is more complicated than an electric blanket and climate change is expressed in many ways – e.g., drought, increased temperatures, altered storm patterns and precipitation rates, increased glacier melting, etc...[11]

So, what was the atmospheric level of all GHGs in 2015, in carbon dioxide equivalent?

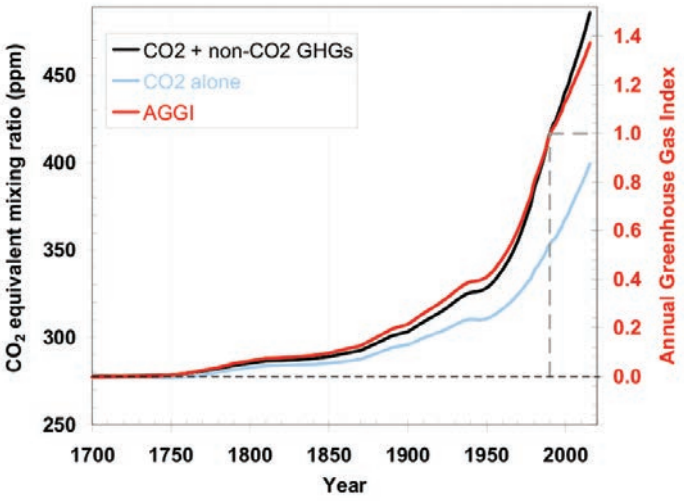


Figure 4: Greenhouse gases in the atmosphere from 1700-2016. The NOAA Annual Greenhouse Gas Index (AGGI), which is indexed to 1 for the year 1990, is shown on the right axis. In 2015, for example, the AGGI was 1.37 which represents an increase in total direct radiative forcing (or direct warming influence) of 37 per cent since 1990.

Source: National Oceanic and Atmospheric Administration, *The NOAA Annual Greenhouse Gas Index (AGGI)*, 2016.

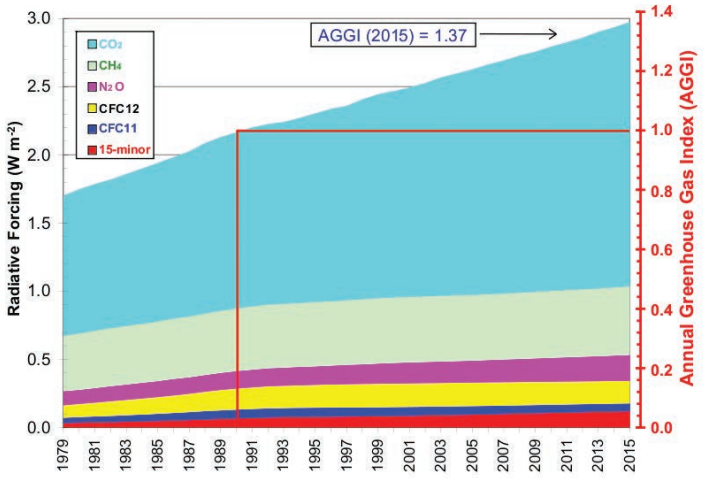


Figure 5: Radiative forcing, relative to 1750, of all the long-lived greenhouse gases. This figure shows radiative forcing for the major gases (carbon dioxide, methane, nitrous oxide) as well as 15 minor long-lived halogenated gases (such as CFC-113, CCl4, CH3CCl3, HCFCs 22, 141b and 142b, HFCs 134a, 152a, 23, 143a, and 125, SF6, and halons 1211, 1301 and 2402). The NOAA Annual Greenhouse Gas Index (AGGI), which is indexed to 1 for the year 1990, is shown on the right axis.

Source: National Oceanic and Atmospheric Administration, *The NOAA Annual Greenhouse Gas Index (AGGI)*, 2016.

CO_2 equivalent Spring 2016 = 485 ppm

What gases are trapping the most heat?

Because humans have emitted so much of it for so long, carbon dioxide has trapped the most heat. But other gases, mainly methane, nitrous oxides and refrigerants, are responsible for nearly a third of the additional heat being trapped today.[12]

ONTARIANS TAKING ACTION

Oxford County

In 2015, after unanimous agreement by county council, Oxford County became the first municipal government in Ontario to commit to a target of 100% renewable energy by 2050. With this commitment in place, the municipality is working towards finalizing a draft Community Sustainability Plan which will establish measures and milestones towards achieving this goal.

1.3.1 How do we Know that Human Activities are Pushing Carbon Levels Up?

There are many natural sources of greenhouse gases. But half a century of evidence, accepted by thousands of scientists and scientific bodies around the world, shows that today's unprecedented carbon dioxide levels are due to humans. For example:

1. Until humans started burning fossil fuels on a massive scale, carbon dioxide levels in the atmosphere had stayed below 280 ppm for hundreds of thousands of years, despite all natural factors such as volcanoes, solar variations, and glaciations.
2. In natural cycles, carbon dioxide contains a radio isotopic form of carbon called carbon 14; carbon dioxide from fossil fuels does not.[13] The carbon dioxide in today's atmosphere has less and less carbon 14, indicating that natural carbon is being overwhelmed by fossil fuel carbon.
3. Some greenhouse gases, like chlorofluorocarbons, hydrofluorocarbons, and perfluorocarbons, were created by humans, and have no natural sources.

1.4 Where Does the Additional Heat Go?

The additional heat trapped by greenhouse gases caused by human activity spreads unevenly around Earth. Some is melting ice and thawing permafrost, warming land and evaporating water. The vast majority of the additional heat – about 93 per cent – has been absorbed by the oceans.[14] Only a very small portion – about 1 per cent – has pushed up the world's average air temperature.[15]

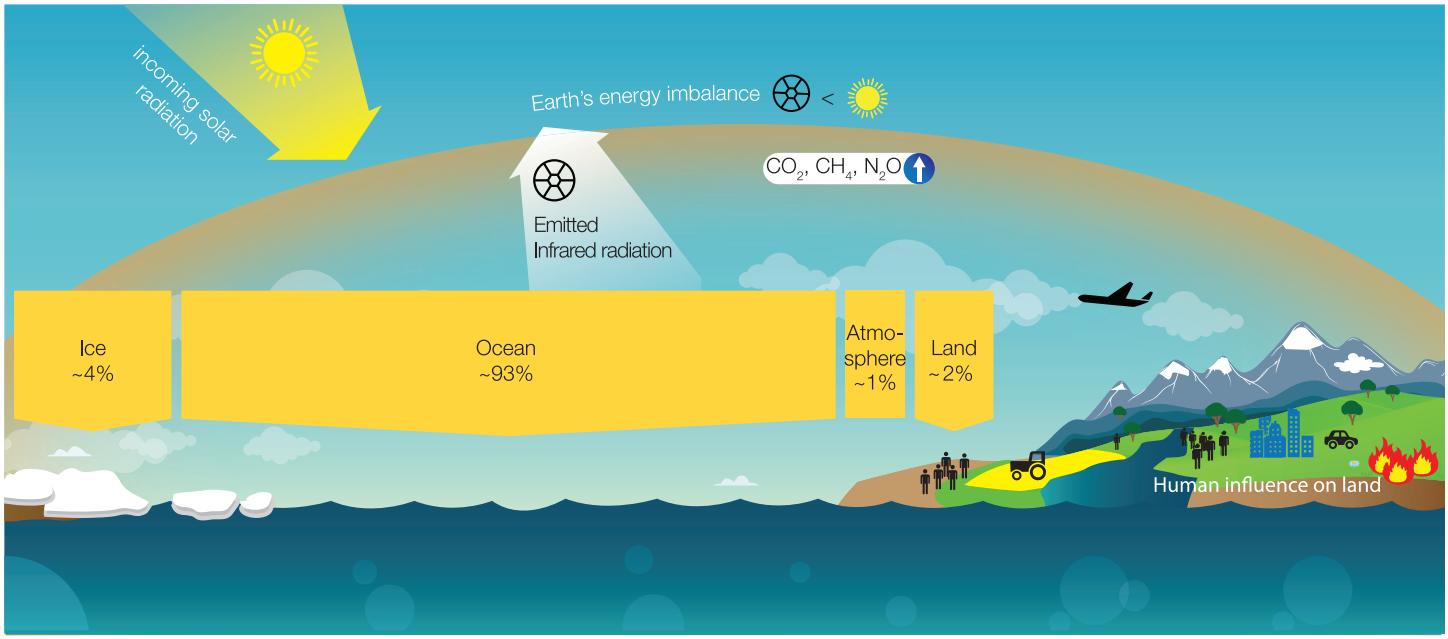
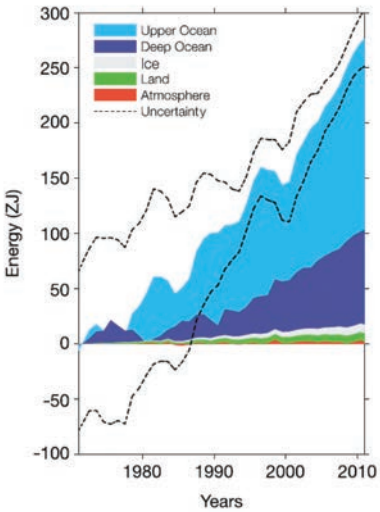


Figure 6: The flow and storage of energy in Earth's climate system. The global ocean is the major heat reservoir, absorbing ~ 93 per cent of the additional heat trapped in the atmosphere by greenhouse gases causes by human activity.

Source: International Union for Conservation of Nature, *Explaining Ocean Warming: Causes, scale, effects and consequences*, 2016. From Laffoley and Baxter 2016, as redrawn and modified after Schuckmann et al. (2016).



The vast majority of the additional heat – about 93 per cent – has been absorbed by the oceans.

Figure 7: Energy accumulation in each component of Earth's climate system expressed in zettajoules (10^{21}) relative to 1971 and from 1971-2010.

Source: Intergovernmental Panel on Climate Change, *Chapter 3: Observations: Oceans in Climate Change 2013: The Physical Science Basis* (contribution of Working Group 1 to the *Fifth Assessment Report of the Intergovernmental Panel on Climate Change*), 2013.

Melting Ice and Thawing Permafrost

A small portion of the excess heat – approximately 4 per cent – is melting snow and ice on land, at sea and in soil.

On land: Glaciers and ice sheets continue to shrink or retreat in most places around the world, including Canada's Rocky Mountains; preliminary data from 2015 indicates that it will be the 36th consecutive year that alpine glaciers around the world shrank in volume.[16] An unusually early and large melt of the Greenland ice sheet in 2016 set a new record early in the year.[17] At the opposite end of the world, there has been shockingly large melting and calving of the West Antarctic ice sheet and the ice of the Antarctic Peninsula.[18]

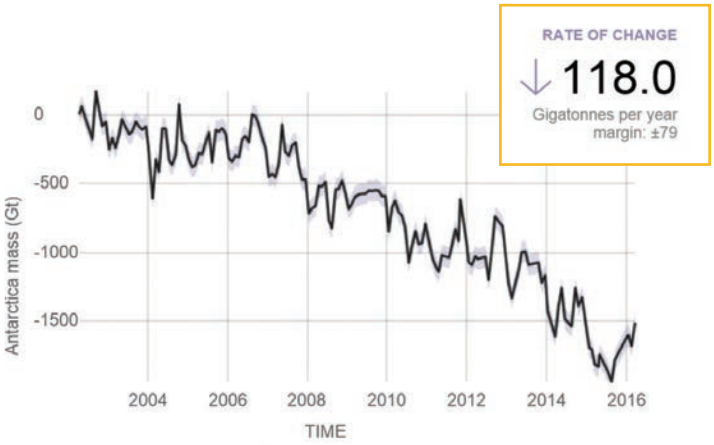


Figure 8: Antarctica mass variation 2002-present.

Source: National Aeronautics and Space Administration, *Global Climate Change: Vital Signs of the Planet, Land Ice,* 2016.

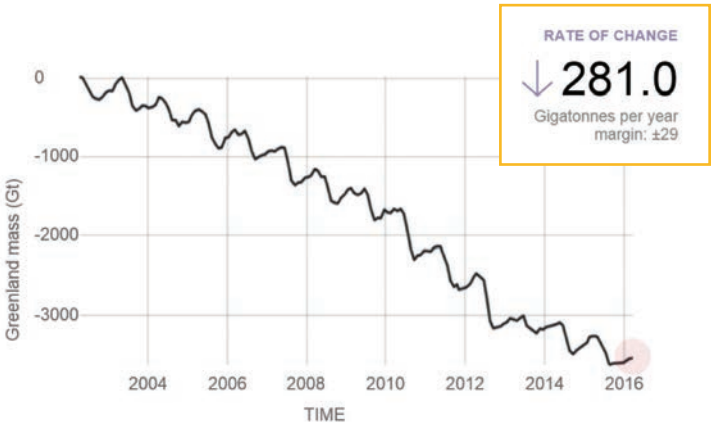


Figure 9: Greenland mass variation 2002-present.

Source: National Aeronautics and Space Administration, *Global Climate Change: Vital Signs of the Planet, Land Ice,* 2016.

As land-based ice melts, it adds to sea level rise (see below). Melting of the Greenland ice sheet alone would raise sea levels about 7 meters.[19] In many countries, loss of land-based ice will also have a serious impact on essential water supplies.

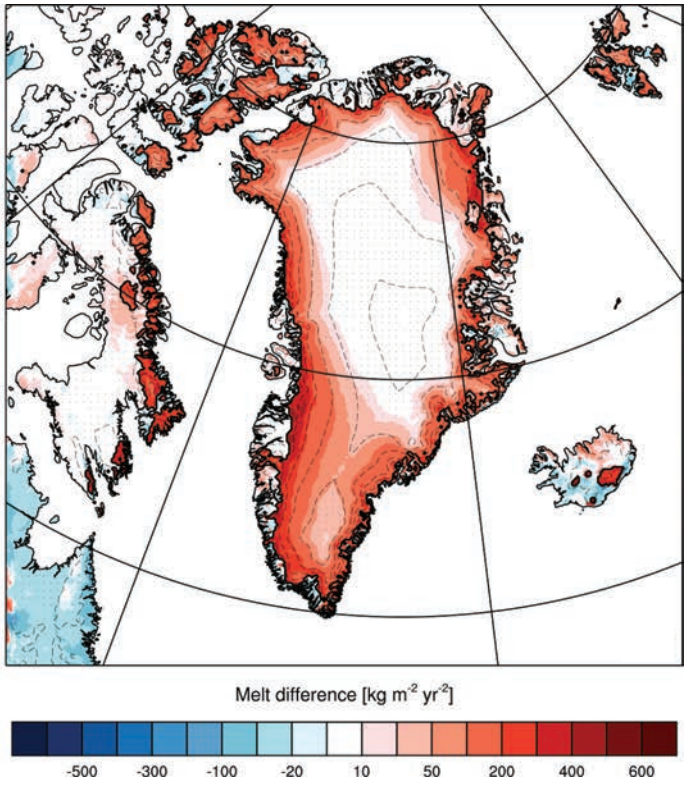


Figure 10: Average Greenland ice melt increase between 1991-2015 over 1961-1991.

Source: M.R. van den Broeke et al., *Greenland ice sheet and sea level rise.* 2016

At Sea: Warmer ocean water melts Arctic and Antarctic sea ice from below. Most sea ice is shrinking, especially in the sensitive Arctic region, which is warming more than twice as fast as the global average.[20] The area covered by Arctic sea ice in the winter of 2016 was the lowest on record for the second year in a row,[21] and the volume and thickness of Arctic sea ice continues to decline sharply.[22]

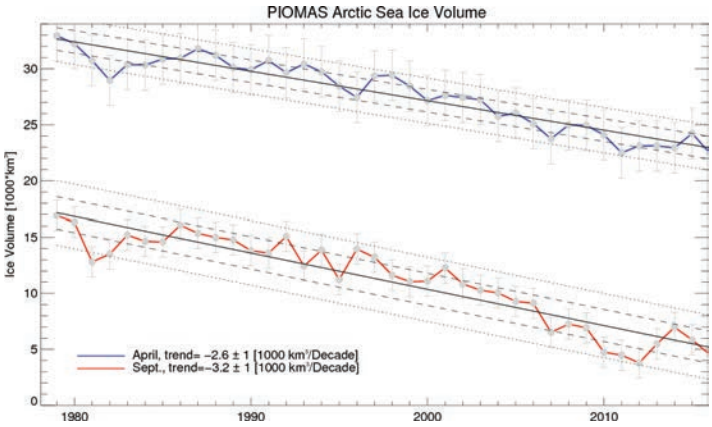


Figure 11: Monthly Arctic sea ice volume as of April and September each year.

Source: Polar Science Centre, *PIOMAS Arctic Sea Ice Volume Reanalysis.* 2016.

Without sea ice coverage – which reflects the sun's energy back into space - Arctic water absorbs even more heat, creating a feedback loop that accelerates climate change. In addition, melt water does not mix instantly with the heavier sea water below it. This can result in a *lid* of cold freshwater that can alter how water, heat and nutrients circulate through the oceans.

In the soil: Buried ice is also melting.[23] Permafrost regions, which cover a quarter of the northern hemisphere land surface,[24] contain vast quantities of trapped carbon – estimated at 1,500 billion tons.[25] This is approximately twice the total amount in the atmosphere, and three times the total amount in the world's vegetation.[26] Throughout human civilization, this huge amount of carbon has been safely trapped in frozen, buried organic material, i.e. partially decomposed plants, animals and soil organisms. As the permafrost thaws, the organic matter is broken down and decomposed by soil organisms, releasing greenhouse gases.[27]

In dry areas, the carbon is released mostly as carbon dioxide; in wetlands, the carbon is released as both carbon dioxide and methane.[28] (As discussed in Chapter 3, the warming impact of methane is much more severe.) These releases are predicted to increase under continued warming. As such, they will contribute to higher carbon levels in the atmosphere which will drive up atmospheric temperatures. This, in turn, will cause increased thawing.[29] This is another positive feedback loop that could become difficult to stop.

Warmer Oceans

The oceans have absorbed an enormous amount of additional heat.

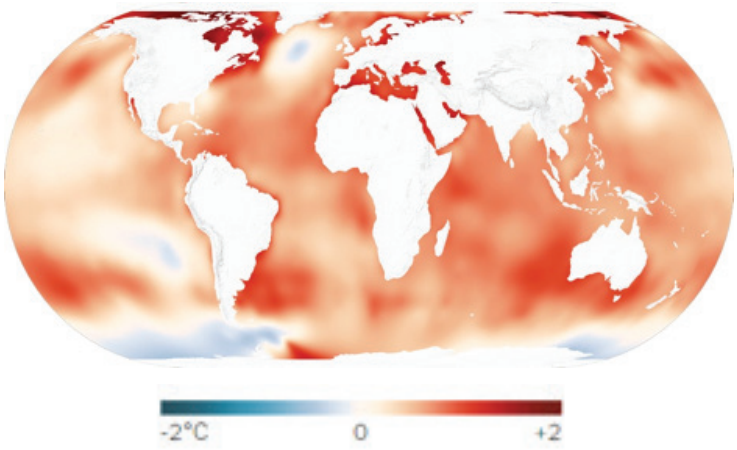


Figure 12: Warming of the oceans over the past century. This figure shows the average temperature increase between 2010-2015 relative to the 20th century average.

Source: New York Times, *Oceans Are Absorbing Almost All of the Globe's Excess Heat,* 2016.

This has many impacts, starting with sea level. When water gets warmer the molecules become more energetic; this causes the water to expand and take up more room.

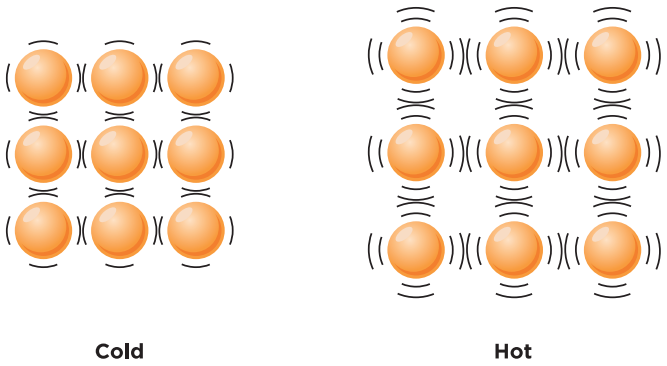


Figure 13: Behaviour of water molecules when heated.

Source: BBC, *Behaviour of matter: Expansion and contraction*, 2014.

When ocean water expands, sea level rises. Together, melting land-based ice (such as glaciers) and expanding ocean water are creating unprecedented rates of sea level rise. The annual rate of sea level rise over the past two decade is approximately twice the average speed of the previous 80 years. Sea level does not rise at the same rate everywhere,[30] but the world average is now 3.4 millimeters per year.[31]

When ocean water expands, sea level rises.

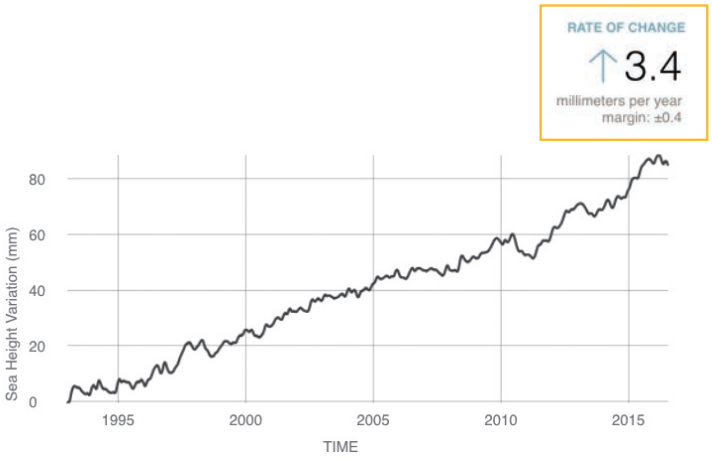


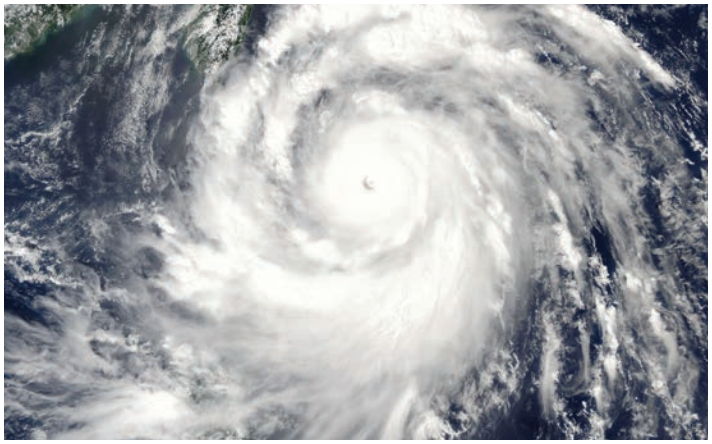
Figure 14: Sea height variation (in millimetres), 1993-Present from satellite observations.

Source: National Aeronautics and Space Administration, *Global Climate Change: Vital Signs of the Planet, Sea Level,* 2016.

In addition to raising sea level, warmer ocean water:

- fuels more extreme storms, hurricanes and typhoons;
- makes other weather cycles, like El Niño, more powerful;
- holds less dissolved oxygen than colder water, and is less productive for fish;[32] and
- combined with acidification, is expected to destroy coral reefs on which many world populations depend for fish habitat and coastal protection, e.g., the massive coral bleaching that occurred in 2016.[33]

Over time, warmer ocean water also leads to higher air temperatures.



Warmer Global Average Air Temperature

The final 1 per cent of excess heat trapped by greenhouse gases caused by human activity is pushing up the global average air temperature. The average annual air temperature is much more variable than carbon levels. Some years the global average air temperature goes up, some years it goes down. Meanwhile, different parts of the world warm and cool at different rates, and short term temperatures go up and down. (This is part of why most scientists don't use the term *global warming* any more. It confused some people into thinking that climate change isn't real unless everywhere is getting warmer all the time).

The average annual air temperature is much more variable than carbon levels.

There are many reasons for these fluctuations, including naturally occurring global circulation patterns of air and water. For example, El Niño years (like 1997 and 2015)[34] tend to be hotter than average. Volcanoes, the 11-year solar cycle, and certain causes of air pollution such as aerosols, all affect each year's average air temperature.[35] Some effects of climate change can change how heat moves through air and water around the world; this can temporarily cool some regions.

But the long-term trend is clear. Here it is since 1880:

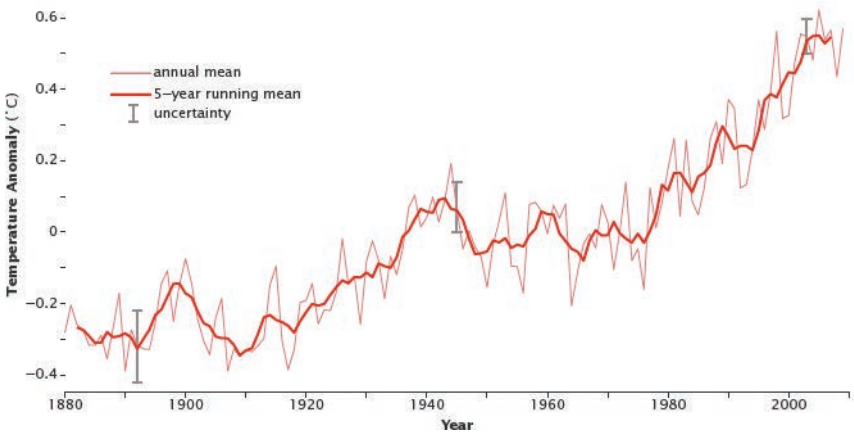


Figure 15: Global average surface temperature from 1880-2010 when compared with the long-term average (1951-1980).

Source: National Aeronautics and Space Administration, *Earth Observatory: 2010 Features – Global Warming,* 2010.

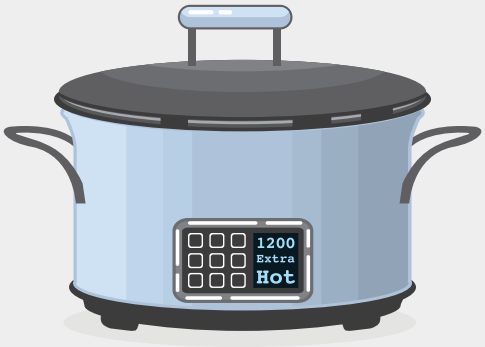
ONTARIANS TAKING ACTION

The Mayors' Megawatt Challenge

The Mayors' Megawatt Challenge brings southern Ontario municipalities together to improve energy efficiency and environmental management in their own buildings. There are currently 10 municipalities participating in the program. Since inception in 2003 the program participants have saved over 510,000 GJ of energy, $9.4 million in operating costs, and reduced GHG emissions by nearly 22,000 tonnes.

1.4.1 The Carbon Blanket is a Slow Cooker

It takes a surprisingly long time - between 25 to 50 years - for Earth's climate system to respond to historic greenhouse gas emissions.[36] One way to think about this is that today's average temperatures are about what we'd expect from the carbon blanket of 40 years ago, when the carbon blanket was less than 350 ppm. It also means that today's thicker carbon blanket will continue to drive up temperatures for decades to come. Going forward, the more we emit, the hotter the world will get.



Why is this?

Greenhouse gases stay in the atmosphere for many years, building up a thicker and thicker carbon blanket. As explained in Chapter 2, different gases have different lifespans in the atmosphere, but even short-lived gases (like methane) trap heat for more than 12 years. Others remain in the atmosphere for decades, centuries or millennia. Approximately 15-40 per cent of carbon dioxide, the most common greenhouse gas, will remain in the atmosphere more than 1,000 years after it is emitted.[37] This is why the Intergovernmental Panel on Climate Change reports that "the long-term global temperature is largely controlled by total CO_2 emissions that have accumulated over time, irrespective of the time when they were emitted."[38]

A second reason is the thermal inertia of the oceans. The oceans have an enormous capacity to absorb excess heat, with much of it being transferred into the deep ocean. But, as the oceans warm, they very slowly contribute to the overall increase in air temperatures.[39]

In general, the foundations of our economy, such as infrastructure and buildings, were designed for the average climate and sea levels of the 20th century. Many crops were also carefully bred for the average climate of the 20th century. That is the climate that most adults think of as *normal*.

Unfortunately, this *normal* will not return in our lifetimes. Here is how the global average temperature in the first 16 years of this century compared to the 20th century average:

Normal will not return in our lifetimes.

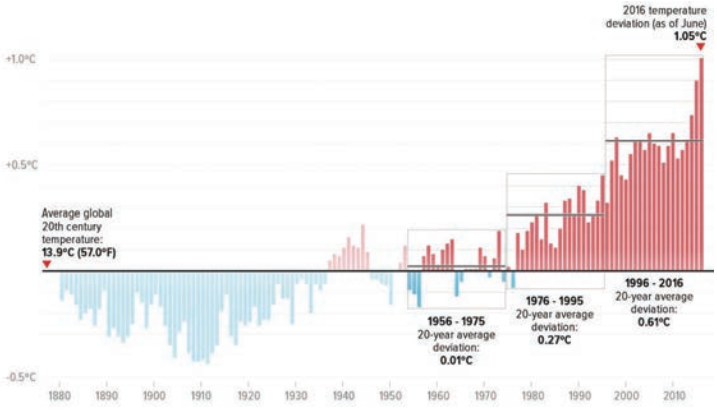


Figure 16: Annual temperature deviations. This chart indicates how average annual temperatures since 1880 compare to the average global temperature of the 20th century.

Source: Mashable (using data from the NOAA National Climatic Data Center), *Leaving the 20th Century Climate Behind,* 2016.

A strong El Niño in 2015, plus the continued upward trend in average temperatures, combined to make 2015 the hottest year since modern temperature records began in the mid- to late 1800s. 2015 was 0.76°C hotter than the world average from 1961-1990, and a full 1°C hotter than the 1850-1900 average.[40] This might not sound like much, but a mere 1-2°C difference was enough to plunge Earth into the Little Ice Age, a cooler period that lasted between the 14th and 19th centuries.[41] According to the U.S. National Research Council,[42] each degree Celsius of global temperature increase can be expected to produce:

- 5-10 per cent changes in precipitation across many regions;
- 3-10 per cent increases in the amount of rain falling during the heaviest precipitation events;
- 5-10 per cent changes in streamflow across many river basins;
- 15 per cent decreases in the annually averaged extent of sea ice across the Arctic Ocean, with 25 per cent decreases in the yearly minimum extent in September;
- 5-15 per cent reductions in the yields of crops as currently grown; and
- 200-400 per cent increases in the area burned by wildfire in parts of the western United States.

2016 continued to break all temperature records. January to August had the highest land and ocean temperatures ever recorded.[43]

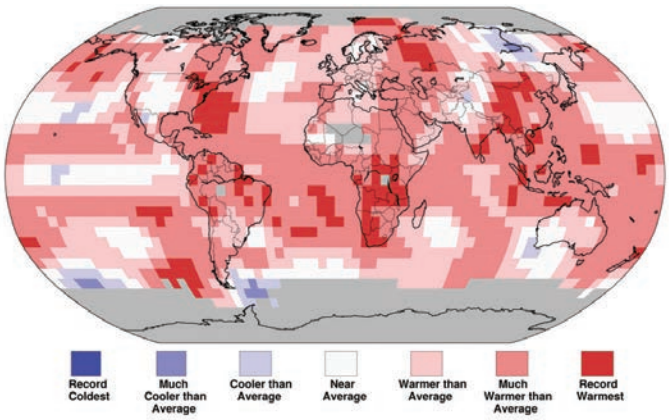


Figure 17: Blended land and sea surface ocean temperature percentiles January to August 2016. Note that blue areas near Greenland and Antarctica may represent meltwater and may indicate a slowing of ocean circulation currents.

Source: National Aeronautics and Space Administration, *State of the Climate: Global Analysis,* 2016.

When all the numbers are in, 2016 is likely to be even hotter than 2015.[44]

As explained in Box 1.4.1, the existing carbon blanket will last a long time. It will continue to trap heat, driving average air temperatures up, for decades to come. Even if atmospheric greenhouse gas levels went no higher than today's carbon dioxide equivalent of 485 ppm, surface air temperatures would increase by at least another 0.6°C by 2100.[45] In other words, future average temperature increases are already 'baked in', but how much depends on humans. As shown in Figure 18, the more we emit from now on, the higher average temperatures will go.

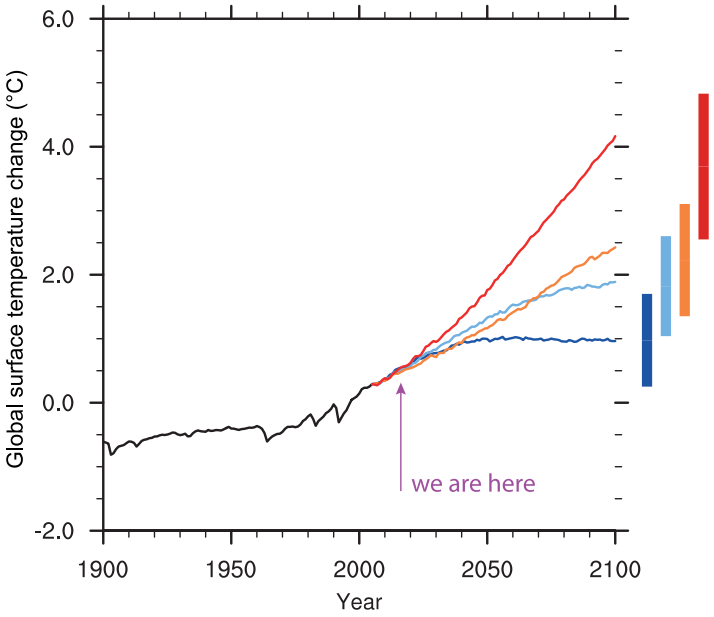


Figure 18: Observed and projected global average temperature change under four emissions pathways (as averaged across numerous models) relative to 1986-2005. Different amounts of heat-trapping gases released into the atmosphere by human activities produce different projected increases in Earth's temperature. In the figure, each line represents an estimate of global average temperature rise (relative to the 1986-2005 average) for a specific emissions pathway (or Representative Concentration Pathway or RCP). The vertical bars at the right show likely ranges in temperature by the end of the century, while the lines show projections averaged across a range of climate models. The lowest emissions pathway (RCP 2.6 - dark blue) assumes immediate and rapid reductions in emissions, whereas the highest pathway (RCP 8.5 – red), is roughly similar to a continuation of the current path of global emissions increases.

Source: Intergovernmental Panel on Climate Change, *Frequently Asked Questions* in Climate Change 2013: *The Physical Science Basis* (contribution of Working Group 1 to the *Fifth Assessment Report of the Intergovernmental Panel on Climate Change*), 2013.

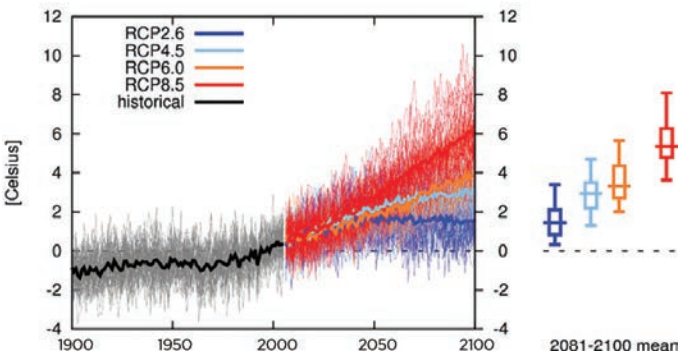


Figure 19: South Ontario temperatures (historic and modelled).

Source: Laboratory of Mathematical Parallel Systems (LAMPS) at York University, *Temperature Change for 1900 to 2100 relative to 1986-2005 from AR5 CMIP5 subset,* 2016.

1.4.2 Head in the Oven, Feet in the Freezer

As the old joke goes: If my head is in the oven, and my feet in the freezer, on average won't I be comfortable? In the same way, the increase in the global average air temperature only tells a small part of the story. What climate change brings is both:

- higher average temperatures that are unevenly distributed; and
- more damaging and more unpleasant extremes.

Warmer average and more extreme air temperatures have many impacts on humans. They:

- increase the frequency and severity of droughts, heat waves, wildfires and floods;
- worsen air quality and trigger fires and dust storms;
- promote the creation of smog that causes respiratory illness, and;
- contribute to the spread of infectious diseases, such as malaria, Zika virus, and Lyme disease, by allowing their carriers (e.g., mosquitos and ticks) to expand their geographic range and to reproduce more quickly.

All of these will present individuals and communities with greater challenges in protecting themselves, their children and their way of life.

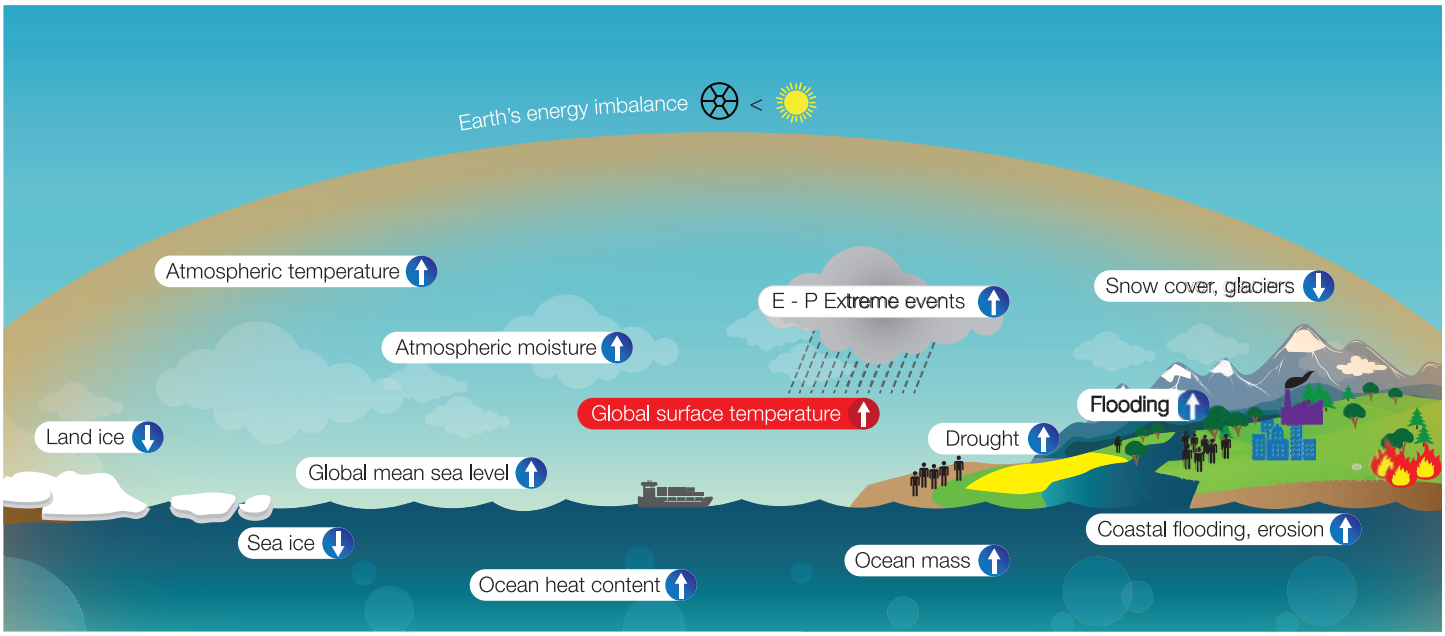


Figure 20: Global impacts from additional energy in Earth's climate system.

Source: International Union for Conservation of Nature, *Explaining Ocean Warming: Causes, scale, effects and consequences,* 2016.

1.5 Why Does it Matter?

If the world's average air temperature increases more than 1.5°C, which is now extremely likely, substantial economic and environmental damage is expected globally. A world average air temperature increase of 2°C, which is now likely, could have catastrophic consequences, including changes to the polar ice sheets, sea levels, food production, water supplies and biodiversity, among others.

The financial and economic impacts of these changes are expected to be profound. Approximately U.S. $2.5 trillion, or 1.8 per cent of the world's financial assets, are already at risk due to the changing climate.[46] The Bank of England,[47] the G20[48] and the Financial Stability Board[49] (a body set up by the G20 central bankers that monitors major risks to the global financial system) have all recently turned their attention to the risks that climate change poses to investments – and by extension, the stability of the current financial system.[50] The Financial Stability Board is so concerned about the potential impact of undisclosed climate related financial risks on international economic stability that it established a high-level Task Force on Climate-related Financial Disclosures.[51] Many senior military staff also recognize climate change as a major security and conflict risk.[52] A large number of major corporations and banks recognize the urgent threat of climate change and are taking action to protect themselves.

Many impacts have already begun. In the single month of August 2016:

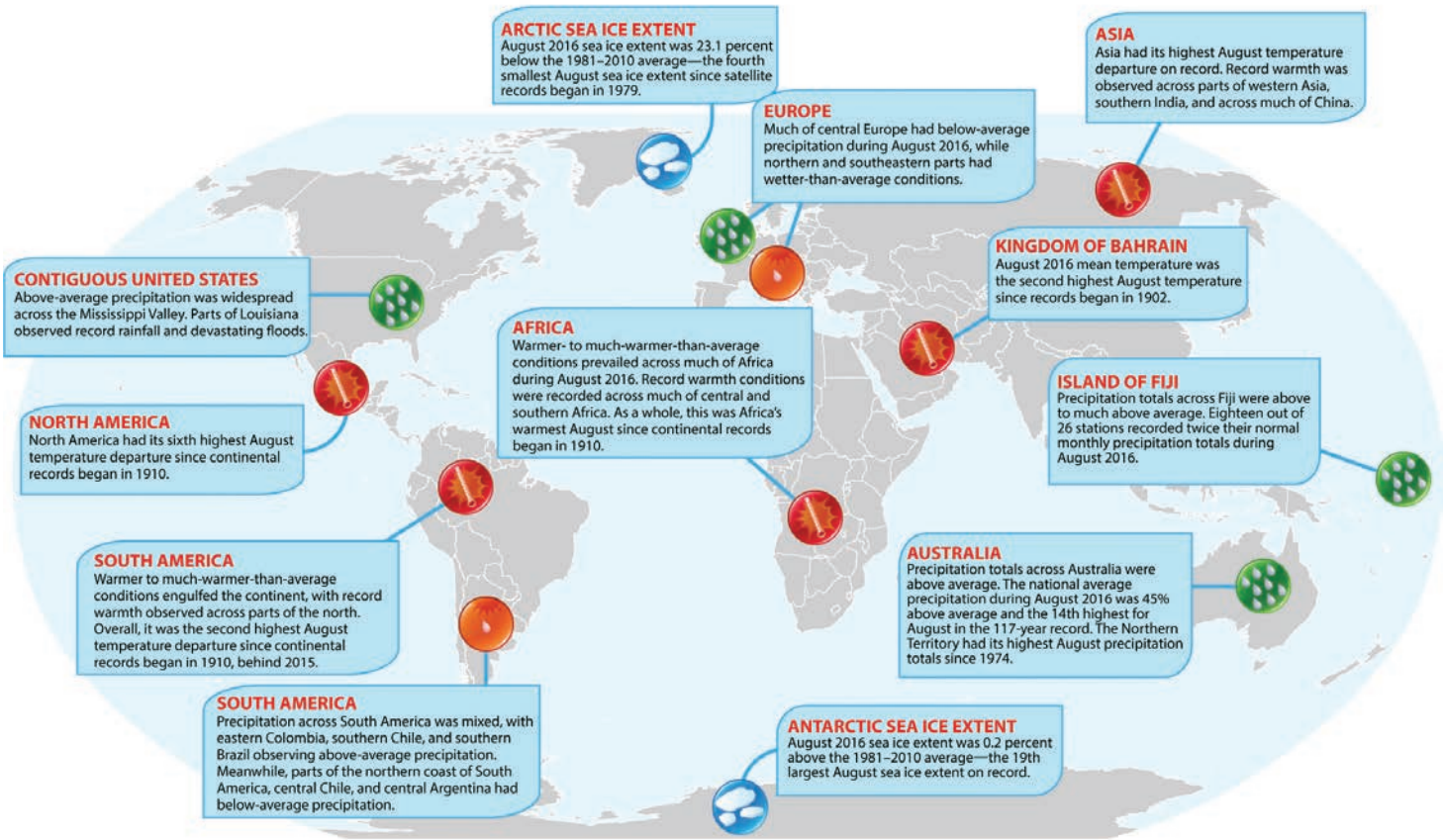


Figure 21: Select significant climate anomalies and events (August 2016).

Source: National Aeronautics and Space Administration, *State of the Climate: Global Analysis,* 2016.

The Middle East is embroiled in conflict and millions of people have become refugees, including more than 25,000 Syrians who have come to Canada. Experts consider climate change to be a contributing factor to civil unrest in this region as it exacerbated drought conditions. Leading up to the conflict in Syria, the region experienced its worst drought in 900 years.[53]

Over the last twenty years, the overwhelming majority (90 per cent) of humanitarian disasters have been caused by floods, storms, heatwaves and other weather-related events.[54] Over this period, weather-related disasters claimed 606,000 lives, with an additional 4.1 billion people injured, left homeless or otherwise in need of emergency assistance. There were an average of 335 weather-related disasters per year between 2005 and 2014, an increase of 14 per cent from 1995-2004 and almost twice the level recorded during 1985-1994.[55] People in developing countries have suffered the most.

The property insurance industry was the first major private sector industry to get serious about climate change, because natural disasters are driving up property insurance losses. In Canada alone:

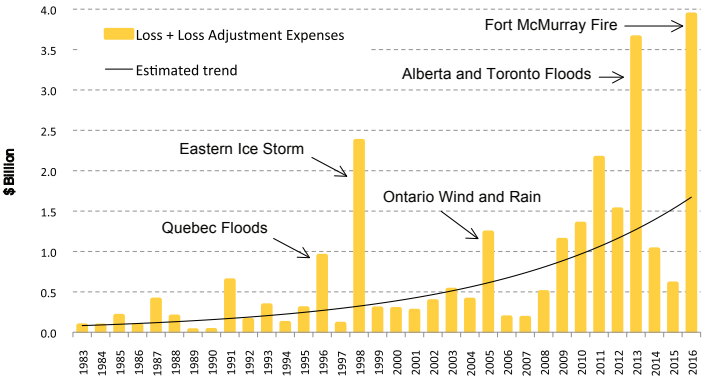


Figure 22: Catastrophic losses in Canada (in billion dollars) 1983-2016. Values in 2015$ CAN, except for 2016.

Source: Chart created by the ECO using information from the Insurance Bureau of Canada's *Facts of the Property and Casualty Insurance Industry in Canada 2016,* and preliminary data for the first seven months of 2016 as provided directly from the Insurance Bureau of Canada.

The 2016 Fort McMurray wildfire burned outside the normal fire season, after a severe drought.[56] It is expected to cost Canadian insurers $3.58 billion.[57]

Sea level rise has huge economic and environmental importance, and not just for the low-lying coastal areas and islands that are directly at risk. Depending upon the emissions scenario used, predictions of future sea level rise range from less than half a metre to 0.82 metres by 2100.[58] However, it is no longer safe to assume that sea level rise will be as slow and as late as this. One important recent paper concludes that we may see "non-linearly growing sea level rise, reaching several meters over a timescale of 50–150 years."[59] In April 2016, a senior official with the National Oceanic and Atmospheric Administration voiced her opinion to a major insurance conference to prepare for sea levels to possibly rise by 2 to 3 meters by 2050-2060.[60] If so, trillions of dollars of property and infrastructure could be damaged or lost, and many millions of people displaced.

The World Bank doubts that property insurance, as an industry, can survive a world in which the world average air temperature goes up more than 2°C compared to pre-industrial levels.[61] We are already more than half way there.

1.6 Climate Change Impacts in Ontario

Ontario is comparatively sheltered from many impacts of climate change. We are far from the searing heat of the Equator and we are blessed with an enviable supply of fresh water.

Compared with other parts of Canada, we are also lucky. Ontario can expect less warming than the high Arctic and the prairies; and less damage from sea level rise than the Atlantic provinces and British Columbia. The prairies are already experiencing more wildfire and flooding.[62] Vancouver is the eleventh most vulnerable major coastal city in the world to economic losses from future flooding.[63] The city of Levis, Quebec, draws its drinking water from the St. Lawrence River, about 40 km from where the water becomes salty. Rising sea levels and higher tides will bring salt water farther upriver, threatening Levis' water supply. The drinking water treatment plant of Lennox Island, PEI, is already threatened.[64]

Climate change brings weather that is both warmer and wilder.

So, Ontarians are fortunate. But climate change is bringing us real challenges, and many more lie ahead. For Ontario, like the rest of the world, climate change brings weather that is both warmer and wilder in the form of:

- higher average temperatures that are unevenly distributed, and
- more damaging and more unpleasant extremes.

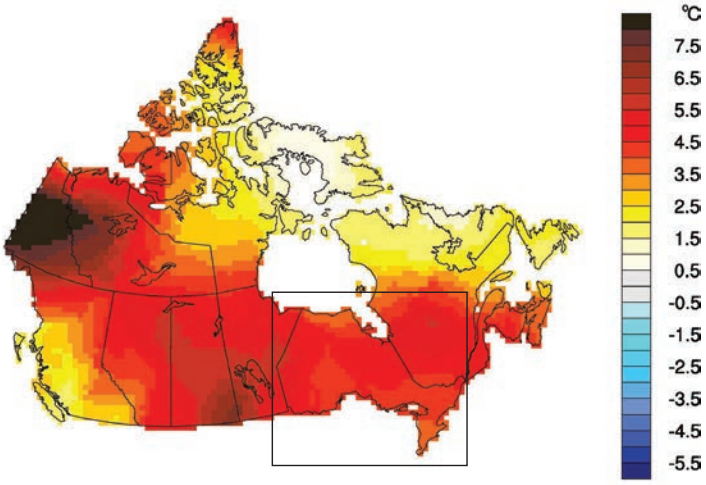


Figure 23: Temperature departures from the 1961-1990 average, winter 2015/2016.

Source: Environment and Climate Change Canada, *Climate Trends and Variations Bulletin, Winter 2015/2016,* 2016.

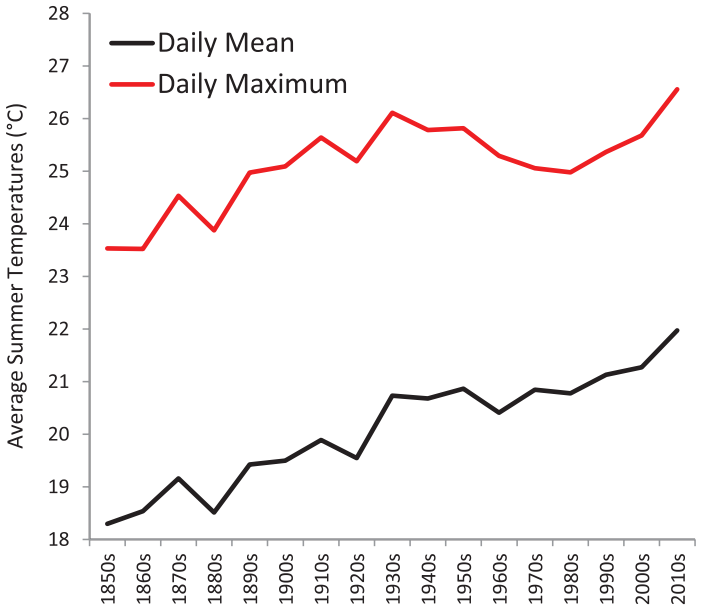


Figure 24: Trends in decadal average summer temperatures at Toronto.

Source: Laboratory of Mathematical Parallel Systems (LAMPS) at York University, *Trends in Historical Temperature and Heat Wave Duration,* 2016.

Warmer, on Average

Ontario is already experiencing more warming than the world average. Ontario summer temperatures are up by 1.0°C since 1901; winter temperatures have increased twice as fast and are now 2.2°C warmer.[65] Ontario is likely to continue to warm faster than the world average, with the largest increases projected to be in the northern areas, such as the Hudson Bay Lowlands.[66] Ontario's waters are soaking up heat even faster than the oceans. Lake Superior – with a warming of 1.16°C per decade – is one of the fastest-warming lakes in the world.[67]

Urban areas have extra warming from the urban heat-island effect, especially at night. When the combined effect of climate change and the heat-island effect push nighttime temperatures above 20°C, sleep can become more difficult without air conditioning. Figure 24 shows the summer temperature trends in Toronto since 1850.

1.6.1 What Good is Winter?

Bitter Canadian winters used to protect us from many pests, including the mountain pine beetle. Warmer winters in British Columbia have enhanced their survival rates and they have now crossed into the boreal forests of north-central Alberta. Scientists are concerned that the beetle will continue to expand its range and chew a destructive path eastward.[68]

In eastern Ontario, milder winters have allowed blacklegged ticks to expand northward, bringing Lyme disease. In 2014 there were 220 reported cases in Ontario, up significantly from 97 in 2010, and 28 in 2002.[69] Ontario must now invest new money in an action plan to address this emerging threat, under the *Provincial Framework and Action Plan concerning Emerging Vector-Borne Diseases Act, 2015.*

Wild Weather

While Ontario's *average* temperature will continue to rise, extreme events will also become more common. Because climate change alters how air masses move around the world, this can sometimes mean prolonged bitter cold as the cold air that normally circles the Arctic extends south,[70] as well as more frequent and severe storms. For example, in July 2013, a severe rainfall overwhelmed Toronto's sewer systems. The resulting flooding caused nearly a billion dollars' worth of damage, as well as serious pollution of the harbour.[71] In Burlington, in August 2014, two months' worth of rain fell in eight hours, flooding more than 3,000 homes.

Impact on Ontarians?

What does a warmer and wilder climate mean for Ontarians? Here are a few of many examples:

For the Greater Toronto Area	Punishing stretches of sweltering summer heat followed by greyer, wetter winters with more slush and freezing rain, less snow.
For those who live on or depend on rivers	Faster spring melts, risking floods; lower summer water levels, risking water shortages.
For those who live on or depend on lakes	Fluctuating water levels, plus warmer water with less oxygen and more algal blooms in some lakes.[72] Both precipitation and evaporation are predicted to increase.[73]
For those who fish for a living, for food or for pleasure	Invasive species will increase to the detriment of prized native species such as lake trout. Popular cold-water fish, like lake trout, require water that is colder than 14°C.

1.6.2 Lake Simcoe Ice Fishing

Every winter, thousands of families make their way to Lake Simcoe for excellent ice fishing. Lake Simcoe is close to Barrie and the Greater Toronto Area and contains many different fish species. Ice fishing on Lake Simcoe is a huge economic boost to the surrounding communities, and a time-honoured tradition for many families.

Ice fishing opportunities on Lake Simcoe are being eroded by climate change. Since 1989, ice cover time has decreased, on average, by one day each year.[74] Warmer winter temperatures will continue to reduce the duration of ice cover, thereby lessening the safe on-ice time for anglers during the ice-fishing season.

For hunters	Heat stress is a serious challenge for moose, already in decline across Ontario.
For farmers and gardeners	Frost dates have changed and precipitation and temperature are less predictable than they used to be. Unusual weather has wreaked havoc on Ontario's fruit growers in several of the last few years. The 2015 crop was down about 50 per cent from what used to be normal.[75] In 2016, apple, cherry and plum crops have again been damaged,[76] while southern and eastern crops suffered a severe drought.[77] [78]
For forest communities	Heat and drought will increasingly damage some forests, also increasing wildfire risk. Insect pests may multiply.
For birders	314 bird species, about a third of the North American total, are predicted to lose more than 50 per cent of their current climatic range by 2080; 126 of them are expected to lose half of their range by 2050.[79]
For electric utilities	Extreme summer heat pushes up peak electrical demand, the most expensive and difficult demand to meet. At the same time, it reduces the availability of water to generate power.
For city residents	Night time temperatures are increasing faster than daytime temperatures, increasing the frequency of nights when it is difficult to sleep without air conditioning. Heat stress shortens tempers, increases violence and worsens air quality, posing significant public health risks for vulnerable populations.[80]
For First Nations communities dependant on winter ice roads	Shorter and less reliable road access, which in turn means higher costs and more isolation. In the far north, thawing permafrost may collapse, destroying buildings and infrastructure.
For skiers, snowmobilers and winter resorts	Less reliable snow and a shorter season.

Climate change will cost Ontarians serious amounts of money.

Climate change will cost Ontarians serious amounts of money. For taxpayers, the cost of federal disaster relief is already soaring. The Parliamentary Budget Office estimated (before the Fort McMurray wildfires) that just in the next five years (i.e., 2016/17 to 2021/22), the federal government will pay out an average of $902 million every year for disaster relief: $229 million per year because of hurricanes, convective storms and winter storms and $673 million for floods.[81] The official disaster relief budget is $100 million a year.[82]

Pensions: Significant Exposure and Weak Disclosure

Ontario present and future pensioners need to wonder whether their savings are secure. Ontario pension funds are generally weak on disclosing how climate change will impact their investments. The Asset Owners' Disclosure Project ranks the climate disclosure of the world's largest investors, which includes pension funds, insurance companies, foundations and sovereign wealth funds. Canadian asset owners fared poorly, with Canada ranking 11th on a country basis, with 44 per cent of its asset owners classified as laggards.[83] Several Ontario-based public sector pension plans received the D rating (i.e., one step up from disclosing nothing about climate risk) including the Ontario Municipal Employees Retirement System (OMERS), Healthcare of Ontario Pension Plan (HOOPP) and the Ontario Public Service Pension Plan.[84]

At the same time, many Ontario pension funds have significant exposure to climate-related risks, not least because they are heavily invested in fossil fuel companies. In Ontario, some of the most carbon exposed funds include the Ontario Teachers' Pension Plan (the most exposed in Canada), Ontario Municipal Employees Retirement System (second) and the Ontario Public Service Pension Plan (ninth).[85] This combination of significant exposure and weak disclosure does not provide much comfort.

Ontarians have a lot at stake.

1.7 Everyone's Problem, Everyone's Challenge

We therefore know that:

- human-caused greenhouse gas emissions are accumulating in the atmosphere, trapping additional heat that is melting ice and (on average) warming air and water around the world;
- much more heat will be trapped by the existing carbon blanket, which humans continue to thicken every year; and
- the additional heat is making Ontario's climate warmer (faster than the world average, especially in winter) and wilder, with profound economic, environmental and human health effects.

> If we act now, there is still time to protect much of what we love.

It is too late to avoid disruptive and expensive changes to our environment and economy. But people can still choose how destructive these changes will be. If we act now, there is still time to protect much of what we love, by reducing the greenhouse gases that we emit into the air, and by preparing for the changes that are coming. The transition to a low-emission future will take money, effort and political will, but inaction will cost far more - in money, in human misery and in ecological destruction.[86] [87] [88] Emission reductions over the next few years and decades will have immensely important impacts, not just in the 21st century but perhaps for the next ten thousand years.[89]

1.8 Paris Agreement

In December 2015, the countries of the world, including Canada, reached a new agreement to limit greenhouse gas emissions.

The Paris Agreement is an agreement within the framework of the United Nations Framework Convention on Climate Change (UNFCCC) dealing with greenhouse gas emissions mitigation, adaptation and finance starting in the year 2020. It was negotiated by representatives of 195 countries at the 21st Conference of the Parties of the UNFCCC in Paris and adopted by consensus on December 12, 2015. The agreement entered into force on November 4, 2016, thirty days after 55 countries that produce at least 55 per cent of the world's greenhouse gas emissions had

ratified, accepted, approved or acceded to the agreement.[90] Canada submitted its formal ratification on October 5, 2016.

The purpose of the agreement is described in Article 2:

> *(a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;*
>
> *(b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production;*
>
> *(c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.*

Each ratifying country agrees to make an ambitious contribution to achieving this shared purpose by reducing emissions and taking other actions, and to reach "global peaking of greenhouse gas emissions as soon as possible." Each country's contribution must increase with time.

The 2°C target will be very challenging to meet; 1.5°C will be even harder. IPCC modelling, relied upon during the Paris negotiations, suggested that global greenhouse gas emissions must be cut 80 per cent by 2050 to have a reasonable chance of meeting the 2°C target. The national reduction commitments that were made in Paris are not nearly enough to keep the average air temperature change to 2°C, (much less 1.5°C) even if every country does what it has promised.[91] Further international meetings are planned to seek more stringent commitments every five years, in the hope that new technologies and greater access to funding may make greater reductions easier with time.

1.8.1 Is an 80 per cent Emission Cut Enough?

How much must world greenhouse gas emissions be cut to keep the average air temperature change below 2°C? Based on sophisticated climate computer modeling, the IPCC 5 report concluded that reducing emissions 80 per cent by 2050 would give us a reasonable chance of keeping the temperature change below 2°C. Unfortunately, even larger reductions will be essential to avoid exceeding the 2°C, (or 1.5°C) thresholds, because of something that is not yet in the model:[92] permafrost.[93]

At the time the IPCC 5 report was being written, the data about permafrost carbon was not yet good enough for inclusion in the model.[94] Now that much better data are available, an IPCC study scheduled for 2018 is expected to show that world air temperature will warm even faster than previously predicted. In other words, it will likely show that an 80 per cent emission reduction by 2050 is not enough to keep world average temperatures from going up more than 2°C.

Canada made a formal commitment in Paris to reduce our national greenhouse gas emissions by 30 percent from 2005 levels by 2030.[95] The federal government is working on policies to achieve and improve this commitment, in co-operation with other levels of government and the public. Ontario has a lot at stake, and we must do our fair share.

1.9 Ontario's Fair Share

Ontario has 38.5 per cent of Canada's population and 37.7 per cent of its Gross Domestic Product (GDP).[96] In the new *Climate Change Mitigation and Low-carbon Economy Act, 2016,* Ontario committed to reduce our own emissions by 80 per cent below 1990 levels by 2050 (see Chapter 2.1.2). Is this fair? The ECO thinks so.

Two common excuses for climate inaction are that:

- "our emissions are too small to matter anyway;" and
- "other people aren't doing enough."

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While Canada has a small share of the world's population, only 0.5 per cent, we are a rich country with very high emissions per person. Countries of the global south have already made it clear that they will not reduce their emissions if richer countries won't.

And other people are doing much more than we think. For example,

- Every country in the world agreed in Paris to do what it could, setting aside the endless arguments about who should go first. 90 of them committed to using carbon markets and trading.
- In 2015, developing countries invested more in renewable energy than all the developed countries combined.
- The U.S. doesn't have a formal carbon price, but it has cut its energy-related carbon emissions more than any other country, from 6,001 million metric tons in 2007 to 5,258 million metric tons in 2015, largely by closing coal-fired power plants.[97] The U.S. closed 94 coal-fired power plants in 2015; another 41 coal plants are scheduled to close in 2016.[98]

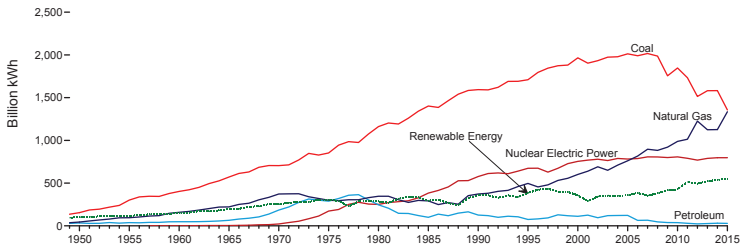


Figure 25: United States electricity net generation in billion kilowatt hours (kWh), major sources (1949-2015).

Source: U.S. Energy Information Administration, *Monthly Energy Review: August 2016,* 2016.

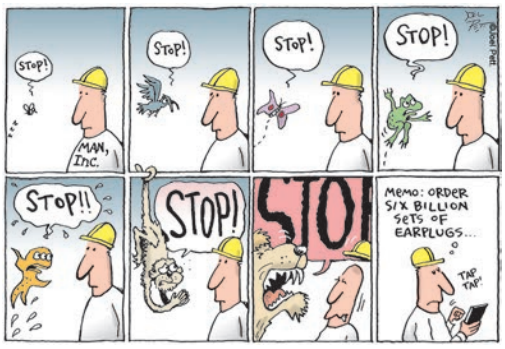
- Korea has what is currently the second largest emissions trading system in the world.[99]
- China's emission trading system will shortly be the biggest in the world. China's coal-derived energy consumption stayed flat in 2014 and likely decreased in 2015.[100] China is also taking dramatic emission reduction steps that no developed country has taken, such as food guidelines that slash meat consumption in half.[101]
- India planted 50 million trees in a day on July 11, 2016.[102]
- In 2015, China had 170,000 electric buses, 200 million electric 2 wheelers, and 200,000 new electric cars.[103] 44,000 electric cars were sold in China in June 2016 alone.[104]

1.10 Conclusion

Ontarians pride ourselves on being good citizens of our communities, of our country, and of the world. We care about the beautiful province we live in, and we care about what life will be like for our children.

To be good citizens, and to provide for our children, we have to pay attention to what human activity has done and is doing to our climate. Once we understand why we need to dramatically reduce our carbon pollution, we can work on a way forward together.

Whether we want to believe it or not, climate change is accelerating in Ontario and around the world. Fortunately, so is climate action. To do our fair share, Ontario has adopted a new climate law, the *Climate Change Mitigation and Low-carbon Economy Act, 2016,* with a legal commitment to reduce our greenhouse gas emissions. But how? The first step is to know what we emit now. The next chapter examines Ontario's greenhouse gases emissions, both the reported numbers and the ones that tell a more complete story.



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Endnotes

[1] Global temperatures in the absence of naturally occurring greenhouse gases, including water vapor, would be -18°C.

[2] Human history is generally considered to begin around 200,000 years ago. During this time, the level of carbon dioxide in the atmosphere has ranged between 180 and 280 ppm.

[3] According to the IPCC, polar ice core samples provide a very high confidence level that current concentrations of greenhouse gases in the atmosphere exceed the levels that have existed over the past 800,000 years ago. (Chapter 5, Information from Paleoclimate Archives, Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, p.385.)

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Chapter 2

Ontario's Carbon Footprint – Where Are We Now?

ABSTRACT

This chapter describes Ontario's 2014 greenhouse gas (GHG) emissions and how they are changing within each economic sector.

Ontario's first formal GHG reduction target was to limit GHG emissions in 2014 to 6 per cent below emissions in 1990. According to the official international method of calculating our carbon footprint, Ontario met that target, mostly by closing our coal-fired power generating stations.

2.1 The Reported Inventory

2.1.1 Total Emissions

Ontario's first formal greenhouse gas (GHG) reduction target was to limit GHG emissions in 2014 to 6 per cent below emissions in 1990. Did we meet that target?

On an annual basis, the federal government prepares estimates of national and provincial greenhouse gas emissions. These estimates are based on methodologies established by the Intergovernmental Panel on Climate Change.[1] The ECO relies on these national inventory reports for data on how Ontario's emissions have changed each year, what changes have occurred within each sector of the economy, and how we fare in relation to other provinces.

According to this national report, Ontario's 2014 overall greenhouse gas emissions were 170 Mt CO_2e.[2] This is the lowest emissions level since tracking began in 1990, and 6 per cent below the 1990 level of 182 Mt.[3] By reducing emissions by 12 Mt, Ontario met its first formal reduction target. This is a substantial achievement to be proud of. As this chapter will show, Ontario met this target primarily by closing its coal-fired power stations. Most other sectors' GHG emissions grew or remained flat.

2.1.2 Ontario's Emission Reduction Targets

In 2007, the government established greenhouse gas emissions reduction targets for 2014, 2020 and 2050;[4] in 2015 the government added an interim target for 2030.[5] The 2020, 2030 and 2050 targets are now enshrined in law in section 6 of the *Climate Change Mitigation and Low-carbon Economy Act, 2016.*

Ontario's targets[6] are to reduce provincial greenhouse gas emissions by:

- 6 per cent below 1990 levels by 2014 (11 megatonne (Mt) reduction to approximately 171 Mt CO2e);7
- 15 per cent below 1990 levels by 2020 (27 Mt reduction to approximately 155 Mt);
- 37 per cent below 1990 levels by 2030 (67 Mt reduction to approximately 115 Mt); and
- 80 per cent below 1990 levels by 2050 (146 Mt reduction to approximately 36 Mt).

As this chapter shows, Ontario slightly surpassed its first target as emissions in 2014 were 170 Mt. This is the lowest annual level of emissions since the baseline year of 1990, when emissions were 182 Mt, and is the first year that almost the full impact of the closure of the coal-fired power plants is reflected in Ontario's inventory.[8]

To reach the 2020 target, Ontario has to reduce emissions a further 9 per cent; an amount that translates into 15 Mt. This is an amount greater than the entire reduction of 12 Mt between 1990 and 2014. Chapters 4 to 6 of this report outline the ambitious measures that the government has put in place within the previous year, including the introduction of a cap and trade program and a climate action plan, to close some of this gap. These chapters explore whether these efforts are likely to be sufficient to meet future targets.

2.2 Which Gases?

For Ontarians to reduce our greenhouse gas emissions, we need to understand how, and in what form, we generate them. As described in Chapter 1, seven[9] main greenhouse gases are counted in the international system:

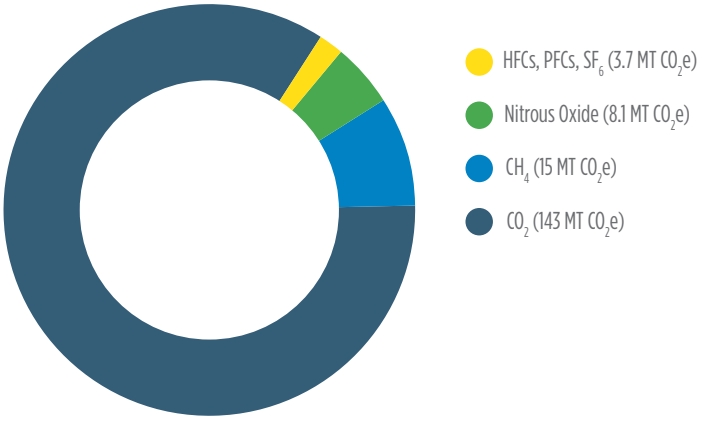


Figure 1: Ontario's 2014 Greenhouse Gas Emissions by Gas Type

Source: Environment and Climate Change Canada, National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada, Part 3, Table A11-13, (2016), p.56.

As shown in Figure 1, Ontario's main greenhouse gas is carbon dioxide (CO_2). Of Ontario's total GHG emissions of 170 Mt in 2014, **143 Mt are carbon dioxide**. CO_2 emissions come primarily from burning fossil fuels (such as gasoline, diesel and natural gas), mostly from transportation, heating and industrial uses. Ontario depends on fossil fuels for over 80 per cent of our energy sources; electricity is the smallest and has the least emissions of our major sources of energy. More detail on Ontario's use of fossil fuels is provided in the ECO 2015/2016 energy report *Conservation: Let's Get Serious*.

15 Mt CO_2e are attributed to methane (CH_4) primarily from the agricultural sector (through, for example, the digestive processes of cattle and sheep), from waste decomposing in landfills or treated in wastewater treatment facilities, and from fugitive emissions from natural gas systems. Although methane constitutes only 8.8 per cent of Ontario's reported emissions, its actual impact in the next two critical decades will be much larger (see Chapter 3.2.1 for more detail).

8.1 Mt CO_2e are attributed to nitrous oxide (N_2O) primarily from the use of synthetic nitrogen fertilizers in the agricultural sector, as well as from combustion of fossil fuels.

Finally, **3.7 Mt CO_2e are attributed to three other gases**: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). These gases are released from activities such as air conditioning, refrigeration, foam blowing (for insulation) and metal production.

2.3 Which Sectors?

Another important way to analyse progress and opportunities for GHG reductions is by breaking down Ontario's total GHG emissions by economic sector.[10] In 2014, transportation was responsible for the largest share of emissions, at 58.7 Mt, followed closely by industry, which contributed 51 Mt. Emissions from buildings (both residential and commercial) totalled 34.8 Mt. The final three sectors (agriculture, waste, and electricity) released a combined total of 25.6 Mt as shown in Figure 2.

Ontario depends on fossil fuels for over 80 per cent of our energy sources.

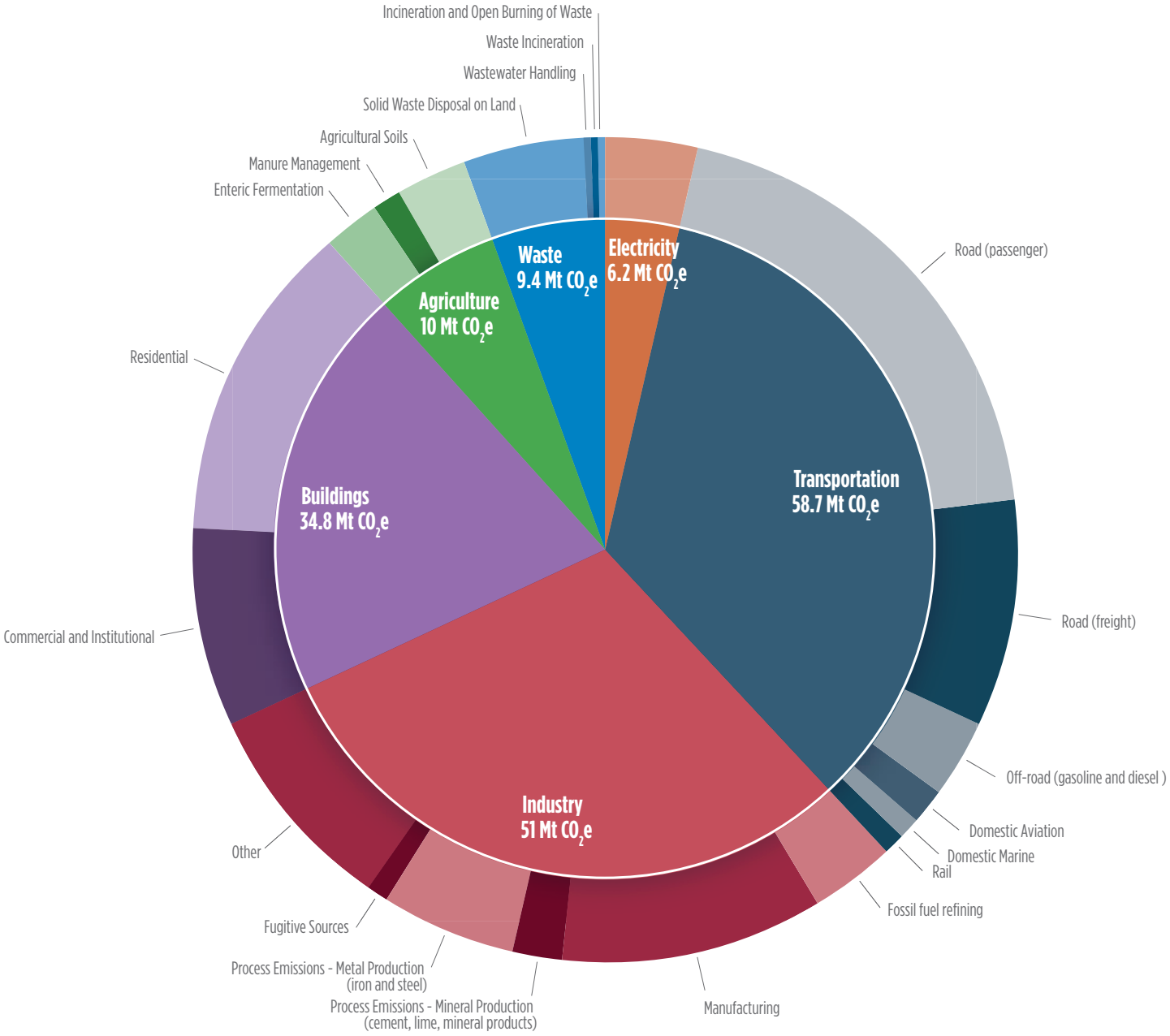


Figure 2: Ontario's 2014 Greenhouse Gas Emissions by Sector

Source: Environment and Climate Change Canada, National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada, Part 3, Table A11-12, (2016), p.55.

As the ECO reported in our 2015/2016 energy report *Conservation: Let's Get Serious*, Ontario consumed more transportation fuels (gasoline and diesel) than any other form of energy in every year since 2007, except 2014. In 2014, due to the unusually cold winter, natural gas edged out transportation fuel to be Ontario's largest source of energy (37 per cent of energy consumed, compared with transportation fuels at 36 per cent).[11] Natural gas use contributes to emissions from several sectors – buildings, industry, and electricity.

Since 1990, there have been significant changes in emissions levels within some sectors as reflected in Figure 3 and discussed below.

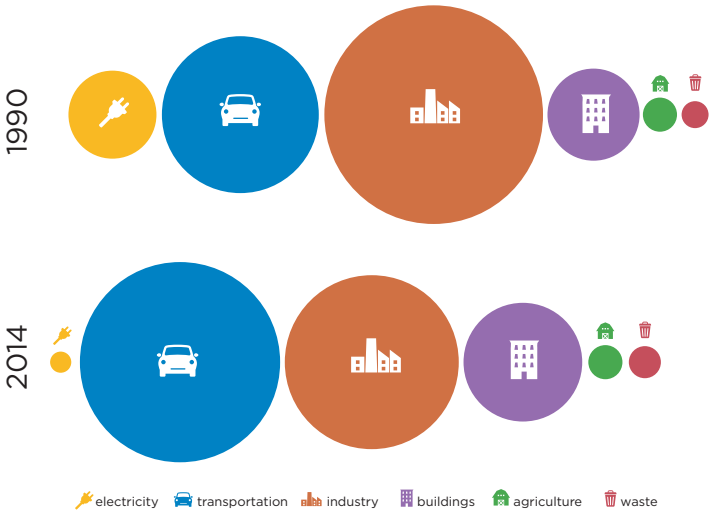


Figure 3: Ontario's Greenhouse Gas Emissions by Sector

Source: Environment and Climate Change Canada, National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada, Part 3, Table A11-12, (2016), p.55.

2.3.1 Why we met our target: Electricity

The principal reason that Ontario met its 2014 GHG reduction target is that, at the direction of the provincial government, Ontario Power Generation closed its coal-fired power generating facilities. The last one, the Thunder Bay Generating Station, ceased using coal to produce electricity in April 2014.[12] This phase out reduced GHG emissions from electricity generation by 19.4 Mt, or 76 per cent; from 25.8 Mt in 1990 (almost entirely from coal) to 6.2 Mt in 2014. This 6.2 Mt consisted of 5.96 Mt of GHG emissions from burning natural gas, and the final emissions from coal in early 2014.[13]

The coal phase out has meant an increase in natural gas use to generate electricity, primarily during times of peak demand. Natural gas provided almost 9 per cent of Ontario's electricity in 2014.[14] The other 91 per cent of Ontario's electricity generation was low-carbon: nuclear, hydro, wind and solar, with a small amount of biomass. In 2014, electricity was the smallest GHG emitter of any major sector in Ontario.

Additional gas-fired generation may be needed during the planned refurbishment of the Darlington and Bruce nuclear facilities between now and 2030, unless the Pickering nuclear facility is permitted to continue operating until the refurbishments are completed.[15] If electricity generation emissions go back up, this would make achieving the 2020 and 2030 GHG emission targets more difficult to reach.

2.3.2 The largest emissions: Transportation

Transportation is responsible for the largest and fastest growing share of Ontario's greenhouse gas emissions. These emissions have grown by 28 per cent since 1990, and totalled 58.7 Mt in 2014. Over 80 per cent of these emissions come from on-road passenger and freight vehicles such as cars and trucks; the rest come from off-road vehicles such as construction and logging vehicles[16], domestic aviation and navigation,[17] and railways.[18]

Although federal standards are improving the fuel efficiency of passenger vehicles, their benefit has been more than offset by an increase in both the number of vehicles and the total distance travelled. As well, many consumers prefer less fuel-efficient vehicles – such as sport-utility, pickups and minivans – which release, on average, 45 per cent more greenhouse gases per kilometre than cars.[19]

An even more dramatic increase in emissions has come from heavy-duty freight vehicles, which has seen a 108 per cent increase since 1990.[20] Again, improved

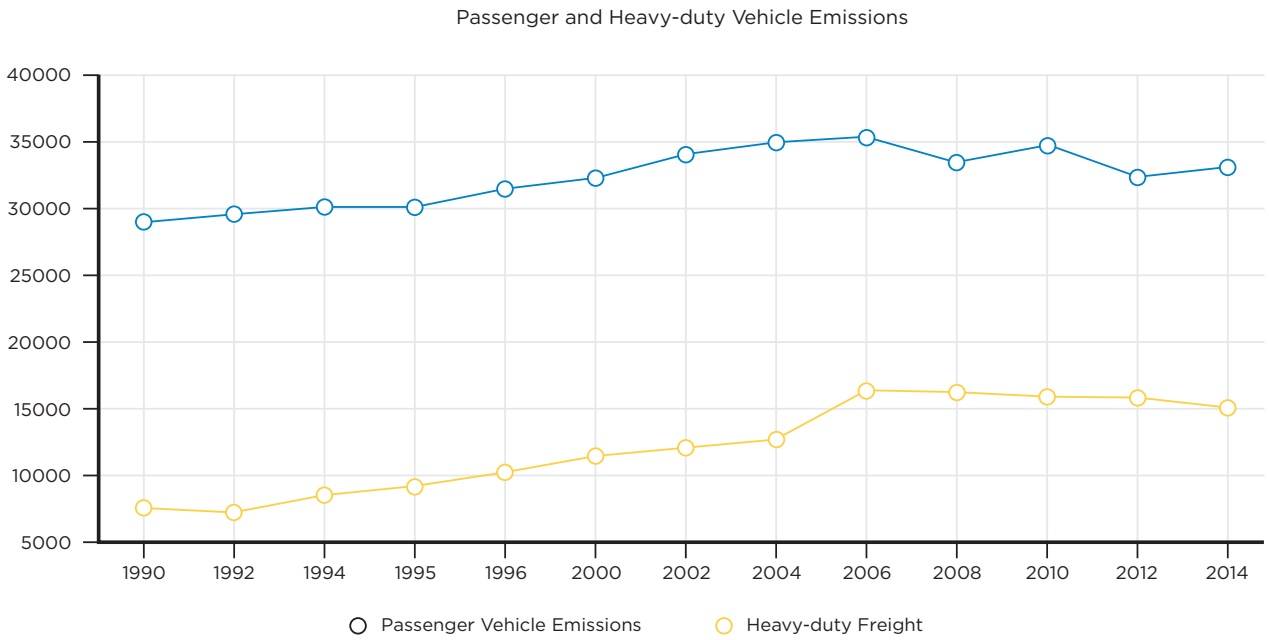


Figure 4: GHG Emissions from Passenger and Heavy-duty Freight Vehicles in Ontario from 1990-2014

Source: Environment and Climate Change Canada, National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada, Part 3, Table A11-12, (2016), p.55.

fuel consumption due to federal efficiency standards has been offset by a substantial increase in the use of diesel trucks to transport goods between urban areas, and a corresponding increase in the number of kilometres travelled.[21]

Transportation is responsible for the largest share of emissions.

2.3.3 Second largest: Industry

The industrial sector is the second largest emitting sector at 51 Mt. Ontario's major industries produce iron and steel, aluminum, chemicals (such as fertilizers), pulp and paper, cement, automobiles, textiles, and food and beverages.[22] Approximately 22 Mt of the total 51 Mt emissions arise directly from the industrial processes (through chemical or physical reactions),[23] while the remaining 29 Mt of emissions are from industries burning fossil fuels for heat and steam.

Since 1990, this sector has witnessed a reduction in overall emissions of 20 per cent. Part of this drop is due to the closure of a single industrial plant (an adipic acid plant), which had a large nitrous oxide footprint.[24] Declining production levels in Ontario's iron and steel industry, combined with an increased use of scrap steel relative to the use of pig iron, have also reduced emissions.[25]

Some industrial sub-categories have seen a significant increase from 1990 emission levels. For example, emissions from the production and consumption of halocarbons (powerful greenhouse gases such as hydrofluorocarbons that are used in air conditioning units, refrigeration units, fire extinguishers, aerosol cans, solvents and foam used for insulation purposes) have increased 250 per cent.[26] These gases replaced other more powerful ozone-depleting substances, such as fluorocarbons and halons, which were restricted under the Montreal Protocol that came into effect in 1996.[27] As such, emissions of halocarbons rose significantly after 1996.[28]

The industrial sector is the second largest emitting sector.

2.3.4 Buildings

Residential, commercial and institutional buildings had a combined total of 34.8 Mt of emissions in 2014; with residential buildings contributing 21.8 Mt and commercial and institutional buildings providing 13 Mt.[29] These emissions come mainly from the use of natural gas to provide comfort and water heating in all of these buildings.[30]

Since 1990, there has been a 28 per cent increase in emissions from the buildings sector, with a greater rise from the commercial subcategory.[31] Despite improvements in energy efficiency, population growth and an increase in total floor space have driven total emissions up.[32]

2.3.5 Agriculture

Agricultural emissions have remained relatively stable at around 10 Mt since 1990.[33] Livestock emissions – which are largely methane gas – are responsible for 55 per cent of total agricultural emissions (see Chapter 3.2.1 for a further discussion of methane). Declining cattle populations have contributed to a slight decrease in methane emissions.[34] There has also been a decline in carbon dioxide from burning crop residues.[35] Offsetting these declines has been an increase in nitrous oxide emissions from agricultural soil due to increased consumption of nitrogen fertilizers.[36]

2.3.6 Waste

Waste is the second smallest emissions sector, at 9.4 Mt, but its estimated emissions have risen 19 per cent since 1990.[37] Approximately 90 per cent of the waste sector's emissions across Canada are believed to be from methane released from the decomposition of organic waste (e.g., food, woodwaste) in landfills.[38] Estimates for methane emissions from landfill are based on limited data.

There are approximately 882 small and large operating landfill sites in Ontario, with a further 1,525 that are closed.[39] Since 2010, Ontario landfills larger than 1.5 million cubic metres have been obliged to operate landfill gas systems to capture and either use or burn the methane, in order to reduce the volume of methane released into the atmosphere.[40] Only 39 landfills have such capture systems in place, and the ECO has concerns about their effectiveness.

A detailed breakdown of the numbers associated with each sector's emissions is provided in Table 1. [41]

ONTARIANS TAKING ACTION

City of Toronto Cycling Network Plan

In June 2016, Toronto City Council approved a 10-year cycling plan to guide future investments in cycling infrastructure over the coming decade. By providing safer cycling routes, the goal is to encourage more residents to see cycling as a viable transportation alternative. At present, Toronto has the lowest level of bicycle infrastructure (i.e., kilometres of bike lanes, pathways, signed routes, etc.) per person when compared with the four other largest cities in Canada, however there have been significant improvements recently with the installation of several separated bike lanes downtown. As an alternative to car-based travel, particularly for short distances, getting more people on bicycles can play a role in reducing GHG emissions from the transportation sector.

Table 1: Ontario's Greenhouse Gas Emissions 1990 and 2014

Emission Sources	Emissions (Mt CO_2e)		Change from 1990 - 2014		Percentage each sector contributes to 2014 total
	1990	2014	Mt CO_2e	%Δ	%
Electricity	**25.8**	**6.2**	**-19.6**	**-76**	**3.6**
Transportation	**46**	**58.7**	**+12**	**+27.6**	**34.5**
Road (passenger)	29	33.1			
Road (freight)	7.3	15.2			
Off-road (gasoline and diesel)	4.8	5.4			
Domestic Aviation	2.2	2.2			
Domestic Marine	0.9	1.3			
Rail	1.8	1.4			
Industry	**64.1**	**51**	**-13**	**-20**	**30**
Fossil fuel refining	6.1	5.7			
Manufacturing	22	17.4			
Process Emissions - Mineral Production (cement, lime, mineral products)	3.9	3.4			
Chemical Industry	10.3	0			
Process Emissions - Metal Production (iron and steel)	11.2	8.8			
Fugitive Sources	1.6	1.4			
Other[45]	9.0	14.3			
Buildings	**27.3**	**34.8**	**+7.5**	**+27.7**	**20.5**
Commercial and Institutional	9.1	13			
Residential	18.1	21.8			
Agriculture	**10.6**	**10**	**-.6**	**-5.6**	**5.9**
Enteric Fermentation	4.4	3.6			
Manure Management	2.1	1.9			
Agricultural Soils	3.9	4.3			
Waste	**7.9**	**9.4**	**+1.5**	**+18.4**	**5.5**
Solid Waste Disposal on Land	7.2	8.5			
Wastewater Handling	.3	.3			
Waste Incineration	.2	.3			
Incineration and Open Burning of Waste	.3	.3			
TOTAL	**182**	**170**	**-12**	**-6.6**	**100**

Endnotes

[1] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, www.ipcc-nggip.iges.or.jp/public/2006gl/index.html

[2] Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada*, Part 3, Table A11-12, p.55, 2016.

[3] Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada*, Part 1, Table S-4, p.25, 2016.

Province	1990 GHG emissions (Mt carbon dioxide equivalent)	2005 GHG emissions (Mt carbon dioxide equivalent)	2014 GHG emissions (Mt carbon dioxide equivalent)
Ontario	181.8	210.6	170.2

[4] Government of Ontario, report, *Go Green: Ontario's Action Plan on Climate Change*, p.6, August 2007.

[5] Ministry of the Environment and Climate Change, news release, *Ontario First Province in Canada to Set 2030 Greenhouse Gas Pollution Reduction Target*, May 14, 2015. news.ontario.ca/ene/en/2015/05/ontario-first-province-in-canada-to-set-2030-greenhouse-gas-pollution-reduction-target.html

[6] The provincial targets are stated in percentage reductions only. The megatonne (Mt) reductions shown here are translations of Ontario's targets into Mt as based on data contained in the 2016 National Inventory Report. These numbers are subject to change in the future as methodologies for estimating emissions undergo revision and improvement.

[7] All emission estimates given in Mt represent emissions of greenhouse gases in megatonnes of carbon dioxide equivalent (Mt CO_2e) unless otherwise stated.

[8] Ministry of Energy, news release, *Creating Cleaner Air in Ontario: Province Has Eliminated Coal-Fired Generation*, April 15, 2014. news.ontario.ca/mei/en/2014/04/creating-cleaner-air-in-ontario-1.html

[9] Nitrogen trifluoride (NF3) is also included, however Ontario has no reported emissions of this gas.

[10] This emissions breakdown by sector is based on categories established by the Intergovernmental Panel on Climate Change and follows the Ministry of the Environment and Climate Change's assumptions for sector aggregations. The 2016 National Inventory Report published, for the first time, a breakdown of Ontario's emissions by economic sector. Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada*, Part 3, Table A12-6, p.78, 2016.

[11] Energy use data from Statistics Canada – Catalogue no. 57-003-X and electricity data from IESO as reported in Environmental Commissioner of Ontario, report, *Annual Energy Conservation Progress Report 2015/2016 – Conservation: Let's Get Serious*, p.32, May 2016.

[12] Ontario Power Generation, news release, *Ontario Power Generation Moves to Cleaner Energy Future, Thunder Bay Station Burns Last Piece of Coal*, April 14, 2014. www.opg.com/news-and-media/news-releases/Documents/140415TBGSBurnsLastCoal.pdf

[13] The burning of 'other fuels' also contributed 0.15 Mt to the total. Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada*, Part 3, Table A13-7, p.94, 2016.

[14] Ontario Energy Board, report, *Ontario's System-Wide Electricity Supply Mix: 2014 Data*. http://www.ontarioenergyboard.ca/oeb/_Documents/Regulatory/2014_Supply_Mix_Data.pdf

[15] IESO, slide deck, *Preliminary Outlook and Discussion: Ontario Supply/Demand Balance to 2035: Prepared for discussion with the IESO Stakeholder Advisory Committee*, slide 23, March 23, 2016. www.ieso.ca/Documents/consult/sac/SAC-20160323-Ontario-Planning-Outlook.pdf

[16] Other vehicles included in this category are tractors and combines used in the agricultural sector, snowmobiles, all-terrain vehicles, and resident equipment such as lawnmowers and trimmers.

[17] Emissions that are associated with domestic aviation and navigation come from the consumption of fossil fuels by aircrafts and marine vessels operating domestically with fuel purchased in Ontario.

[18] Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada*, Part 3, Table A11-12, p.55, 2016. As indicated above, this emissions breakdown by sector is based on categories established by the Intergovernmental Panel on Climate Change and follows the Ministry of the Environment and Climate Change's assumptions for sector aggregations.

[19] Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada*, Part 1, p.50, 2016.

[20] In 1990, heavy-duty gasoline and diesel vehicles were responsible for 7.3 Mt; by 2014 this had increased to 15.2 Mt. Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada*, Part 3, Table A11-12, p.55, 2016.

[21] Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada*, Part 1, p.22, 2016.

[22] Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada*, Part 3, Table A11-1, p.44, 2016.

[23] Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada*, Part 3, Table A11-12, p.55, 2016. A small portion of industry emissions are also due to HFCs.

[24] Located in Maitland, Ontario, the plant was operated by Invista Canada; it has been indefinitely idled since spring 2009. Adipic acid is primarily used to make nylon, but also has uses in medicine and food production. In 1990 it accounted for approximately 10 Mt, or 17% of Ontario's total industrial sector emissions, which gradually declined over time to zero from 2010 on. Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada*, Part 1, p.99.

[25] Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada*, Part 1, p.54, 2016. Note that this reference supports this statement for Canada as a whole, not Ontario. However, given that process emissions for steel Canada-wide are 8.6Mt and that Ontario is responsible for 8.57Mt, an inference has been made that the reference primarily applies to Ontario steel facilities. Energy efficiency improvements in the industrial sector have also contributed to emissions reductions.

[26] In 1990, these emissions were 970 kilotonnes; by 2014 this had increased to 3,400. Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada*, Part 3, Table A11-12, p.55, 2016.

[27] The Montreal Protocol on Substances that Deplete the Ozone Layer is a protocol to the Vienna Convention for the Protection of the Ozone Layer. ozone.unep.org/en/treaties-and-decisions/montreal-protocol-substances-deplete-ozone-layer

[28] Government of Canada, Canada Gazette –Archived Content, *Ozone-depleting Substances and Halocarbon Alternatives Regulations,* Vol. 149, 2015. www.gazette.gc.ca/rp-pr/p1/2015/2015-03-21/html/reg1-eng.php

[29] Located under the "energy" category. Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada,* Part 3, Table A11-12, p.55, 2016.

[30] These estimates do not include emissions related to the generation of electricity used in buildings, nor HFCs from air conditioning.

[31] *Ibid.* Emissions from the buildings sector overall rose from 27.24 Mt in 1990 to 34.8 Mt in 2014, the commercial and institutional sector in particular rose from 9.1 Mt in 1990 to 13 Mt in 2014, a 43% increase.

[32] Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada*, Part 1, p.47, 2016.

[33] In 1990, emissions associated with agriculture were 11 Mt and in 2014 they were 10 Mt. Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada,* Part 3, Table A11-12, p.55, 2016. These estimates are related to non-energy sources only; as such, they do not include on-farm fuel use.

[34] Livestock emissions are from enteric fermentation (3.6 Mt) and manure management (1.9 Mt). Enteric fermentation emissions originate almost entirely from cattle production and so while sheep populations have been steadily increasing over this time period, the decline in cattle likely has a greater overall impact on methane emissions.
Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada,* Part 1, p.56, 2016.
Statistics Canada. 2015h. Table 003-0032: Number of cattle, by class and farm type, annual (head). CANSIM (database) [accessed April 28, 2016]. Available online at: http://www5.statcan.gc.ca/cansim/003-0032.

[35] Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada,* Part 1, p.139, 2016.

[36] Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada,* Part 1, p.22, 2016.

[37] Emissions from this sector rose from 7.9 Mt in 1990 to 9.4 Mt in 2014. Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada,* Part 3, Table A11-12, p.55, 2016.

[38] Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada,* Part 1, pp.60, 2016. The other 10 percent come from composting (1.0 Mt), wastewater sewage plants (about 1.1 Mt), and incineration and open burning (0.56 Mt).

[39] Government of Ontario, Open Data website, Large landfill sites https://www.ontario.ca/environment-and-energy/map-large-landfill-sites; Small landfill sites list https://www.ontario.ca/environment-and-energy/small-landfill-sites-list?drpDistrict=all&drpStatus=Open

[40] Regulation 347 under the *Environmental Protection Act* requires landfill gas collection and flaring (burning), or use, for operating landfills larger than 1.5 million cubic metres. Regulation 347 also requires implementation of specific landfill gas facilities by December 31, 2010.

[41] Ontario Waste Management Association, information provided to the ECO, August 30, 2016.

[42] Environmental Commissioner of Ontario, report, *Annual Greenhouse Gas Progress Report 2012 – A Question of Commitment,* pp.68-69, December 4, 2012.

[43] This year, recalculations due to data improvement and quantification methodology changes necessitated the restatement of emissions across all years and sectors.

[44] This emissions breakdown by sector is based on categories established by the Intergovernmental Panel on Climate Change and follows the Ministry of the Environment and Climate Change's assumptions for sector aggregations using the data provided in Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada,* Part 3, Table A11-12, p.55, 2016. The 2016 National Inventory Report published, for the first time, a breakdown of Ontario's emissions by economic sector. Environment and Climate Change Canada, report, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada,* Part 3, Table A12-6, p.78, 2016 which aggregates the data according to economic sector. As such, slight differences exist between the two depending on the categorization method used.

[45] The 'other' category includes emissions from stationary combustion in mining, construction, agriculture and forestry; emissions from pipelines; emissions associated with the production and consumption of halocarbons; and emissions from the use of petroleum fuels as feedstock for petrochemical products.

Chapter 3

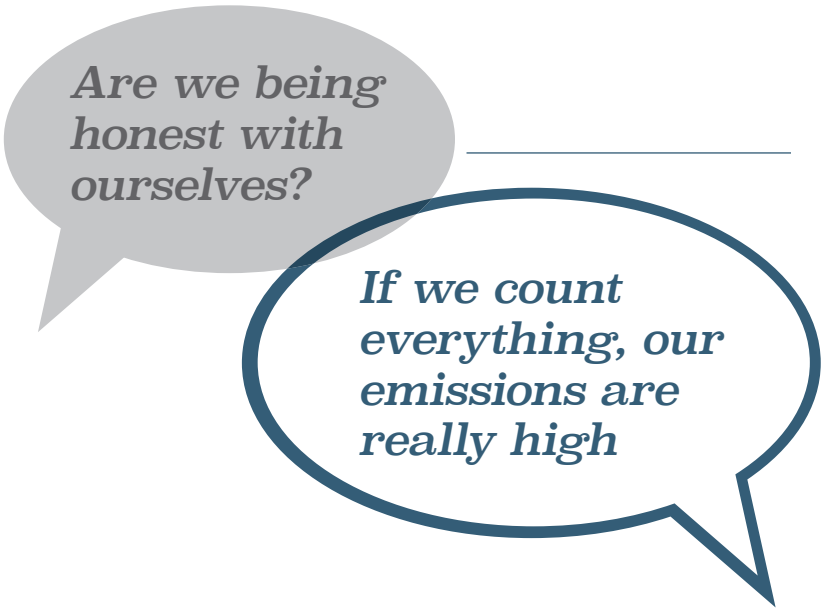
Ontario's Carbon Footprint – Beyond the Reported Numbers

ABSTRACT

Chapter 2 describes Ontario's 2014 greenhouse gas (GHG) emissions, using the international method of calculating the province's direct carbon footprint. These GHG numbers are used in Ontario's *Climate Change Mitigation and Low-carbon Economy Act, 2016*, its cap and trade program and its Climate Change Action Plan. While legitimate, these numbers underestimate Ontario's true carbon footprint. This part examines what our carbon footprint would look like if we took into account:

1. The full impact of short-lived climate forcers, such as methane and black carbon;
2. The emissions we cause by consuming things grown or made outside the province; and
3. The emissions we cause through international aviation and shipping.

As well, this part also looks at how high Ontario's emissions per capita are when compared with those of other citizens from around the world.



3.1 Beyond the Reported Numbers

The federal inventory numbers, described in Chapter 2, are a legitimate way of measuring Ontario's progress towards its reduction targets. But they do not capture Ontarians' true impact on the global climate, especially in the critical period of the next two decades as described in Chapter 1. Ontarians do more damage to the global climate than these numbers suggest, because Ontario's reported GHG emission numbers leave out:[1]

- most of the impact that our methane emissions will have in the next twelve to twenty years;
- all the impact of our black carbon emissions;
- all the impact of the emissions created to make the fuels, food and products we consume in Ontario; and
- our fair share of emissions from the international aviation and shipping that we cause.

Ontarians do more damage to the global climate than the reported numbers suggest.

3.2 Short-Lived Climate Forcers

3.2.1 Methane

Canada's national inventory report lists Ontario as releasing 0.61 Mt of methane in 2014, which the inventory equates to 15 Mt of CO_2 equivalent. Methane is released primarily from waste management (57 per cent) and secondarily from agriculture (30 per cent). The third largest source of methane (7 per cent) comes from the oil and gas sector.[2]

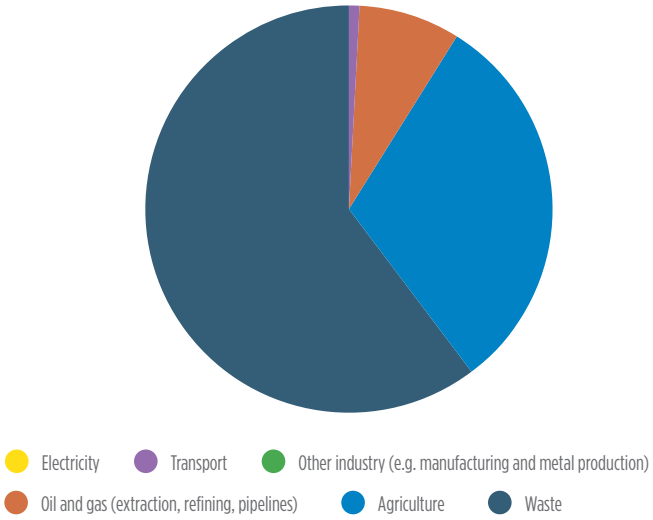


Figure 1: Methane emissions by sector in Ontario (2014).

Source: Figure created by the ECO using information from Environment and Climate Change Canada, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada, Part 3*, 2016.

3.2.2 Global Warming Potential and Carbon Dioxide Equivalencies

As described in Chapter 1, greenhouse gases warm the earth by absorbing the sun's energy and by slowing down the rate at which that energy escapes into space. Gases differ both according to the length of time they remain in the atmosphere (their lifetime) and their ability to trap heat (their radiative efficiency).

The concept of **global warming potential** (GWP) was developed in order to allow a comparison of the warming impact of different gases. The GWP of a particular gas indicates how much energy the emissions of that gas will absorb over a given time period when compared with an equivalent amount of carbon dioxide. The Intergovernmental Panel on Climate Change (IPCC) provides the GWP number for each greenhouse gas, for two time periods: 20 years and 100 years. As the reference gas, carbon dioxide has been assigned a GWP of 1, regardless of the time period used. The larger the GWP, the more that gas warms Earth compared to carbon dioxide over the same time period.

Table 1: Examples of the Global Warming Potential (GWP) of Various Greenhouse Gases. This table shows the GWP both with and without incorporating climate-carbon feedback (cc fb). Climate-carbon feedback is the intensification or reduction of the global warming impact of carbon in the atmosphere due to climate change impacts on natural ecosystem processes (e.g., cloud formation, rainforest loss due to changing precipitation patterns, increasing forest fires, desertification, melting permafrost releasing methane from peat bogs, etc.). As shown in this table, the climate change feedback loop is primarily one of intensification. Though uncertainties in the carbon cycle are substantial, the most recent IPCC report concludes that it is likely that including the climate-carbon feedback for non-CO_2 gases provides a better estimate of the metric value than including it only for CO_2.

GHG	Lifetime (years)		GWP over 20 years	GWP over 100 years
CO_2	*	With cc fb	1	1
CH_4	12.4	No cc fb	84	28
		With cc fb	86	34
N_2O	121	No cc fb	264	265
		With cc fb	268	298
CF_4	50,000	No cc fb	4,880	6,630
		With cc fb	4,950	7,350
HFC-134_A	13.4	No cc fb	3,710	1,300
		With cc fb	3,790	1,550
CFC-11	45	No cc fb	6,900	4,660
		With cc fb	7,020	5,350

Source: 2013: Table created by the ECO using information from the Intergovernmental Panel on Climate Change, *Climate Change 2013: The Physical Science Basis, Chapter 8: Anthropogenic and Natural Radiative Forcing* (contribution of Working Group 1 to the *Fifth Assessment Report of the Intergovernmental Panel on Climate Change*), 2013.

3.2.3 Canada follows UNFCCC Guidelines

In accordance with the United Nations Framework Convention on Climate Change (UNFCCC) Reporting Guidelines, Canada's inventory uses the IPCC's 2007 GWP numbers to convert all emissions into **carbon dioxide equivalencies**. As per the UNFCCC Guidelines, Canada's official inventory calculates and reports emissions of all greenhouse gases using the 100-year GWP.

The IPCC's 2007 Fourth Assessment Report stated that methane's 100 year global warming potential was 25 times more than carbon dioxide. The Canadian inventory uses this number to convert methane emissions into carbon dioxide equivalencies. The Ontario regulation, *O. Reg. 452/09: Greenhouse Gas Emissions Reporting* (the rules for emissions reporting for the entities in the cap and trade program) uses an even lower GWP number of 21 in order to align with its Western Climate Initiative partners, California and

Quebec. According to the most recent IPCC report from 2013, however, the 100-year GWP for methane is actually 34.[3] This is one reason that the reported numbers in Canada's National Inventory Report underrepresent the true warming impact of methane.

A second problem is that the use of the 100-year time horizon hides an important fact. While much of the carbon dioxide that is released into the atmosphere is absorbed relatively quickly by plants and, over time, the land and oceans, a significant portion – as much as 20 per cent – remains in the atmosphere for thousands of years.[4] Methane doesn't stay in the atmosphere nearly as long as CO_2; instead, it has a lifetime there of about 12 years.[5] But during its time in the atmosphere, it does far more than 34 (or 25, or 21) times as much damage than an equivalent amount of CO_2. According to the latest IPCC report, the 20-year global warming potential of methane is 86;[6] in other words, one tonne of methane traps 86 times more heat than the same amount of CO_2 over a 20-year time period.[7] Over a 12 year period, methane's actual residence time in the atmosphere, the GWP of methane is about 100.[8]

Table 2: Ontario's 2014 Methane Emissions (0.16 Mt), Calculated in CO_2 Equivalents, using Various Methods. IPCC AR5 numbers include the carbon feedback, because this likely provides a better estimate of the warming.

	100 Years	20 Years	
Using IPCC AR2 (1995)	GWP of 21 = 13 Mt CO_2e	GWP of 56 = 34 Mt CO_2e	**Used in Ontario's cap and trade regulation**
Using IPCC AR4 (2007)	GWP of 25 = 15 Mt CO_2e	GWP of 72 = 44 Mt CO_2e	**Current UN reporting standard**
Using IPCC AR5 (2013)	GWP of 34 = 21 Mt CO_2e	GWP of 86 = 52 Mt CO_2e	**A more accurate reflection of methane's impact over the critical shorter term**

Source: Table created by the ECO using information from the Intergovernmental Panel on Climate Change, *Climate Change 2013: The Physical Science Basis, Chapter 8: Anthropogenic and Natural Radiative Forcing* (contribution of Working Group 1 to the *Fifth Assessment Report of the Intergovernmental Panel on Climate Change*), 2013; and *Climate Change 2007: The Physical Science Basis, Chapter 2: Changes in Atmospheric Constituents and Radiative Forcing* (contribution of Working Group 1 to the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change*), 2007; and *Climate Change 1995: The Science of Climate Change, Technical Summary* (contribution of Working Group 1 to the *Second Assessment Report of the Intergovernmental Panel on Climate Change*), 1995.

This matters enormously, because emissions over the next twelve to twenty years could have an outsized impact on the options left to salvage a habitable world. 2028 is not very far away; most of Ontario's current population will still be here in 2028.

The national inventory report lists Ontario as releasing 0.61 Mt of methane in 2014. It equates this to 15 Mt of CO_2e because it uses a 100-year GWP of 25. This 15 Mt CO_2e number is the one used in government communications and is shown in Chapter 2. If the more recent IPCC 100-year GWP of 34 were applied, the inventory would show methane emissions of 20.7 Mt CO_2e for 2014, which would have pushed Ontario's total emissions to 175.7 Mt CO_2e, higher than the reported amount of 170 Mt CO_2e for 2014.

If we used the most recent IPCC 20-year GWP of 86, those 0.61 Mt of methane would have the global warming impact of 52 Mt CO_2e, an extra 37 Mt of CO_2e every year for the next twenty years.

Ontario does little to control methane.

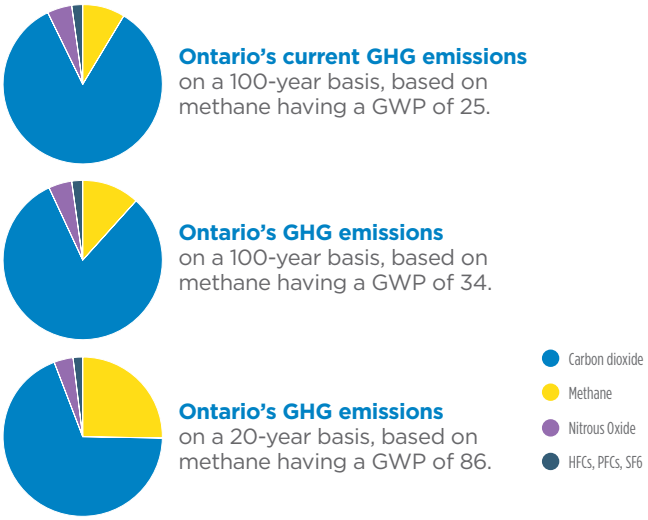


Figure 2: Methane, a short-lived and underreported gas.

Source: Figure created by the ECO using information from Environment and Climate Change Canada, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada, Part 3*, 2016; and Intergovernmental Panel on Climate Change, *Climate Change 2013: The Physical Science Basis, Chapter 8: Anthropogenic and Natural Radiative Forcing* (contribution of Working Group 1 to the *Fifth Assessment Report of the Intergovernmental Panel on Climate Change*), 2013.

In fact, Ontario does little to control methane. Most methane emissions are not regulated at all, except for those from larger landfills. The agricultural and waste sectors are not covered under the cap and trade program, though they may eventually be able to sell offsets into the system (which could create incentives to reduce their methane emissions).

The recently passed *Resource Recovery and Circular Economy Act, 2015* could help a little to reduce future methane emissions from landfills, where organic waste often ends up.[9] It requires the Ministry of the Environment and Climate Change to develop a waste strategy. A draft Strategy was released November 26, 2015. A key commitment within the strategy is to develop an organics action plan to reduce the volume of organics going to landfill. This could eventually reduce methane generation in landfills, though it could also reduce the cost-effectiveness of methane capture systems.

3.2.4 Black Carbon

A second key emission that plays a significant warming role over the short term is black carbon. This impact is not included at all in the federal inventory, and is not covered by the cap and trade program.

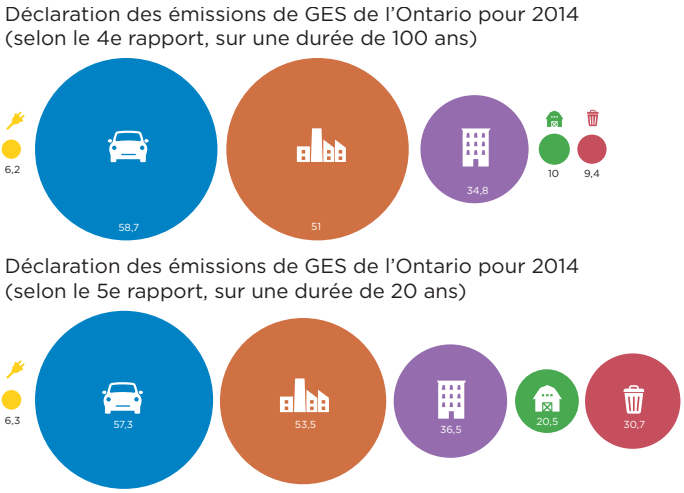


Figure 3: How we calculate our emissions has policy implications. Canada's 2016 National Inventory Report does not provide the raw emissions data for HFCs and PFCs, therefore it was not possible to recalculate these emissions. HFCs and PFCs represent a small fraction of Ontario's 2014 reported industrial emissions. Had it been possible to recalculate emissions for HFCs and PFCs it would have increased the overall emissions in the industrial sector as the global warming potentials for the various chemical formulas are typically much higher over a 20-year timeframe compared to a 100-year timeframe (see Climate Change 2007: The Physical Science Basis, Chapter 2: Changes in Atmospheric Constituents and Radiative Forcing (contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change), 2007). This emissions breakdown by sector is based on categories established by the Intergovernmental Panel on Climate Change and follows the Ministry of the Environment and Climate Change's assumptions for sector aggregations.

Source: Figure created by the ECO using information from Environment and Climate Change Canada, *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada*, Part 3, 2016; and Intergovernmental Panel on Climate Change, *Climate Change 2013: The Physical Science Basis, Chapter 8: Anthropogenic and Natural Radiative Forcing* (contribution of Working Group 1 to the *Fifth Assessment Report of the Intergovernmental Panel on Climate Change*), 2013.

Black carbon is a major component of soot, and is a solid particle that is produced through the incomplete combustion of fossil fuels and biomass.[10] It is a portion of small particulate matter less than 2.5 micrometres in size ($PM_{2.5}$). Although it is not a greenhouse gas, it plays a significant role in short-term warming of the climate.[11] First, as an airborne particle, it absorbs extra incoming sunlight, thus warming the air around it.[12] Secondly, when it settles on snow and ice, it darkens their surface.[13] Under normal conditions, these otherwise light-coloured surfaces reflect radiation back into the atmosphere; black carbon diminishes this reflective capacity and accelerates the rate of melting. This exposes the darker land or water that lies underneath, which absorbs more solar radiation and

leads to enhanced warming. Black carbon emissions from latitudes higher than 40° (i.e., all of Ontario) have a significantly greater impact on warming than black carbon emissions closer to the Equator, as they are more likely to deposit on Arctic snow and ice.[14] Due to its ability to trap heat, black carbon may be the second largest contributor to global warming after CO_2.[15]

Black carbon on snow increases the rate at which the snow absorbs the sun's heat.

In addition to its strong warming effect, black carbon also has profound impacts on public health, contributing to hundreds of thousands of premature deaths each year globally.[16] Because black carbon stays in the atmosphere only for several days to one week,[17] rapid reductions in black carbon emissions can yield immediate environmental and public health benefits.

Ontario is one of the largest provincial contributors to Canada's black carbon emissions;[18] in 2014, nation-wide black carbon emissions were 43,000 tonnes[19] with Ontario contributing nearly one-quarter of this total with 10,000 tonnes.[20] Although high, this is an improvement from 2006 when Ontario emitted 12,920 tonnes,[21] the highest amount of any province.

Black carbon is produced through incomplete combustion of fossil fuels and biomass.

A full 65 per cent of Ontario's black carbon emissions come from transportation and mobile sources such as: air, marine and rail transportation; on-road vehicles; and off-road transport.[22] Within this category, off-road diesel engines contribute the largest amount with 36 per cent of the overall total. Off-road sources include farm and construction equipment (e.g., bulldozers), as well as smaller items such as lawn and garden equipment, snowmobiles, and recreational vehicles.[23] On-road diesel is a second major source in the transportation category with approximately 18 per cent. On-road engines include heavy-duty diesel vehicles such as large freight trucks, school buses, and garbage trucks.

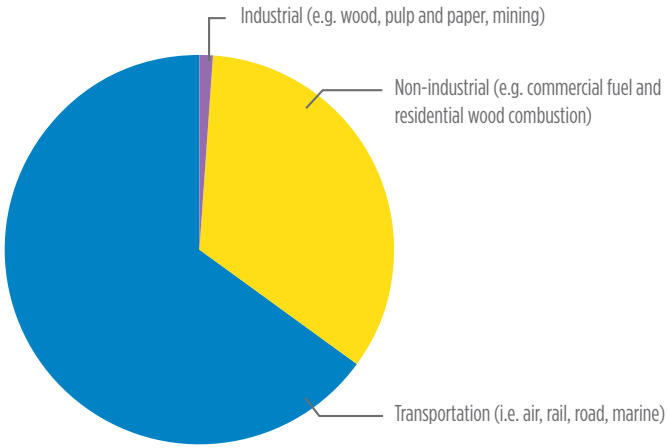


Figure 4: Sources of black carbon emissions in Ontario (2014).

Source: Figure created by the ECO using information from Environment and Climate Change Canada, *Response to ECO Information Request*, 2016.

Federal regulations to limit air pollutants from vehicles and engines, as well as the sulphur content in gasoline and diesel fuel, have played a key role in reducing black carbon as a component of particulate matter in diesel exhaust.[24] At the provincial level, Ontario has several programs that address vehicle emissions, and thereby reduce black carbon emissions. These include, for example, mandatory vehicle emissions testing (including for heavy duty diesel vehicles), required emissions control devices, and electric vehicle purchase incentives to shift towards lower emissions vehicles.[25]

In Ontario, approximately 3 per cent of households are heated by wood or wood pellets.[26] Residential wood burning is a significant source of black carbon

and contributes 2,900 tonnes, or 29 per cent of the total.[27] Under the Climate Change Action Plan, up to $4 million will be made available for northern and rural communities to replace older wood stoves with new high-efficiency ones; a similar program in British Columbia has resulted in the replacement of approximately 6,000 stoves, with a corresponding reduction of 370 tonnes of $PM_{2.5}$ per year.[28] As such, Ontario's initiative is a step in the right direction toward reducing black carbon emissions, however it is unclear at what rate the stoves will be replaced and what reductions are anticipated with this initiative.

3.3 Taking Responsibility for Our Consumption

The climate-damaging emissions reported in Chapter 2 are the emissions released into the atmosphere within the boundaries of Ontario. This direct production-based approach is used Canada wide, and is consistent with international reporting requirements.[29] However, this is not the only way to assess emissions.[30]

A new model – consumption-based emission accounting – assigns responsibility for emissions to the jurisdiction in which goods and services are ultimately used, i.e. to those who benefit from the products that generated the emissions.[31] Given the disparities in how much some countries consume compared to others, this approach to carbon emissions accounting can provide a more complete picture of each country's carbon footprint on the world's climate. It would also keep a jurisdiction from claiming to have reduced its emissions, just because manufacturing emissions (and jobs) have been shipped offshore. As well, it can help to inform consumer decisions and government policy as is being explored in the United Kingdom (see box 3.3.1).

Consumption-based emission accounting shows that Canada, and Ontario, have even larger climate impacts than reported numbers suggest.

Ontario residents are relatively wealthy compared with much of the world, and we buy a lot of products – from electronics to food to clothing to automotive parts – from many other jurisdictions.[32] Many of those items we import have a significant carbon footprint. The emissions from these products contribute to climate change, regardless of where they are released.

3.3.1 Consumption-Based Accounting in the United Kingdom

Although few countries are using consumption-based data to develop carbon policy[33], the United Kingdom has explored this issue to gain a better understanding of emissions embodied in its trading patterns. In 2011, a government study found that of the 726 Mt of emissions tied to household consumption patterns, a full 55 per cent[34] were released by offshore production activities, primarily in China.[35] In 2012, a House of Commons Energy and Climate Change Committee analyzed various data sets and concluded that there was a "clear divergence between the UK's territorial emissions and its consumption-based emissions."[36] While territorial emissions in the UK were found to be dropping (due to a switch from coal to gas-fired electricity generation, as well as a decline in manufacturing within the country), this decrease was offset by a rise in consumption-based emissions. Despite the progress it had made towards its emissions reductions targets, therefore, the UK proved to be a net contributor to global emissions.

Based on these findings, the House committee recommended the government explore options for setting emissions targets on a consumption basis, as well as incorporating consumption-based emissions data into its policy making process.[37] In turn, the Committee on Climate Change was tasked by the government to examine the second question. The committee concluded that stronger policies to encourage resource efficiency and sustainable consumption, such as consumer information programs and measures to promote reuse and recycling, could assist with reducing consumption-based emissions.[38]

Within Canada, a recent study examined the emissions associated with national, as well as provincial, consumption patterns between 1995 and 2009.[39] It found that the emissions associated with products imported to Canada exceed those associated with Canadian exports, despite our nation's role as a large exporter of oil and gas.[40] While emissions associated with U.S. imports have always been large, those from China began – in 2003 – to make a significant contribution to Canada's carbon footprint, driven by consumption of Chinese goods, which are produced using high-emitting coal-fired electricity.

At a provincial level, Ontario's high population and income levels drive consumption. Ontario's demand for goods and services, including emissions-intensive goods such as oil and gas, means it has the highest demand-based emissions total of all the provinces. In 2009 approximately 711 Mt of emissions were released worldwide to manufacture goods and services that were ultimately consumed within Canada.[41] Of this amount, Ontario was responsible for approximately 248 Mt – a significantly higher amount than the 171 Mt reported for Ontario for that year in Canada's 2015 National Inventory Report[42] (see Figure 5). Within Canada, Ontario should also be fairly held responsible for a share of the oil and gas emissions created in Alberta, to produce the petroleum products that we consume.[43]

As shown in Figure 5, Ontario's consumption-based emissions are higher than the production-based ones, and the gap between the two grew larger during the period under study. In other words, part of why we have reduced GHG emissions in Ontario is that we have shifted production of the things we consume to other places. There is no benefit to the global atmosphere when emissions are simply shifted from one jurisdiction to another.

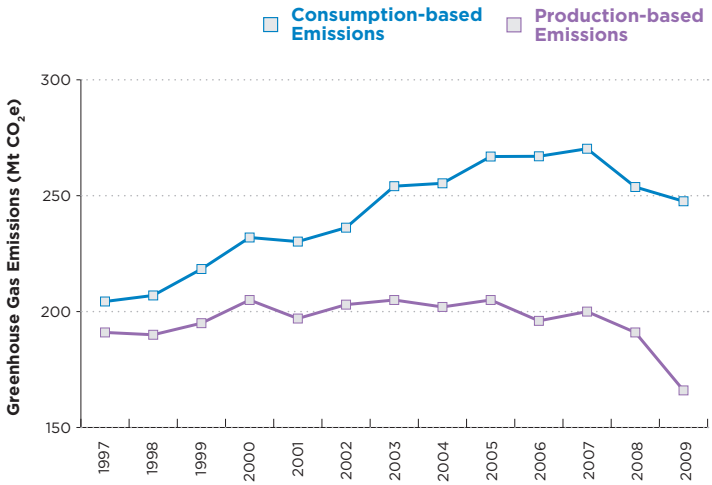


Figure 5: Ontario's consumption- and production- based greenhouse gas emissions.

Source: Dolter, Brett and Peter Victor (2016) "Casting A Long Shadow: The Implications of Demand-based accounting of Canada's Greenhouse Gas Emissions: Supplementary Material" *Ecological Economics*. 127, pp. 156-164. DOI: 10.1016/j.ecolecon.2016.04.013.

3.3.2 Carbon Labelling

To reveal the emissions that are embodied within products, several voluntary carbon labelling programs for consumer products and food have been introduced, primarily in Europe. The idea is that if consumers are informed of the associated emissions, they will factor this into their purchasing decisions.[44] In 2013 the International Organization for Standardization issued guidelines on what information such labels should contain, to quantify and communicate the carbon footprint associated with consumer products.[45] Ontario does not yet have anything similar.

Ontario's has the highest demand-based emissions total of all the provinces.

3.4 What Else We Don't Count: International Aviation and Shipping

Another climate impact that the reported numbers do not count is *international* aviation and shipping. Aviation is the most carbon intensive, and fastest growing, form of transportation.[46] As documented in the ECO's 2016 report, *Conservation: Let's Get Serious*, aviation is also the largest beneficiary of Ontario's fossil fuel subsidies.[47]

Canada's 2016 National Inventory Report, and the Ontario total of 170 Mt CO_2e, does include the GHG emissions from *domestic* aviation and shipping. But under the current UNFCCC framework, emissions from international flights and shipping are not assigned to any particular jurisdiction. Instead, they are tracked and recorded as separate entries but are not counted toward either Canada's national, or provincial, totals.[48] In fact, emissions from international flights leaving Canada totalled 11.7 Mt CO_2e in 2014, almost double what they were in 1990.[49] This is consistent with global trends in air travel emissions, which have also witnessed a dramatic increase since 1990.[50] This rapid growth is partly offset by a drop in emissions from international navigation, from 3.1 Mt in 1990 to 1.3 Mt.[51] Thus, international aviation and shipping from Canada created an additional 13 Mt of GHG emissions in 2014. Ontario's share of this can fairly be calculated to be at least 5.48 Mt.[52]

3.5 Adding it All Up

To understand our true climate footprint, Ontarians should be honest with ourselves about our full contribution to climate damage, including:

1. methane;
2. black carbon;
3. the emissions created to make the products, fuel and produce we consume; and
4. our share of international aviation and shipping.

If these additional emissions were reflected within Ontario's annual totals, our level of climate responsibility would be much higher. In grappling with the important challenges of climate change, Ontarians deserve an honest and respectful conversation with their government that is based on all the facts.

3.6 Emissions Per Capita – What's fair?

One of the enduring global debates about climate responsibility is the weight that should be given to population versus consumption. At least since the Earth Summit in 1992, developed countries have emphasized the environmental and climate damage caused by the rapidly growing populations of certain developing countries, and developing countries have emphasized the environmental and climate damage caused by the consumption habits of developed countries. This debate was again prominent at the Paris climate conference in December 2015, where less developed countries repeatedly demanded climate justice. This demand refers to many things (including financial assistance), but part of it is a demand for a

Canadians – and Ontarians – have some of the world's highest per capita emissions.

per capita allocation of the climate system's capacity to absorb greenhouse gas emissions.

Ontario's direct emissions are a small percentage of the world's total GHG emissions (0.4 per cent in 2012, the most recent year available for data),[53] mostly because Ontario has an even smaller percentage (about 0.2 per cent[54]) of the world's population, and does not count its indirect emissions. Ontarians may hold this out as an excuse for limiting efforts to reduce emissions. Looking at our per capita emissions is one way of assessing whether this excuse is justified.[55]

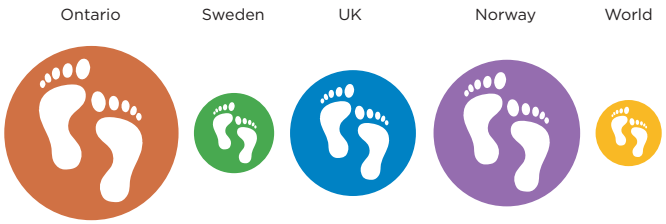


Figure 6: Ontario's per capita GHG emission footprint (12.6 tonnes), compared to Sweden (5.8 tonnes), the U.K. (9.1 tonnes), Norway (10.6 tonnes) and worldwide (4.9 tonnes).

Source: Figure created by the ECO using information from the Conference Board of Canada, *How Canada Performs Provincial and Territorial Ranking: Greenhouse Gas (GHG) Emissions*, 2016.

So how do Ontarians' carbon footprint compare to that of other people both within Canada and globally?

Within Canada, Ontario scores well. Our per capita production-based emissions are 12.6 tonnes per person;[56] the fourth lowest among all provinces and territories, and lower than the national average of 20.65 tonnes per person.[1] Closing the coal-fired generating plants has slashed Ontario's per capita emissions 29 per cent since 1990, when they were 18 tonnes per person.[57] Oil and coal dependent provinces have much higher per capita emissions, such as Alberta's 66.7 tonnes per person.[58] Quebeckers, at 10.1 tonnes per capita, have the lowest emissions of all provinces and territories, largely due to their extensive hydro-based electricity.[59]

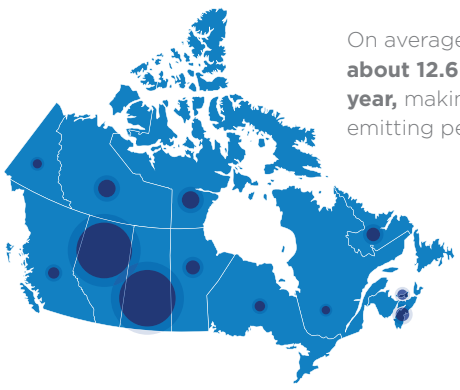
Compared to the majority of the world's countries and population, however, Canada, and Ontario, score very poorly.[60] Canadians, and Ontarians, have some of the world's highest per capita emissions, higher than most other developed countries, even other northern countries with cold climates.[61]

Ontario therefore faces a daunting challenge. To reach the GHG emission target established by section 6 of the *Climate Change Mitigation and Low-carbon Economy Act, 2016*, Ontario's emissions in 2050 will have to be less than 2 tonnes per person.[62] This will require an unprecedented transformation of the way we live, and especially of the energy that we use.

3.7 Recommendations

Recommendation: The provincial government should report regularly to Ontarians on the province's entire climate change footprint, not only on Ontario's direct GHG emissions as calculated pursuant to international guidelines.

Recommendation: The provincial government should give a higher priority to reducing Ontario's methane and black carbon emissions.



On average, **Ontarians each emit about 12.6 tonnes of GHGs a year,** making us the 4th lowest emitting people in Canada.

Figure 7. Ontario's 2013 per capita GHG emissions (12.6 tonnes) relative to other provinces and territories.

Source: Figure created by the ECO using information from the Conference Board of Canada, *How Canada Performs Provincial and Territorial Ranking: Greenhouse Gas (GHG) Emissions*, 2016.

[1] Ontario's per capita emissions using a consumption-based approach, however, were 18.9 tonnes per person in 2009. This is similar to other provinces and reflects the fact that consumption patterns (or citizen lifestyles) do not differ greatly across Canada.

Endnotes

[1] Also excluded from the reported totals are the emissions that result from, and are removed by, managed lands, the harvested wood products derived from such lands, as well as those associated with land-use change. (As such emissions resulting from wildfires and controlled burning, for example, are not included in the inventory but are reported separately). On a Canada-wide basis, if all land use, land-use change and forestry emissions were included in the national totals, they would increase Canada's overall emissions by 9.8 per cent. This contribution would be much higher if forests did not serve as significant carbon dioxide sinks; their capacity to sequester carbon dioxide is diminished in years where the number of forest fires has been unusually high. Environment and Climate Change Canada, report, National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada, Part 1, p.142.

[2] Environment and Climate Change Canada, report, National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada, Part 3, Table A11-13, p.56, 2016.

[3] The most recent IPCC report increased the global warming potential of methane over a 100-year period to 34 and to 86 over a 20-year period. This includes the climate-carbon feedbacks. See G. Myhre, et al., Chapter 8, Table 8.7, Anthropogenic and Natural Radiative Forcing in Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 2013.

[4] NASA Earth Observatory, website, The carbon cycle, http://earthobservatory.nasa.gov/Features/CarbonCycle/page1.php

[5] Table 8.7, Chapter 8, Anthropogenic and Natural Radiative Forcing, Change 2013: The Physical Science Basis. Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

[6] When the climate-carbon feedback is incorporated.

[7] Table 8.7, Chapter 8, Anthropogenic and Natural Radiative Forcing, Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. The GWP used includes the climate-carbon feedback as the IPCC states that "though uncertainties in the carbon cycle are substantial, it is likely that including the climate-carbon feedback for non-CO2 gases as well as for CO2 provides a better estimate of the metric value than including it only for CO2."

[8] Figure 8.29, Chapter 8, Anthropogenic and Natural Radiative Forcing, Change 2013: The Physical Science Basis. Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

[9] Ministry of the Environment and Climate Change, draft policy, Draft Strategy for a Waste Free Ontario: Building the Circular Economy, p.25, 2015.

[10] Along with other components such as organic carbon and inorganic compounds such as sulfates, black carbon is a component of particulate matter that is smaller than 2.5 micrometres in diameter ($PM_{2.5}$). Each source of $PM_{2.5}$ contains a different fraction of black carbon; diesel engines, for example, have relatively high emission rates of $PM_{2.5}$, and black carbon represents a relatively high fraction of diesel-related $PM_{2.5}$. For more about black carbon, see Arctic Council, report, An Assessment of Emissions and Mitigation Options for Black Carbon for the Arctic Council. Technical Report of the Arctic Council Task Force on Short-lived climate forcers, 2011.

[11] Particularly in the Arctic. See: Arctic Council, report, An Assessment of Emissions and Mitigation Options for Black Carbon for the Arctic Council. Technical Report of the Arctic Council Task Force on Short-lived climate forcers, p.2-4, 2011.

[12] Ibid.

[13] Ibid, p.2-4 to 2-5.

[14] Arctic Council, report, An Assessment of Emissions and Mitigation Options for Black Carbon for the Arctic Council. Technical Report of the Arctic Council Task Force on Short-lived climate forcers, p.3-2, 2011.

[15] T.C. Bond, et al., article, Bounding the role of black carbon in the climate system: A scientific assessment. Journal of Geophysical Research: Atmospheres, Vol. 118, p.5381, June 2013.

[16] Arctic Council, report, An Assessment of Emissions and Mitigation Options for Black Carbon for the Arctic Council. Technical Report of the Arctic Council Task Force on Short-lived climate forcers, p.2-10-2-11, 2011.

[17] Arctic Council, report, An Assessment of Emissions and Mitigation Options for Black Carbon for the Arctic Council. Technical Report of the Arctic Council Task Force on Short-lived climate forcers, p.TS-2 and 1-3, 2011.

[18] Note that this refers to human-released sources only. Natural sources, such as wildfires, are not included.

[19] Environment and Climate Change Canada, report, Canada's Black Carbon Inventory 2016 Edition, p.5, 2016.

[20] As per information provided by Environment and Climate Change Canada, May 9, 2016.

[21] Environment Canada, Greenhouse Gas Division, report, Black Carbon/Organic Carbon Emission Inventory: National and Provincial Estimates Year 2006, p.5, Revised September 2010.

[22] As per information provided by Environment and Climate Change Canada, May 9, 2016.

[23] Environment and Climate Change Canada, report, Canada's Black Carbon Inventory 2016 Edition, p.10, 2016.

[24] Environment and Climate Change Canada, report, Canada's National Black Carbon and Methane Report, p.6, 2015.

[25] Other initiatives also include Ontario's Ethanol in Gasoline regulation (O. Reg. 535/05) and the Greener Diesel regulation.

[26] Statistics Canada, Environment Accounts and Statistics Division, Households and the Environment: Energy Use – 2011. Table 2, Type of main heating fuel used, by province, 2011. www.statcan.gc.ca/pub/11-526-s/2013002/t002-eng.htm

[27] As per information provided by Environment and Climate Change Canada, May 9, 2016.

[28] Environment and Climate Change Canada, report, Canada's National Black Carbon and Methane Report, p.8, 2015.

[29] IPCC, Revised 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Reporting Instructions, p.8.4.

[30] Pursuant to a territorial-based approach, for example, emissions that occur extra-territorially (such as those arising from international aviation and shipping) are not counted within a particular country's emissions inventory. A second approach is a more comprehensive production-based one under which emissions from international aviation and shipping are allocated to the country of the relevant vessel's operator. Similarly, emissions from international tourism are allocated based on where individual tourists are resident, rather than their destination. John Barrett, et al., article, Consumption-based GHG emission accounting: a UK case study, journal, Climate Policy, 13:4, 451-470, 2013.

[31] Several studies have concluded that consumption-based emissions of developed countries (such as the United States and the United Kingdom) have increased faster than their production-based emissions. See, for example, Glen P. Peters, et al., journal, Growth in emission transfers via international trade from 1990 to 2008, PNAS, Volume 108, no.21, p.8903-8908, May 24, 2011.

[32] Ontario imported nearly $209 billion of merchandise in 2013. Simon Richards, Library of Parliament (Publication No. 2015-67-E), Trade and Investment, Ontario Provincial Profile, p.2, November 16, 2015.

[33] John Barrett, et al., article, Consumption-based GHG emission accounting: a UK case study, journal, Climate Policy, 13:4, p.452, 2013. It is noteworthy, however, that Section 37 of the Climate Change (Scotland) Act, 2009 requires that an annual report be presented to Parliament that sets out "the emission of greenhouse gases (whether in Scotland or elsewhere) which are produced by or otherwise associated with the consumption and use of good and services in Scotland during that year."

[34] Sustainability Research Institute, report, UK Consumption Emissions by Sector and Origin, A research report completed for the Department for Environment, Food and Rural Affairs, p.16, May 2011.

[35] Sustainability Research Institute, report, UK Consumption Emissions by Sector and Origin, A research report completed for the Department for Environment, Food and Rural Affairs, p.19, May 2011.

[36] House of Commons Energy and Climate Change Committee, report, Consumption-Based Emissions Reporting, Twelfth Report of Session 2010-12, Volume 1, p.10, 2012.

[37]House of Commons Energy and Climate Change Committee, report, Consumption-Based Emissions Reporting, Twelfth Report of Session 2010-12, Volume 1, p.35, 2012.

[38] Committee on Climate Change, report, Reducing the UK's carbon footprint and managing competitiveness risks, April 2013.

[39] Brett Dolter and Peter Victor, journal article, Casting a long shadow: Demand-based accounting of Canada's greenhouse gas emissions responsibility, Ecological Economics, 127 (2016) 156-164. Within the study, emissions associated with products exported to other countries, such as petroleum, were subtracted from Canada's emissions totals, while emissions associated with imports were added to our totals.

[40] Brett Dolter and Peter Victor, journal article, Casting a long shadow: Demand-based accounting of Canada's greenhouse gas emissions responsibility, Ecological Economics, 127, p.159, 2016.

[41] Brett Dolter and Peter Victor, journal article, Casting a long shadow: Demand-based accounting of Canada's greenhouse gas emissions responsibility, Ecological Economics, 127, p.159, 2016. Note that these calculations used a global warming potential of 25 for methane and 298 for nitrous oxide.

[42] Environment and Climate Change Canada, report, National Inventory Report 1990-2013: Greenhouse Gas Sources and Sinks in Canada, Part 3, p.54, 2015.

[43] Ontario imports most of its crude oil requirements from western Canada. Canadian Association of Petroleum Producers, report, Crude Oil: Forecast, Markets & Transportation, p.ii, June 2014.

[44] An interesting example of carbon labelling is the recent passage of Amendment Bylaw 2015, No. 8437., to Bylaw 2004, No. 7584 in North Vancouver to provide greenhouse gas emissions information labels on gas pumps. Several other municipalities have been exploring this possibility.

[45] International Organization for Standardization, technical specification, ISO/TS 14067:2013 Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification and communication, May 15, 2013. (This Technical Specification is based on existing International Standards ISO 14020, ISO 14024, ISO 14025, ISO 14040 and ISO 14044 and aims to set specific requirements for the quantification and communication of the carbon footprint of a product, including additional requirements where this information is intended to be publicly available.)

[46] Carbon Market Watch, briefing paper, Aviation and Climate Change, 2015.

[47] Environmental Commissioner of Ontario, report, Annual Energy Conservation Progress Report 2015/2016 –Conservation: Let's Get Serious, Chapter 7, section 7.5.1, May 31, 2016.

[48] Environment and Climate Change Canada, report, National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada, Part 1, p.67, 2016.

[49] In 1990, emissions from international aviation were 6.2 Mt. Environment and Climate Change Canada, report, National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada, Part 1, p.68, 2016.

[50] Gencsu, I. and Hino, M., The New Climate Economy, article, Raising Ambition to Reduce International Aviation and Maritime Emissions, p.4, 2015.

[51] Environment and Climate Change Canada, report, National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada, Part 1, p.68, 2016.

[52] Statistics Canada, Information Request, August 4, 2016. (international aviation, 2014 = 5,399 kt CO2eq; international shipping, 2014= 81 kt CO2eq; based on GWPs of 25 for CH4 and 298 for N2O,).

[53] Environment and Climate Change Canada, website, Global Greenhouse Gas Emissions, accessed July 13, 2016. www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=54C061B5-1, based on data from 2012 (when Ontario emissions were 167 Mt).

[54] Ontario Ministry of Finance, website, Ontario Fact Sheet October 2016. http://www.fin.gov.on.ca/en/economy/ecupdates/factsheet.html

[55] For this comparison, we use the official, international, production-based emissions, because it is the data that is most easily available, and the easiest to compare across jurisdictions.

[56] Conference Board of Canada, website, How Canada Performs, Provincial and Territorial Ranking, Environment, Greenhouse Gas Emissions, Accessed July 14, 2016. www.conferenceboard.ca/hcp/provincial/environment/ghg-emissions.aspx

[57] Conference Board of Canada, website, How Canada Performs, Provincial and Territorial Ranking, Environment, Greenhouse Gas Emissions, Accessed July 14, 2016. www.conferenceboard.ca/hcp/provincial/environment/ghg-emissions.aspx

[58] Conference Board of Canada, website, How Canada Performs, Provincial and Territorial Ranking, Environment, Greenhouse Gas Emissions, Accessed July 14, 2016. www.conferenceboard.ca/hcp/provincial/environment/ghg-emissions.aspx

[59] Conference Board of Canada, website, How Canada Performs, Provincial and Territorial Ranking, Environment, Greenhouse Gas Emissions, Accessed July 14, 2016. www.conferenceboard.ca/hcp/provincial/environment/ghg-emissions.aspx

[60] The peer group is comprised of countries that are deemed of "high income" by the World Bank and have population over one million, a land mass over 10,000 square kilometres, and rank above a five-year average of real income per capita. Conference Board of Canada, website, How Canada Performs, Provincial and Territorial Ranking, Environment, Greenhouse Gas Emissions, Accessed July 14, 2016. www.conferenceboard.ca/hcp/provincial/environment/ghg-emissions.aspx

[61] Conference Board of Canada, website, How Canada Performs, Provincial and Territorial Ranking, Environment, Greenhouse Gas Emissions, Accessed July 14, 2016. www.conferenceboard.ca/hcp/provincial/environment/ghg-emissions.aspx

[62] Subnational Global Climate Leadership Memorandum of Understanding - Under 2 MOU. http://under2mou.org/wp-content/uploads/2015/04/Under-2-MOU-English.pdf

Chapter 4

Cap and Trade

ABSTRACT

The Ontario government is joining a world-wide movement to put a price on carbon pollution to reduce greenhouse gas (GHG) emissions in the province. As part of the Western Climate Initiative, with California and Quebec, Ontario has launched a GHG cap and trade program that begins January 1, 2017, under a new law, the *Climate Change Mitigation and Low-carbon Economy Act, 2016*.

All cap and trade programs are complex. **The fundamentals of Ontario's new cap and trade program are explained in Appendix A, which is available online at eco.on.ca.**

This chapter focuses on the key design choices that Ontario has made, and how they may affect the success of the program in reducing Ontario's GHG emissions at the lowest cost, from the points of view of policy makers, major emitters, and the public.

4.1 Introduction

Ontario's new *Climate Change Mitigation and Low-carbon Economy Act, 2016* ("Climate Act") and its two regulations - a cap and trade regulation, *O. Reg. 144/16*[1], and a reporting regulation, *O. Reg. 143/16*[2] - set out the legal framework to reduce greenhouse gases (GHGs) in the province. The central feature is a cap and trade program for GHG emissions. The cap and trade program has already come into effect; the first four-year compliance period begins January 1, 2017.

A cap and trade program is an indirect way of putting a price on GHG emissions.

A cap and trade program is an indirect way of putting a price on GHG emissions (see text box 4.1.1). Covered emitters[3] must obtain, and subsequently remit to the government, an amount of allowances equal to their emissions over the term of the compliance period. Emitters can obtain allowances from government for free or at an auction, or by buying them from other companies (the trade).[4]

Allowances are effectively permits to emit GHG pollution. The government limits, and gradually cuts, the total number of allowances available, thereby driving down the amount of emissions that covered facilities (and fuel consumers) can lawfully release each year (this is the cap). As allowances become scarce, their cost should rise. The rising cost of the allowances, and the prospect of increasing scarcity, gives emitters (and fuel consumers) a predictable financial incentive to reduce their carbon pollution.

For an introduction to the basic functioning of a cap and trade program, see Appendix A (available online only at eco.on.ca), which draws on the excellent work of Quebec's Sustainable Development Commissioner.

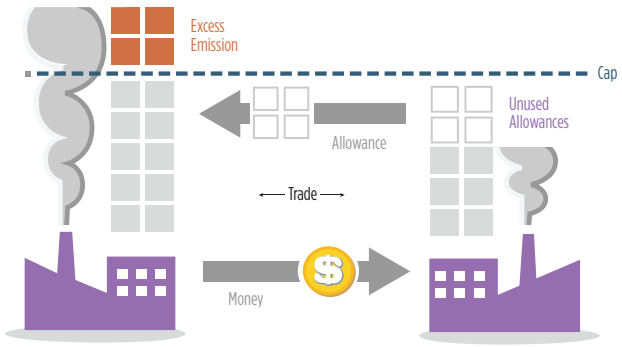


Figure 1: Schematic of how cap and trade works
Source: Adapted from Ontario's Climate Change Strategy (2015)

4.1.1 Why Put a Price on Carbon?

The ECO, many major companies, and economists around the world have long supported carbon pricing, i.e., putting a price on GHG pollution. One of the major reasons for such a thick carbon blanket in Earth's atmosphere (see Chapter 1) is that polluting the atmosphere with greenhouse gases has long been free. In the Paris Agreement[5], governments around the world recognized the need for stronger efforts to fight carbon pollution. Putting a price on carbon pollution gives businesses and citizens an economic incentive to reduce their GHG emissions.

In 2016, about 40 countries and over 20 subnational governments – or about 13 per cent of the world's GHG emissions – had a carbon pricing initiatives in place.[6] Many more are planned for 2017, including the world's largest emitter, China. As carbon pricing policies become more widespread, they evolve and countries learn from each other.[7]

There are two main ways to put a price on carbon pollution: a direct carbon tax, and/or a cap and trade program. Each can work well, or badly, depending on design and implementation. A carbon tax and cap and trade can be used individually or together. British Columbia chose a carbon tax. Ontario and Quebec chose cap and trade. Most calculations show that the price of carbon has to be significantly higher than current levels in order to drive significant emission reductions.[8]

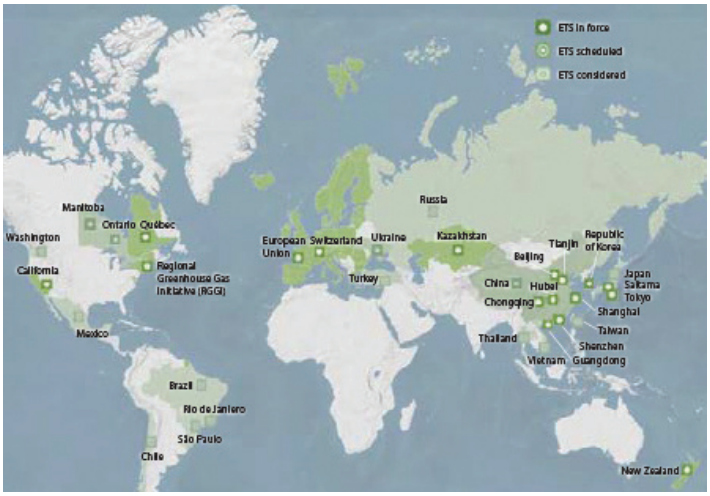


Figure 2: Cap and trade spreading around the world

Source: World Bank's PMR-ICAP Emissions Trading 2016 Handbook

The cap and trade program is just one element of Ontario's new GHG reduction strategy. Others include:

- **A policy framework:** a provincial climate change strategy,[9] 5-year action plan[10], a co-ordinated review of land-use planning, and the aforementioned *Climate Change Mitigation and Low-carbon Economy Act, 2016*. A second new law, the *Waste-Free Ontario Act, 2016* could play an important supporting role.
- **Partnerships:** Ontario signed a climate policy memorandum of understanding (MOU) with Quebec[12] and Manitoba,[13] a joint declaration with Quebec and Mexico,[14] hosted the first Climate Summit of the Americas,[15] and signed the Under 2 MOU, a voluntary commitment by subnational governments to reduce GHGs.[16] Ontario is working closely with California and Quebec to create a linked carbon market. Ontario is actively participating in various working groups to create a Pan-Canadian climate change framework with the federal government and other provinces and territories.
- **Use of proceeds:** In 2017-2020, the government expects to earn annual proceeds of $1.8-1.9 billion from the sale of GHG allowances, which it plans to spend through the Greenhouse Gas Reduction Account. For details on what the government proposes, and issues around transparency and accountability for the use of these funds, see *Chapter 5: Spending the money well*.

4.2 Key Design Issues for Policy Makers

All GHG cap and trade programs are complex. What key design choices did Ontario make? How will they affect the success of the program in reducing Ontario's GHG emissions? Did the chosen design anticipate and address the issues that have arisen in other jurisdictions with cap and trade programs? Will the program produce GHG reductions within Ontario? Will the reductions be at the lowest cost?

We address these questions in three main categories, based on the stakeholders for whom they are a primary concern: policymakers, capped emitters (emitters who must submit allowances) and the public. We begin here with the key design issues for policymakers.

All GHG cap and trade programs are complex.

4.2.1 The Emitters: Who Needs Allowances?

Who is part of the cap and trade program, i.e., required to surrender allowances equivalent to their GHG emissions? Using the National Inventory Report data (see Chapter 2), the Ministry of the Environment and Climate Change (MOECC) estimates that the cap and trade program will be mandatory for 82 per cent of Ontario's direct GHG emissions.[17] In 2017, Ontario's total GHG emissions are predicted to be 172.5 Mt.[18]

Entities engaged in the following economic activities require allowances for their own direct emissions and those of most[19] of their customers, and must buy the allowances:

- Importers of electricity;
- Generators of gas-fired electricity who are connected directly to international or inter-provincial pipelines;[20]

Cap and trade program will be mandatory for 82 per cent of Ontario's direct GHG emissions.

- Natural gas distributors; and,
- Wholesale vendors of transportation and other liquid fuels, including propane and fuel oil.

In 2017, these sectors are forecast to be responsible for roughly 100 Mt of GHG emissions.[21]

Entities engaged in the following economic activities require allowances for their own direct emissions, but will receive most of them free of charge for the 2017-2020 compliance period:

- large industrial and commercial operations (such as manufacturing, base metal processing, steel, pulp and paper, and food processing); and,
- institutions (e.g., universities).[22]

In 2017, these sectors are forecast to be responsible for roughly 40 Mt of GHG emissions.[23]

Ontario's remaining 2017 emissions are forecast to be roughly 31 Mt,[24] primarily from sectors such as agriculture, waste management and forestry. These sectors do not require allowances for their direct emissions in 2017 – 2020, although their suppliers of petroleum products, natural gas and electricity will have paid for allowances for their fossil fuel use. GHG reductions and co-benefits in these sectors are intended to be encouraged by a program of offset credits, and perhaps by regulations.[25]

4.2.2. Setting the Cap

The cap is the government-imposed limit on carbon allowances for all sectors covered by the regulation, which goes down over time. It is supposed to be initially set to match their collective projected carbon emissions for the first year. If set correctly, the cap should force emission reductions as the number of available allowances gradually declines and their price may increase.

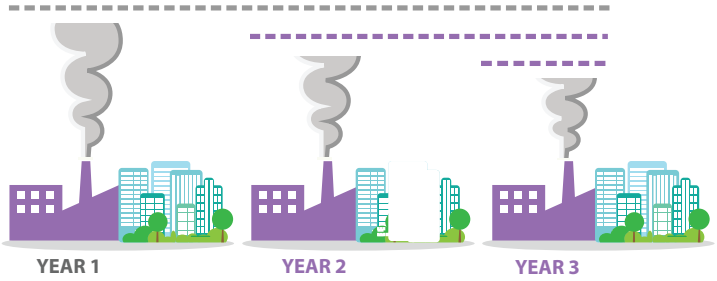


Figure 3: Cap declines over time

Source: Ontario's Climate Change Strategy (2015)

An initial cap that is set too high may do little to reduce emissions, yet can be difficult to avoid. First, setting the cap is difficult because of the many unpredictable factors that influence future GHG emissions, including energy prices, industry output, new technology, fuel costs and economic growth rates. Second, there is a political incentive to set a fairly loose cap in the program's early years, to make it easy for companies to comply, and to help the program gain acceptance. Other programs, including those of the Regional Greenhouse Gas Initiative and the European Union, set high initial caps, resulting in limited emission reductions and low allowance prices. Third, linking to other jurisdictions who have surplus allowances can also loosen a cap; see Chapter 4.2.6.

Ontario set its 2017 cap by projecting emissions into the future based on current trends and the government's best estimates of factors such as economic growth. This is notoriously difficult to do accurately.[26] The cap decline rate[27] of just over 4 per cent per year to 2020[28] is quite aggressive, and is declining faster than the caps of our partner jurisdictions in their initial years.[29,30] Ontario's cap decline rates in later compliance periods (post-2020) are currently unknown, but will have to continue to be aggressive to meet the *Climate Act*'s GHG reduction target of 37 per cent below 1990 levels by 2030.

How many allowances will Ontario issue?

Allowances will be created under section 30 of the *Climate Act*. As per O. Reg. 144/16, section 54, the

maximum number of allowances that the Ontario government may create is capped, and cannot exceed:

142,332,000 Ontario emission allowances for 2017.

136,440,000 Ontario emission allowances for 2018.

130,556,000 Ontario emission allowances for 2019.

124,668,000 Ontario emission allowances for 2020

In total, over the 2017-2020 period, the Ontario government cannot issue more than 533,996,000 allowances. This is 93.8 per cent of 569,328,000, the number of allowances that would have been issued if 142,332,000 allowances were issued every year. Five per cent of the allowances issued will go into a strategic reserve.

4.2.3 Early Reduction Credits

Under section 35 of the *Climate Act*, the Minister can also create an unspecified number of credits. The government has indicated that it will create early reduction credits (to recognize GHG emission reductions that occurred in the four years before the compliance period begins in 2017) and offset credits (to recognize certain GHG emission reductions that occur in non-capped sectors).

By definition, early reduction credits will not create new emission reductions during the 2017-2020 compliance period. They represent a measure of compensation for organizations that already reduced their emissions, before such reductions were legally required. It is fair and reasonable for the government to provide such compensation, but it will not produce additional reductions.

4.2.4 Offsets

Offsets can produce economic and environmental co-benefits as well as cost-effective emission reductions in Ontario. The government proposes that emitters who do require allowances (sometimes called covered entities) will be permitted to buy offsets and to use them for up to 8 per cent of their compliance obligation.

Offsets can produce economic and environmental co-benefits as well as cost-effective emission reductions in Ontario.

At the time of writing, the government had not yet issued its plan for recognizing Ontario offsets, but thirteen protocols were being considered.[31] The first three have been prioritized as they are already in use in Quebec and/or California.

1 Mine methane capture and destruction protocol[32]
2 Landfill gas capture and destruction protocol[33]
3 Ozone depleting substances capture and destruction protocol[34]
4 N_2O Reductions from Fertilizer Management in Agriculture Protocol[35]
5 Emission Reductions from Livestock Protocol[36]
6 Organic Waste Digestion Protocol[37]
7 Organic Waste Management Protocol[38]
8 Forest Project Protocol[39]
9 Afforestation Protocol[40]
10 Urban Forest Project Protocol[41]
11 Grassland Protocol[42]
12 Conservation Cropping Protocol[43]
13 Refrigeration Programs Protocol[44]

The ECO will review the design of Ontario's offset program in a future climate report.

4.2.5 Allocating Allowances

How best to distribute the province's allowance budget (i.e., the cap) among emitters is another key decision for policymakers, as it strongly affects the revenue the program will generate for government and the compliance costs for emitters.

Why free allowances?

Ontario has chosen to give most industries (i.e., the large final emitters) most of their allowances for free

during the initial compliance period, 2017 to 2020, and to distribute the rest by auction. This limits the revenue the government will collect from the program, and may undercut the financial incentive for companies to reduce emissions.[45] The number of free allowances provided to large emitters for combustion will decline 4.57 per cent per year between 2017 and 2020.[46]

The government has made this decision because of its concern about carbon leakage and economic competitiveness. Industries that are covered by the cap and trade program are naturally concerned about higher production costs as a result of carbon pricing.[47] If businesses, or their customers, switch to lower cost alternatives from jurisdictions without a carbon price, or by relocating to jurisdictions without carbon pricing, then 'carbon leakage' occurs.[48] Because of Ontario's low emission electricity and stringent air pollution controls, driving emission intensive industries out of Ontario can increase global GHG emissions and other forms of pollution.

The industries most vulnerable to competitiveness concerns and carbon leakage are those sectors that are both emissions-intensive and trade-exposed (EITE). The degree of risk they face is a function of their emissions intensiveness and trade exposure, the extent to which they can pass costs onto customers, and other factors such as market concentration and elasticity of demand for their products.

Ontario has chosen to allocate free allowances to *all* industrial and institutional market participants in the first compliance period, regardless of their EITE status. This is understandably controversial. No evidence has been made public that shows why and how *all* these industries are at risk of competitiveness pressures from companies outside Ontario, and therefore merit free allowances. The government's research shows that purchasing allowances would have modest impacts on profits for most emitters, averaging 1.5 per cent.[49] The Ecofiscal Commission reported that only a small percentage of the Ontario economy is actually exposed to competitiveness pressures from carbon pricing,[50] challenging the rationale for such large free allocations.

On the other hand, the carbon pricing risks to vulnerable EITE sectors occur in the context of other risks these sectors face in the normal course of doing business. For example, market prices for key production inputs fluctuate, though governments rarely intervene to protect companies. Firms choose to locate in a particular country or region for a variety of reasons, including the size of the local market, access to key inputs including energy, capital, natural resources, infrastructure and labour, and the existence of supporting industries, among others.

Some free allowances are appropriate to manage carbon leakage.

There is a delicate balance between protecting industries that legitimately require it, and retaining the incentives that a carbon pricing scheme is intended to provide, to shift towards lower-carbon production. The ECO agrees that some free allowances are appropriate to manage carbon leakage for emission-intensive trade-exposed industries. Ontario has a more open economy that is more exposed to trade pressures, than our Quebec or California partners, and Ontario manufacturers already face many challenges. EITE industries need protection in the short term from rising energy costs and the need to invest in emission reducing technologies and processes that result from the introduction of a carbon pricing policy. Europe, California and Quebec also started off with a high percentage of free allowances in their initial compliance periods, and moved to more auctioning over time.

Transparency, predictability and defensibility of the allocation is important.

Any free allowances should, however, be distributed to industries on a fair, principled, non-political basis. Transparency, predictability and defensibility of the allocation is important. The formulas, methods, and bases, of free allowance distribution are indicated in the regulation, but are difficult to understand. The government will report who has received free allowances, although not until 24 months post allocation.

Recommendation: Ontario should be more transparent about which entities are receiving free allowances, and why.

Why auction?

Most of the remaining allowances that the government does not distribute for free will be sold through auction. In the Western Climate Initiative (WCI) system, auctioned allowances from all linked jurisdictions have a price collar which includes a common floor price that increases on a set formula year to year. The *price collar* only applies at the quarterly government auctions of allowances. It does not apply to allowances that are voluntarily traded on the secondary market, which can sell at prices above or below those paid at the auctions.

According to a group of leading environmental economists,

- the prevailing view in the field of economics is that using an auction to distribute emission allowances advances values of equity, economic efficiency and environmental efficacy...
- Auctioning allows for significant policy benefits including promoting transparency in the emissions trading market by establishing a known price and ensuring equity between new and incumbent firms. Auctions also avoid the possibility of windfall profits for emitters...[51]

4.2.6 Linking

Another fundamental design choice is Ontario's plan to link its cap and trade program to those of fellow WCI members, Quebec and California, beginning in 2018. As Ontario has not yet negotiated its linking agreement, details of the link are not yet available,[52] and some of the ECO's concerns may be addressed in the agreement.[53] In future, Ontario may link its carbon market to other jurisdictions, including those which are exploring cap and trade, such as Manitoba and Mexico.[54]

Table 1: How does Ontario compare with its cap and trade partners?

	Ontario	Quebec	California
2014 GDP ($ millions)	$721,970 CAD[55]	$370,064 CAD[56]	$2,310,000[57] ($3,049,200 CAD)[58]
2014 GHG emissions	170.2 Mt	82.7 Mt	441.5 Mt
GDP per tonne of GHG (CAD)	$4,241.9	$4,474.8	$6,8061.6
2020 Target	15% below 1990	20% below 1990	Equal to 1990
2030 Target	37% below 1990	37.5% below 1990	40% below 1990
Cap (allowance budget) Expressed in million tCO_2e	**n/a**	**2013:** 23.20 **2014:** 23.20 **2015:** 65.30 **2016:** 63.19	**2013:** 162.8 (electricity and industry only) **2014:** 159.7 **2015:** 394.5 (includes all covered sectors) **2016:** 382.4
	2017: 142.3 **2018:** 136.4 **2019:** 130.6 **2020:** 124.7	**2017:** 61.08 **2018:** 58.96 **2019:** 56.85 **2020:** 54.74[59]	**2017:** 370.4 **2018:** 358.3 **2019:** 346.3 **2020:** 334.2 (15 per cent reduction between 2015 and 2020)[60]

Ontario intends to claim allowances originating from California and Quebec towards achieving Ontario's 2020 GHG emission reduction target.

Ontario intends to claim allowances originating from California and Quebec towards achieving Ontario's 2020 GHG emission reduction target. At present, GHG reductions achieved outside the province but claimed for compliance by Ontario emitters would not count towards Ontario's emissions total[61] or international targets. However, the Paris Agreement, agreed to at the December 2015 United Nations climate change conference, created an enabling framework which could allow Ontario to use emissions reductions achieved outside Canada towards its own targets,[62] if the Canadian government successfully negotiates an appropriate bilateral agreement with the United States. For Ontario to count California allowances to reduce Ontario's emissions in the international system, it will need the federal government to negotiate such an agreement with the U.S.

Does it matter if GHG reductions don't occur in Ontario? GHGs are global pollutants, not local ones, and the climate benefits from reductions wherever they occur. On the other hand, there could be major co-benefits to reducing GHGs in Ontario, such as better air quality, health outcomes[63] and soil health; encouraging technological innovation and positioning Ontario for the new low-carbon economy. Industries that retool for a low-carbon economy can then operate into the future with reduced emissions.

These co-benefits will not materialize in Ontario if Ontario emitters rely on California allowances instead of reducing emissions here. Industries that rely on purchased allowances must continue to purchase them every year, unless and until they reduce their own emissions.

The key purpose of linking is to reduce compliance costs for Ontario emitters.[64] Linking reduces compliance costs in two main ways:

1. creating a bigger, more liquid market for allowances; and
2. giving Ontario emitters access to lower cost allowances from other jurisdictions.[65]

The key purpose of linking is to reduce compliance costs for Ontario emitters.

Ontario has signalled its intent to link its program with similar programs operating in Quebec and California, on that grounds that it will:

- enable access to a bigger pool of low-cost emissions reductions;
- level the international playing field by harmonizing carbon prices across jurisdictions;
- leverage common infrastructure, reducing implementation costs;
- simplify administration for industries operating in multiple jurisdictions.[66]

Compliance costs would likely be much higher in an unlinked, Ontario-only cap and trade program, as shown in Figure 4.[67]

In 2020	**C&T WCI linked, Program:** Transitional Assistance, Mixed Use of Proceeds	**Ontario Alone C&T, Unlinked:** Transitional Assistance, Mixed proceeds	**Ontario Alone, Carbon Tax or C&T Full Auction:** Mixed proceeds	**Ontario Alone, Carbon Tax or C&T Full Auction:** Tax Reductions
Environmental Effectiveness				
GHG reductions (Mt)				
Ontario abatement and offsets, WCI imports, Ontario offsets or Action Plan reductions	18.7	18.7	18.7	18.7
Leakage (Mt)	-0.28	-1.75	-5.84	-6.03
Net GHG Reductions (Mt)	18.42	16.95	12.9	12.7
Economic Efficiency and Cost				
Carbon price ($ nominal)	$18	$157	$69	$72
GDP impact (%	-0.03%	-0.39%	-0.40%	-0.21%
Trade impact (%) (net exports))	-0.51%	-8.4%	-7.0%	-2.5%
Distribution				
Household energy ($/month; $2016)	$13	$107	$48	$50

Figure 4: Summary of impacts across policy alternatives in 2020

Source: Dave Sawyer, Jotham Peters, and Seton Stiebert, EnviroEconomics, summary report, *Impact Modelling and Analysis of Ontario's Proposed Cap and Trade Program*, May 27, 2016.

Other modelling has come to the same conclusion: linking will lower compliance costs for Ontario emitters.[68] A linked program may also have less price volatility.[69] Economic theory suggests that linking can be beneficial for smaller jurisdictions like Ontario.[70]

Asymmetrical relationship

The relationship between Ontario and its WCI partners will not be symmetrical. Modelling commissioned by the government predicts that the cap and trade program alone will not produce very many of the reductions Ontario needs to meet its 2020 target in Ontario.[71] In other words, once Ontario links with California and Quebec, many Ontario emitters may find it less expensive to buy allowances from California than to reduce emissions in Ontario. Other researchers' modelling shows the same trend to 2030.[72] ICF projects that $250-$300 million could flow from Ontario to purchase California allowances, per year, by 2020.[73]

Why will there likely be a net outflow to California? The principal reasons include:

1. **California's cap is very large.** Since California's economy is the sixth largest in the world, and more than four times larger than Ontario's, its allowances will greatly outnumber those to be issued by Ontario.[74]
2. **California has lower GHG emissions in relation to its GDP.** California benefits from a warmer climate, from a different industrial base, and from a long history of controlling emissions from vehicles. For example, California has about 200,000 electric vehicles; Ontario has about 7,000.
3. **California has lower abatement costs than Ontario.** California has a much larger and more varied economy, with more emission reduction opportunities. Ontario has already used up some less expensive reduction opportunities. For example, replacing coal-fired electrical generation with natural gas or renewable electricity has been a relatively inexpensive way of producing large GHG reductions.[75] Ontario already closed all its coal-fired facilities before cap and trade begins.
4. **California's cap is reducing more slowly than Ontario's.** California's cap and trade program started in 2013 with an initial cap about 2 per cent below its 2012 emissions forecast. The cap then declined about 2 per cent in 2014 and about 3.1-3.5 per cent annually from 2015 to 2020; compared to

Ontario's cap decline rate of just over 4 per cent per year to 2020. This makes California's cap less stringent – i.e., easier for entities to comply with.

5. **California allowances are selling near the legal floor price, which is currently $12.73 US.** In 2016, none of the quarterly auctions sold out. In the May and August 2016 auctions, respectively, 89% and 65% of current year allowances went unsold, even at the floor price. Under current California law, unsold allowances create an overhang on the market that keeps future prices down. Unsold utility allowances are offered for sale at the next auction. Unsold state allowances are placed in a holding account and will gradually be offered for sale again once two sold out auctions have occurred with prices at least 1 penny above the floor price.[76]
   a. On the other hand, the higher value of the U.S. dollar will lead to a higher minimum allowance price for Ontario emitters, because the floor price for linked auctions is set at the highest of each participating jurisdiction's floor price (after applying the exchange rate). Once Quebec linked with California, the rise in the value of the American dollar drove up Canadian dollar allowance prices by 22 per cent.[77] This exchange rate risk adds another layer of complexity for companies trying to predict allowance prices and plan compliance strategies.
6. **California is likely to have more allowances than it needs until after 2020.** Some economists expect that California will have a cumulative surplus of unneeded allowances in its holding account by 2020, and that prices will not start to increase until well into the next decade.[78] Ontario's compliance gap in 2020 is estimated to be less than 24 Mt; California had almost 117 Mt of unsold allowances in the May and August 2016 auctions alone.[79]

Furthermore, there are **legal doubts** about whether the California program will survive its litigation and legislative challenges long enough to reach the next decade. This legal uncertainty has contributed, in part, to suppress the selling price of allowances at both the May and August 2016 auctions; see text box.

Legal doubts about California's cap and trade program

Legal Problem #1:
The California market failed to sell all allowances for the first time in February 2016. This auction occurred several days after the U.S. Supreme Court granted a stay in a legal challenge (in federal court) to the U.S. federal Clean Power Plan. While the federal Clean Power Plan does not directly relate to the California cap and trade program, the stay shook confidence in carbon markets across the US.

Legal Problem #2:
On April 8, 2016, the California Court of Appeal issued an alarming direction in an important court case challenging the legality of California's current cap and trade program.[80]

Under California's Proposition 13, a new tax can only be imposed with a super majority in both the House and the Senate. The current cap and trade law was adopted without a super-majority, and therefore cannot lawfully impose a tax. The California Court of Appeal is considering, among other things, whether the existing cap and trade program is an illegal tax.[81] If it is invalid, one appellant has requested that all remaining allowances be distributed free of charge.[82]

On April 8, in an unusual move, the court asked the parties for further submissions on seven detailed questions, including what remedy it should grant if it rules that California cannot lawfully require emitters to buy allowances. Shortly afterwards, at their May 2016 auction, California and Quebec sold only 11 per cent of the allowances offered for sale, essentially all at the price floor.[83] Secondary market prices for allowances dropped below the price floor for several months.

The August 2016 auction results were a little better, but prices remained at the floor and about 65 per cent of allowances remained unsold.[84,85]

Under California law, the first allowances to sell in each auction are those that are consigned by California utilities. Unsold utility allowances automatically roll over and are offered for sale again in the next auction. About half of the utility allowances were sold at the August 2016 auction; all of the proceeds from those sales go directly to the utilities for the benefit of their ratepayers.[86]

The second group of allowances offered for sale at each auction are state allowances offered by the California Air Resources Board to fund the California Greenhouse Gas Reduction Account. None of these 2016 allowances sold in either May or August.[87] Since then, there have been some trades of allowances on the secondary market, at prices slightly above the legal floor price.

Whatever the Court of Appeal decides, the litigation is expected to go to the California Supreme Court, and to be decided in 2017 or 2018.

Legal Problem #3:
There is an even more serious barrier to California's cap and trade program continuing after 2020. The legal authority for California's current cap and trade program in its *Global Warming Solutions Act, 2006*, likely expires in 2020; the legislature has not yet decided whether to extend it.[88] According to California's legislative counsel, Proposition 26, adopted in 2010, means that California cannot extend cap and trade without a super-majority in both the House and the Senate, or a new electoral ballot initiative. The Governor has signaled his intention to offer such an initiative in November 2018.

Without a super-majority, the California legislature amended the *Global Warming Solutions Act* in August, 2016 to add an ambitious new climate target, a 40 per cent reduction target below 1990 by 2030. California is consulting with stakeholders about how to meet this ambitious target,[89] but the amendments did not authorize continuation of cap and trade after 2020.[90] The amendments also added a new requirement that California "prioritize… emission reduction rules and regulations that result in direct emission reductions". It is unclear whether this includes cap and trade.

For both of these reasons, Ontario needs to plan for the possibility of California ceasing to operate its cap and trade program, whether before or after linking begins.

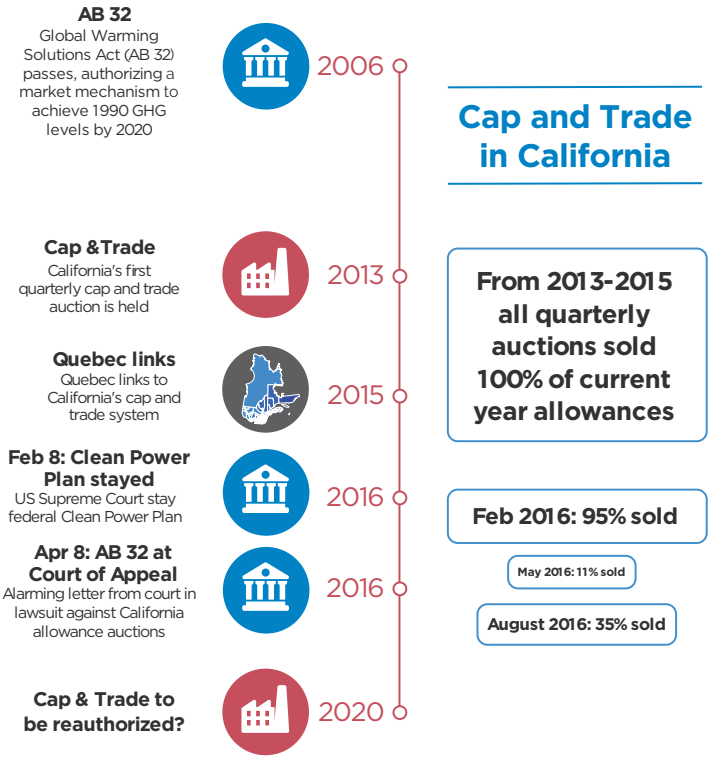


Figure 5: California litigation timeline

For a cap and trade program to result in emission reductions, it is vital that participants in the program expect the supply of allowances to drop and their price to rise. The expectation of future scarcity and higher prices drives companies to invest in reducing their own emissions. Low prices and legal uncertainty erode this expectation.

Figure 6: The price of California carbon allowances has dropped over time, in part due to the legal uncertainty of the cap and trade program.

Source: Climate Policy Initiative, California Carbon Dashboard, 2016

Recommendation: Ontario needs a contingency plan for the possibility that California's cap and trade program may not continue to operate in its present form, and/or may not be reauthorized after 2020.

Facilitating the purchase of inexpensive California allowances by Ontario emitters, instead of requiring more expensive emission reductions in Ontario, is the *intended* result of linking. Linking also can have *unintended* consequences. For example, the Ontario government must give up some policy flexibility and control. Policy and political changes in linked jurisdictions may not be favourable for Ontario. California is a much larger and more powerful jurisdiction. California and Quebec's programs have been in place longer than Ontario's and face different political, legal and economic pressures.

Financial drain?

Some economists are concerned that the asymmetries described above could lead to an ongoing financial drain out of Ontario to California, and to limited emission reductions here. Such a financial drain could possibly be reduced by the terms of the linking agreement.

More broadly, however, the cap and trade program as a whole, coupled with the Climate Change Action Plan, could reduce demand for imported petroleum and natural gas. In turn, this would reduce the amount of money leaving the province. Statistics Canada reports that in 2014, Ontario imported essentially all of its fossil fuels including approximately 20,590 ML crude oil, and 29,473 GL natural gas.[91] At commodity prices of $60/ barrel oil, and $3.50/mmBTU of gas (roughly the prices over the past year), this would represent an annual financial drain from Ontario of about $7.8 billion for oil and $3.6 billion for natural gas, a total of $11.4 billion a year. At these fuel prices, a 3 per cent reduction in the amount spent to import fossil fuels would more than offset allowance purchases from California of $300 million / year.

The effect of linking on revenues

As shown in chapter 5, the province is counting on, and already starting to spend from the $1.9 billion per year from the cap and trade proceeds it expects to earn.[92] The Climate Change Action Plan's implementation depends on these moneys, which may not materialize as predicted.

Ontario emitters will have several options for meeting their compliance obligations. Not all of them will produce revenue for the Greenhouse Gas Reduction Account (GGRA). Two illustrative examples are included in the end notes.[93]

Ontario emitters will have several options for meeting their compliance obligations. Not all of them will produce revenue for the GGRA.

4.2.7 Fraud, compliance and enforcement

Fraud, theft and non-compliance have to be controlled in any regulatory, tax or trading program. In its initial years, the European Union Emissions Trading System (EU ETS) dealt with various types of fraud, as well as allowance theft.[94] Subsequent emissions trading programs, including WCI programs such as Ontario's, have learned from this experience. Ontario's cap and trade program also benefits from Ontario's long experience as a securities regulator. Ontario's new *Climate Act* and cap and trade regulation[95] set out extensive compliance and enforcement mechanisms. Some of these were modelled on the *Ontario Securities Act*.[96]

A key question is whether the MOECC can effectively enforce the *Climate Act*. The *Climate Act* gives the MOECC extensive powers to investigate and inspect. Non-compliance will result in significant financial penalties: emission shortfalls at the end of a compliance period will require companies to submit an additional three allowances for every allowance they are short, which can also be converted to a debt owed to the government. The MOECC has substantial experience in enforcing environmental laws, but enforcing the *Climate Act* bears more resemblance to tax and securities enforcement.[97] The Ontario Securities Commission has a large enforcement branch, including a whistleblower hotline with monetary rewards, which the MOECC does not offer.[98]

The *Climate Act* prohibits market manipulation in the form of unauthorized transfers, holding on behalf of others, and insider trading, among others. To combat fraud, MOECC will collect very detailed registration and trading information from all participants in the program, will require third party verification of emissions, and will bar those with criminal records from participating. The MOECC advises that a Market Oversight Working group is being struck in fall 2016 and will include participants from multiple MOECC divisions, Ministry of Finance, Ontario Financing Authority, Ontario Securities Commission, and relevant police services. The working group is to develop information sharing protocols and operational procedures for dealing with instances of market fraud and malfeasance, and to coordinate enforcement activities across the various regulatory bodies.

4.3 Key Design Issues for Emitters

4.3.1 Market power

In Ontario, because most industries will receive mostly free allowances, significant market power will be in the hands of the small number of natural gas and petroleum products distributors[99] who are obliged to buy most of the program's non-free allowances in 2017 to 2020.[100] This problem could be exacerbated by the recent merger of Ontario's main natural gas distributors. Market concentration could affect market liquidity and the cost of allowances in the Ontario-only market, i.e., the effectiveness of Ontario's program in achieving its GHG reduction targets at least cost. The *Climate Act* tries to limit this risk through measures such as a price collar (intended to keep official allowance prices within a certain range), holding limits for individual entities, and a market monitor, who will be looking for evidence of non-competitive behaviour. Linking (see Chapter 4.2.6) is also proposed as a response to this risk.

4.3.2 Stability and predictability

Most companies need policy stability and predictability to justify substantial investments in large emissions reductions. Emitters typically have decision-making horizons that are longer than the cap and trade program's three and four-year compliance periods, especially because it typically takes one to two years to obtain MOECC approvals to upgrade equipment. Companies need to know about the program's features as far as possible into the future, especially the cap post-2020. Although the desired level of predictability may not always be possible, the province should provide as much clarity as it is able about its timeline for any modifications to the program, and how and when stakeholders can be involved.

Chapter 4. Cap and Trade

The United Kingdom (UK) *Climate Change Act 2008*, creates a much better framework than Ontario's for encouraging long-term private and public sector investment in emission reductions.[101] The UK Act has the same general emission reduction target as Ontario: an 80 per cent reduction below 1990 levels by 2050. However, instead of three or four-year compliance periods which are set with little notice, the UK sets legally binding five-year carbon budgets, which limit the UK's total GHG emissions for the five years. Government has to keep total economy-wide GHG emissions within that carbon budget, by whatever means it chooses.

Critically, each carbon budget must, by law, be approved twelve years in advance, based on a public recommendation from an independent and highly respected Committee on Climate Change.[102] The Committee consults broadly and assesses, by sector, what can be achieved to reduce emissions at least cost, taking account of available technologies and government policy. The government does not have to adopt the precise initiatives examined by the Committee, but has always found it politically feasible to adopt the recommended carbon budget.

This program limits political interference in the carbon budget, and gives both the public and private sector enough time and predictability to plan and invest in the necessary facilities and equipment. It also reduces cost, by allowing facility owners to plan now to replace high carbon capital assets as opportunities arise. A program of total carbon budgets also focuses attention on what really matters, cumulative emissions and not simply the emissions in a particular target year.

The first five carbon budgets, until 2032, have already been set in law, as shown in Table 2. The UK is currently in the second carbon budget period (2013-17). Meeting the fifth carbon budget (2028-32) will require that emissions be reduced by 57 per cent below 1990 levels.

Table 2: UK carbon budgets

Carbon budget	Carbon budget level ($MtCO_2e$)	Per cent reduction below base year
1st (2008-2012)	3,018	23
2nd (2013-2017)	2,782	29
3rd (2018-2022)	2,544	35
4th (2023-2027)	1,950	50
5th (2028-2032)	1,765, including emissions from international shipping	57[103]

Source: The UK Committee on Climate Change, website, *Carbon Budgets and targets*, accessed October 2016. www.theccc.org.uk/tackling-climate-change/reducing-carbon-emissions/carbon-budgets-and-targets/

If Ontario used this approach, a legally binding economy-wide carbon budget would be set well in advance, and the cap for covered emitters would decline within that budget. This would give both public and private emitters long term predictability, and encourage emission reduction investments with longer payback periods.

Recommendation: Ontario should follow the UK example and set legally binding carbon budgets well in advance, within which a cap and trade program would operate.

4.4 Key Design Issues for the Public

4.4.1 Cost and fairness

Cap and trade is *intended* to increase the cost of fossil fuels, so that people and organizations have an economic incentive to use less. This means that the public can expect to pay more for fossil fuels after January 1, 2017. The province estimates that, by 2020, the cap and trade program will increase the costs of home heating bills (due to the rise in natural gas cost) by an average of $5/month, and gasoline prices by 4.3 cents per litre.[104] As decided by the Ontario Energy Board, this additional cost will not be specifically disclosed on consumers' utility bills.[105]

Electricity prices may also rise slightly as a result of the program, as some natural gas generators may be able to pass on the slightly higher cost of natural gas, which was used to generate 10 per cent of Ontario's electricity in 2015. Any such increase may be offset by recently announced subsidies to electricity ratepayers, including a subsidy to the Global Adjustment announced in the Climate Change Action Plan,[106] which is analyzed in more detail in Chapter 6.

These increases are likely too small to lead to a major shift towards lower carbon lifestyles. However, they could be large enough to be a hardship for some lower-income people. The Ecofiscal Commission notes that the net impact on the least wealthy 20 per cent of Ontarians could be completely offset by household transfers equal to about 4 per cent of anticipated cap and trade revenues.[107] The ECO agrees that it would be fair and wise to fully compensate the poorest members of society for the extra cost of pricing carbon. Low-income families often contribute the least to GHG emissions, suffer the most from the adverse effects of climate change, and have the least ability to invest in emission reductions. However, the ECO does not consider this to be a legitimate use of cap and trade proceeds – see Chapter 5.

4.4.2 Accountability and transparency

The public will rightfully demand a very high degree of accountability and transparency on how the government manages the cap and trade program.

The government will provide some information, but long after the fact, such as reporting who has received free allowances 24 months later. It may be difficult for the program to earn public trust with such limited and late disclosure. The ECO would like to see more timely disclosure from the province on which entities received free allowances, how many they received, and a justification for why they received them.

The same concerns apply, but even more so, to how the government will collect and use the huge amount of new money that cap and trade may raise. Will the money be genuinely used to accelerate reductions of Ontario's GHG emissions? We look at this issue in Chapter 5.

4.5 Will Ontario Emissions Go Down?

Ontario's emissions may, but will not necessarily, go down as a result of cap and trade.

Most calculations show that the price of carbon in Canada has to be significantly higher than current levels in order to drive significant emission reductions. Third-party modelling commissioned by the Ontario government projects that cap and trade, by itself, will cause Ontario emitters to make 2.8 Mt of emission reductions by 2020, out of the predicted gap of 18.5 Mt between Business as Usual emissions and Ontario's 2020 target.[108] The estimate of 2.8 Mt by 2020 may be optimistic, since the model does not include any delays in obtaining MOECC approvals to upgrade or replace equipment. As indicated above, such approvals often take a year or two.

In order to achieve its emission reduction targets, the government has focused on the 9.8 Mt of reductions

that, it estimates, will be produced by its Action Plan in 2020. As shown in Chapter 6, the ECO has not seen credible evidence that the Action Plan will produce as many emission reductions as the government claims, or as quickly as it predicts. Even if the Action Plan were highly successful, a large gap would remain between Ontario's predicted emissions for 2020, and the 2020 target. This gap could be bridged by GHG reductions through Ontario offset credits and/or by purchasing California or Quebec allowances.

GHG emissions in Ontario are not capped by the number of Ontario allowances issued

Ontario emissions are not, in practice, limited by the number of allowances that Ontario distributes, for two main reasons:

- Some emitters, which the government estimates release ~31 Mt (or 18%) of Ontario GHG emissions, are not subject to cap and trade and do not require allowances for their emissions. This includes some entire sectors (such as agriculture and waste), and smaller companies in capped sectors. Their emissions could grow.
- By the time capped emitters must submit allowances to the government, i.e., in 2021, Ontario expects to be linked to the California and Quebec carbon market. If so, Ontario emitters will be able to meet their 2017-2020 obligations with Ontario emission allowances and with other instruments that are not subject to the Ontario allowance cap:
  - Ontario offset credits
  - CA/ Que offset credits
  - Ontario early reduction credits, and
  - CA/ Que allowances.

GHG emissions in Ontario are not capped by the number of Ontario allowances issued.

Understanding the relationship between allowances and emissions

To understand this conundrum, here is how Ontario emitters may comply with the *Climate Act*. For simplicity, this example focuses on the single year of 2020, instead of the entire compliance period 2017-2020.

Ontario's Business as Usual (BAU) emissions in 2020 are predicted to be 173.5 Mt. The *Climate Act* target is for a 15 per cent reduction, which means total, economy-wide emissions of 155 Mt by 2020.

31.1 Mt of these emissions are predicted to come from agriculture, waste and other sectors which are not covered directly by cap and trade, i.e. they are not required to submit allowances. 142.4 Mt of the BAU emissions would, without the *Climate Act*, come from covered sectors.

Each year, the government will distribute a certain number of allowances. The maximum number of allowances distributed, in 2020, will be 118.4 Mt, after setting aside 6.2 Mt for the strategic reserve. This leaves a gap of 24 Mt between the covered sectors' BAU emissions and the allowances to be distributed (free or by auction) in 2020 (see Figure 7).

ONTARIANS TAKING ACTION

The Maitland Valley Conservation Authority Carbon Footprint Initiative

Maitland Valley Conservation Authority partnered with five local companies and one municipality to develop a leadership team for the Carbon Footprint initiative. The Leadership Team is comprised of people who are recognized as leaders in their respective sectors and in the communities where their companies/municipality operate. All have developed carbon footprint strategies aimed at reducing their use of fossil fuels and planting trees to compensate for the fossil fuels that they do use.

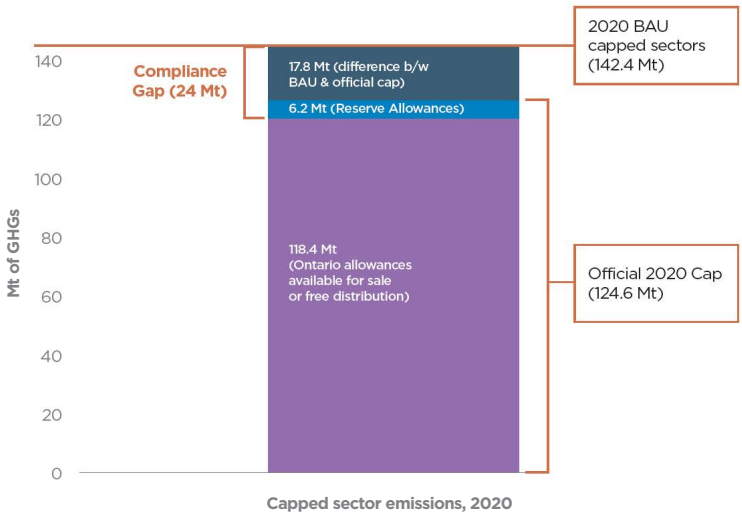


Figure 7: Cap and trade covered entity emissions in 2020, BAU vs. the cap. Though Ontario's official cap on allowances for 2020 is 124.6 Mt, because 6.2 Mt of allowances will be set aside for sale at about $40/tonne (a.k.a. the strategic reserve), our assumption is that these allowances will not be purchased; therefore, we have added 6.2 Mt to the Compliance Gap.

Source: Adapted from: Dave Sawyer, Jotham Peters, and Seton Stiebert, EnviroEconomics, presentation, *Impact Modelling and Analysis of Ontario's Proposed Cap and Trade Program,* p.10, May 17, 2016.

Emitters may bridge this gap, i.e. meet their compliance obligations, in one or more of the following ways:

- Reduce their emissions more than they had previously predicted;
- Claim early reduction credits;
- Purchase offsets, for up to 8% of their emissions;
- Purchase California/Quebec allowances, and/or
- Theoretically, purchase allowances from the strategic reserve at $40/tonne.

The government has not proposed any limit on the total number of California and Quebec allowances and offsets that may be used in Ontario. Since a large number of inexpensive allowances are available from California, Ontario's cap and trade program does not, in practice, limit Ontario's GHG emissions from 2017 to 2020.

Table 3: Example of Allowances and compliance gap options for 2020

BAU emissions in 2020	173.5 Mt	
BAU emissions of non-capped sectors (assuming no growth in emissions)	31.1 Mt	
BAU emissions of capped sectors		= 142.4 Mt
Cap on allowances	124.6 Mt	
Allowances reserved for strategic reserve (i.e. for sale above $40/tonne)	6.2 Mt	
Maximum number of allowances remaining (to be distributed free or sold at auction in 2020)		= 118.4 Mt
Compliance gap, i.e., difference between BAU emissions of capped sectors and number of allowances remaining		= 24 Mt
Maximum possible offsets (8% of capped sectors' BAU emissions)	11.4 Mt	
Predicted emissions reductions from cap and trade itself	2.8 Mt	
Remaining gap, i.e., the amount of emissions for which emitters must submit compliance instruments (these may be early reduction credits, additional emission reductions by capped sectors or fuel users, perhaps as a result of the Climate Change Action Plan, and/or California or Quebec allowances)		= 9.8 Mt

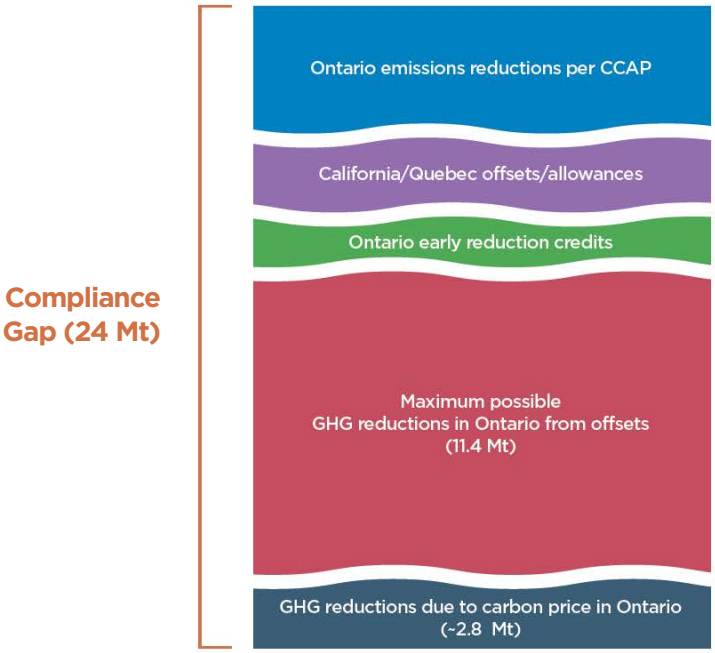


Figure 8: How emitters can meet the compliance gap (2020). The 2.8 Mt predicted GHG reductions due to the carbon price in Ontario is an estimate from industry, which assumes no approvals delays. The number of offsets purchased in Ontario will be affected by several factors, including how quickly offset protocols are finalized, how quickly projects are developed and registered, and the price of Ontario offset credits as compared to those available from other jurisdictions.

Source: Adapted from: Dave Sawyer, Jotham Peters, and Seton Stiebert, EnviroEconomics, summary report, *Impact Modelling and Analysis of Ontario's Proposed Cap and Trade Program*, p.10, May 27, 2016.

As shown above, for the 2017-2020 compliance period, Ontario emitters are expected to have essentially unlimited access to inexpensive California allowances, at close to the floor price. If they buy such allowances instead of reducing emissions in Ontario, Ontario emissions may not go down much, and there could be a substantial capital outflow to California.

The key to maximizing Ontario reductions and to minimizing this capital outflow is to find cost-effective reductions in Ontario's uncapped sectors. This is the objective of some portions of the Action Plan, and also of Ontario's proposed system of offset credits. As in California, there should be many Ontario offset opportunities that are less expensive than the floor price for allowances. The ECO is encouraged to learn that the government is currently developing offset protocols. While it is important that the offset protocols be released in a timely basis, the overriding consideration must to ensure that any resulting offset credits are high-quality in nature.

Recommendation: The government must prioritize the approval of offset protocols to enable the creation of a timely and ample supply of high-quality Ontario offsets.

4.6 Recommendations

Cap and trade design is hard to get perfect the first time. The Ontario government has made a reasonable, good-faith effort to address the major known risks of cap and trade design, but the ECO expects that some revisions will prove necessary.

A key feature of the current design is that, for the 2017-2020 compliance period, industrial emitters will receive mostly free allowances, in order to combat carbon leakage.

Recommendation: Ontario should be more transparent about which entities are receiving free allowances, and why.

Because of the significant legal doubts about the future of California's cap and trade program, Ontario must be prepared for the possibility that California's cap and trade program may not continue in its current form.

Recommendation: Ontario needs a contingency plan for the possibility that California's cap and trade program may not continue to operate in its present form, and/or may not be reauthorized after 2020.

In addition, Ontario offsets are key to minimize the outflow of capital from the province, and to maximize domestic emission reductions.

Recommendation: The government must prioritize the approval of offset protocols to enable the creation of a timely and ample supply of high-quality Ontario offsets.

Ontario's program does not provide Ontario emitters with adequate predictability to encourage long-term investments in GHG reductions.

Recommendation: Ontario should follow the UK example and set legally binding carbon budgets well in advance, within which a cap and trade program would operate.

ONTARIANS TAKING ACTION

Chatham-Area Businesses Collaborating to Reduce Emissions

Greenfield Specialty Alcohols in Chatham is an ethanol plant that uses corn as a feedstock to produce 200,000 million litres of ethanol a year. In producing ethanol, carbon dioxide and waste heat are generated. Across the street from Greenfield is Truly Green Farms, where a 90-acre hydroponic tomato greenhouse facility is being constructed in phases. Given that tomatoes thrive in high carbon dioxide conditions, under the first phase Truly Green is using the CO_2 from Greenfield to grow its tomatoes. Under the next phase of the project, Truly Green plans to use the excess waste heat from Greenfield to heat its greenhouses. At present, Truly Green runs two 1.25 megawatt natural gas boilers; by using the waste heat, it will not only provide an estimated 85% of Truly Green's heating needs, it will reduce carbon dioxide emissions by 16,000 tonnes per year.

Endnotes

[1] O. Reg. 144/16 (The Cap and Trade Program), made under the *Climate Change Mitigation and Low-carbon Economy Act*.

[2] O. Reg. 143/16 (Quantification, Reporting And Verification of Greenhouse Gas Emissions), made under the *Climate Change Mitigation and Low-carbon Economy Act, 2016.*

[3] Facilities with annual emissions over 25,000 tonnes of CO_2e, and those that opt in to the program.

[4] Center for Climate and Energy Solutions, website, *Climate Change 101: Cap and Trade*, accessed August 2016. www.c2es.org/docUploads/climate101-captrade.pdf

[5] Reached in Paris at the 21st session of the Conference of the Parties to the Framework Convention on Climate Change in December 2015.

[6] World Bank Group and Ecofys, report, *Carbon Pricing Watch 2016: An advance brief from the State and Trends of Carbon Pricing 2016 report*, p.2, 2016. www.ecofys.com/en/project/state-and-trends-of-carbon-pricing/

[7] Richard Schmalensee and Robert Stavins, Harvard Kennedy School, Faculty Research Working Paper Series, *Lessons Learned from Three Decades of Experience with Cap-and-Trade*, November 2015. research.hks.harvard.edu/publications/getFile.aspx?Id=1278

[8] Bataille, C. et al., report, *Pathways to deep decarbonization in Canada*, p.37, 2015. deepdecarbonization.org/wp-content/uploads/2015/09/DDPP_CAN.pdf

[9] Government of Ontario, *Climate Change Strategy*, November 2015. www.ontario.ca/page/climate-change-strategy

[10] Government of Ontario, *Climate Change Action Plan*, June 2016. www.ontario.ca/page/climate-change-action-plan

[11] Government of Ontario, website, *Co-ordinated Land Use Planning Review*, accessed August 2016. www.mah.gov.on.ca/Page10882.aspx

[12] Office of the Premier, news release, 2015 Québec-Ontario *Joint Meeting of Cabinet Ministers: Progress on Shared Priorities*, September 11, 2015. news.ontario.ca/opo/en/2015/09/2015-quebec-ontario-joint-meeting-of-cabinet-ministers-progress-on-shared-priorities.html

[13] Office of the Premier, news release, Ontario, Québec and Manitoba Form a Dynamic Alliance to Fight Climate Change: New MOU Intends to Link Cap and Trade Programs, Increase Joint Initiatives, December 7, 2015. news.ontario.ca/opo/en/2015/12/ontario-quebec-and-manitoba-form-a-dynamic-alliance-to-fight-climate-change.html

[14] Government of Ontario, news release, *Ontario Working with Quebec and Mexico to Advance Carbon Markets*, August 31, 2016. news.ontario.ca/opo/en/2016/08/ontario-working-with-quebec-and-mexico-to-advance-carbon-markets.html

[15] Government of Ontario, website, *Climate Summit of the Americas* retrospective, accessed October 2016. www.ontario.ca/page/climate-summit-americas-retrospective

[16] Under 2 MOU, report, *UNDER 2 MOU – Final Appendix*, 2015. under2mou.org/wp-content/uploads/2015/05/Ontario-appendix.pdf

[17] Some facilities with emissions between 10,000 and 25,000 tonnes of CO_2e can opt into the program. See Appendix A, available online at eco.on.ca.

[18] Dave Sawyer, Jotham Peters, and Seton Stiebert, EnviroEconomics, summary report, *Impact Modelling and Analysis of Ontario's Proposed Cap and Trade Program*, p.2, May 27, 2016. drive.google.com/file/d/0B9FT5KrVwYmwZHV2M1RZbnZmUGM/view

[19] Customers emitting 25,000 tonnes or more of CO_2e are regulated market participants, and must provide their own verified annual emission reporting to the government, and submit their own allowances. The cap and trade regulation also permits entities between 10,000 and 25,000 tonnes of CO_2e to participate voluntarily in the program (subject to the same reporting requirement and to the same obligation to submit their own allowances).

[20] Other gas-fired electricity generators are covered upstream at the fuel distributor level.

[21] ICF International, presentation to the Environmental Commissioner of Ontario, *Ontario Cap and Trade: Overview and Allowance Price Outlook*, May 4, 2016.

[22] For both categories, participation in the program also depends on whether a facility's emissions exceed 25,000 tonnes per year, or the facility has opted in with emissions between 10,000 to 25,000 tonnes.

[23] ICF International, presentation to the Environmental Commissioner of Ontario, *Ontario Cap and Trade: Overview and Allowance Price Outlook*, May 4, 2016.

[24] Dave Sawyer, Jotham Peters, and Seton Stiebert, EnviroEconomics, summary report, *Impact Modelling and Analysis of Ontario's Proposed Cap and Trade Program*, May 27, 2016. drive.google.com/file/d/0B9FT5KrVwYmwZHV2M1RZbnZmUGM/view

[25] *The Waste Free Ontario Act, 2016* for example, may lead to more diversion of organics from landfills.

[26] There are other possible methods, including doing a detailed bottom up analysis. (See Partnership for Market Readiness, World Bank; International Carbon Action Partnership, report, *Emissions Trading in Practice: A Handbook on Design and Implementation*, p.56, 2016. openknowledge.worldbank.org/handle/10986/23874)

[27] As reflected by the number of allowances that the government will issue each year, dropping from 142 Mt to ~124 Mt by 2020.

[28] On combustion emissions only. There is no cap decline on process emissions until at least 2020.

[29] California Air Resources Board, report, *Overview of Arb: Emissions Trading Program*, 2015. www.arb.ca.gov/cc/capandtrade/guidance/cap_trade_overview.pdf

[30] Quebec Ministry of Sustainable Development, Environment and the Fight against Climate Change, report, *Québec's cap-and-trade program - in brief*, 2013. www.mddelcc.gouv.qc.ca/changements/carbone/documents-spede/in-brief.pdf

[31] Ontario Ministry of the Environment and Climate Change, information provided to the ECO in response to ECO inquiry, September 29, 2016.

[32] GHG emission reductions associated with the capture and destruction of methane that would otherwise be vented into the atmosphere as a result of mining operations at active underground and surface coal and trona mines and abandoned underground coal mines.

[33] This protocol provides guidance to quantify, report, and verify GHG emission reductions associated with installing a LFG collection and destruction or treatment program at landfill operations.

[34] This protocol quantifies GHG emission reductions associated with the destruction of high global warming potential ODS destroyed within Canada or the US that would have otherwise been released to the atmosphere. This project category includes ODS used in both foam blowing agent and in refrigeration or air conditioning equipment.

[35] No details provided.

[36] Addresses GHG emission reductions associated with management of manure and enteric fermentation on livestock operations including, but not limited to, those associated with the installation of manure biogas control

programs, other manure management practices and livestock feeding practices.

[37] For GHG reduction projects that divert and anaerobically digest eligible organic waste and/or wastewater streams that otherwise would have gone to uncontrolled anaerobic storage, treatment and disposal programs, such as solid waste landfills or on-site anaerobic wastewater treatment facilities. The protocol should also address the co-digestion of eligible organic waste streams with livestock manure. If considered feasible and advantageous, the livestock protocol and the organic waste digestion protocol may be combined in a manner that allows Project Developers to apply relevant components of the protocol to a project.

[38] For reductions from projects that avoid methane emissions to the atmosphere through the diversion and composting of municipal food waste and food-soiled paper waste that would otherwise have been sent to a landfill. This may include the incineration of organic waste to achieve the same objective.

[39] This protocol provides guidance for the development of forest carbon projects. The protocol addresses emissions removals and reductions associated with reforestation, improved forest management, and avoided conversion projects. It will also address (to the extent possible), emissions removals and reductions associated with long-lived forest products.

[40] This protocol addresses eligibility and accounting requirements for the calculation of emissions removals and reductions associated with afforestation projects. If considered feasible and advantageous, the Forest Project protocol and the Afforestation protocol may be combined in a manner that allows Project Developers to apply relevant components of the protocol to a project.

[41] This protocol should include urban tree planting and urban forest management. The protocol provides for emissions removals and reductions from tree planting, maintenance, and/or improved management activities implemented to increase carbon storage through trees.

[42] This protocol addresses emissions removals and reductions associated with avoided conversion of grasslands to croplands.

[43] This protocol specifically quantifies GHG emissions reductions from new carbon stored annually in agricultural soil, and from lower N_2O emissions from soils under no-till management.

[44] This protocol quantifies GHG emission reductions associated with the conversion of commercial and industrial cooling programs using synthetic refrigerants (ODS and others) to newer programs using carbon dioxide, glycol or other refrigerants having little or no impact on global warming

[45] Matthew Ranson and Robert N. Stavins, periodical (Climate Policy), *Linkage of Greenhouse Gas Emissions Trading Programs: Learning from Experience*, pp.1-17, 2015.

[46] The total cap decline is just over 4% 2017-2020. Because process emissions of the large final emitters are not required to decline, the number of free allowances that they receive for their combustion emissions must decline faster, i.e., 4.57%.

[47] In addition, the cap and trade program is somewhat challenging and costly for Ontario emitters to navigate, including understanding their obligations and executing strategies to participate in the market.

[48] Sustainable Prosperity, policy brief, *The Competitiveness of a Trading Nation: Carbon Leakage and Canadian Climate Policy*, March 2011. www.sustainableprosperity.ca/content/competitiveness-trading-nation

[49] Dave Sawyer, Jotham Peters, and Seton Stiebert, EnviroEconomics, summary report, *Impact Modelling and Analysis of Ontario's Proposed Cap and Trade Program*, May 27, 2016. drive.google.com/file/d/0B9FT5KrVwYmwZHV2M1RZbnZmUGM/view

[50] Ecofiscal Commission, report, *Provincial Carbon Pricing & Competitiveness Pressures*, p.14, November 2015. /ecofiscal.ca/wp-content/uploads/2015/11/Ecofiscal-Commission-Carbon-Pricing-Competitiveness-Report-November-2015.pdf

[51] Amicus brief to the California Court of Appeal of *Economists, Dallas Burtraw et al.*, May 15, 2015. www.edf.org/sites/default/files/content/economistamicusbrief5_15.pdf

[52] While the details are not yet available, some insight is provided through: California Air Resources Board, *Linkage Readiness Report*, November 1, 2013. www.arb.ca.gov/cc/capandtrade/linkage/arb_linkage_readiness_report.pdf

[53] California can only link with Ontario after the Governor of California makes four findings about similar design features and minimum stringency. (Gov. Code, § 12894(f).) Under SB 1018, the Governor must find that:

• The linked program has adopted program requirements for greenhouse gas reductions; including, but not limited to, requirements for offsets; that are equivalent to or stricter than those required by AB 32;

• The State of California is able to enforce AB 32 and related statutes against any entity subject to regulation under those statutes, and against any entity located within the linking jurisdiction to the maximum extent permitted under the United States and California Constitutions;

• The proposed linkage provides for enforcement of applicable laws by the linking jurisdiction of program requirements that are equivalent to or stricter than those required by AB 32; and

• The proposed linkage shall not impose any significant liability on the State or any State agency for any failure associated with the linkage.

Governor Brown has not yet made such findings for Ontario.

[54] Government of Ontario, news release, *Ontario Working with Québec and Mexico to Advance Carbon Markets*, September 2, 2016. news.ontario.ca/opo/en/2016/08/ontario-working-with-quebec-and-mexico-to-advance-carbon-markets.html

[55] Gross domestic product, expenditure-based, per Statistics Canada. www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/econ15-eng.htm

[56] *Ibid.*

[57] California Legislative Analyst's Office, blog, *2014 GDP: California Ranks 7th or 8th in the World*, July 1, 205. www.lao.ca.gov/LAOEconTax/Article/Detail/90

[58] Converted at the exchange rate of $1.32, as posted by the Bank of Canada, October 5, 2016.

[59] Government of Quebec, *Gazette Officielle Du Québec*, Vol. 144, No. 51, December 19, 2012. www2.publicationsduquebec.gouv.qc.ca/dynamicSearch/telecharge.php?type=1&file=2389.PDF

[60] California Air Resources Board, regulation, *Final Regulation Order: Article 5: California Cap On Greenhouse Gas Emissions and Market-Based Compliance Mechanisms*, p.100, 2016. www.arb.ca.gov/cc/capandtrade/capandtrade/unofficial_ct_030116.pdf

[61] Ontario's emissions total as reported in Canada's National Inventory Report.

[62] United Nations Framework Convention on Climate Change (UNFCCC), FCCC/CP/2015/L.9, *Adoption of the Paris Agreement*, Article 6, December 12, 2015. unfccc.int/resource/docs/2015/cop21/eng/l09.pdf. Canada and other jurisdictions may also use Internationally Transferred Mitigation Outcomes (ITMOs) to comply with their Paris Agreement commitments.

[63] See, for example, Toronto Public Health, report, *Health Benefits of a Low-Carbon Future*, July 2016.

[64] A further purpose of linking is to create new markets for Ontario emitters to sell any surplus allowances they may hold. Sustainable Prosperity, report,

Gains from (Cap and) Trade: Linking Quebec's and California's Carbon Trading Programs, April 2015. www.sustainableprosperity.ca/sites/default/files/publications/files/Quebec%20California%20Issue%20Summary%20April%202014.pdf; EcoFiscal Commission, report, *The Way Forward: A Practical Approach to Reducing Canada's Greenhouse Gas Emissions*, April 2015. ecofiscal.ca/wp-content/uploads/2015/04/Ecofiscal-Commission-Report-The-Way-Forward-April-2015.pdf. (A further purpose of linking is to create new markets for Ontario emitters to sell any surplus allowances)

[65] Sustainable Prosperity, report, Ontario *Consultation on Greenhouse Gas Emissions Reductions Program Design 2013*, April 2013. www.sustainableprosperity.ca/sites/default/files/publications/files/Ontario%20Consultation%20on%20Greenhouse%20Gas%20Emissions%20Reductions%20Program%20Design.pdf

[66] Government of Ontario, website, *How cap and trade works*, accessed October 2016. www.ontario.ca/page/how-cap-and-trade-works

[67] Dave Sawyer, Jotham Peters, and Seton Stiebert, EnviroEconomics, summary report, *Impact Modelling and Analysis of Ontario's Proposed Cap and Trade Program*, May 27, 2016. drive.google.com/file/d/0B9FT5KrVwYmwZHV2M1RZbnZmUGM/view

[68] Institute for Competitiveness and Prosperity, report, *Towards a Low-Carbon Economy: The costs and benefits of cap-and-trade*, April 2016. www.competeprosper.ca/work/working_papers/working_paper_25. (Note: though these modelling exercises were independent, one of the same consultants was used (Navius Research).)

[69] Matthew Ranson and Robert N. Stavins, periodical (Climate Policy), *Linkage of Greenhouse Gas Emissions Trading Programs: Learning from Experience*, pp.1-17, 2015.

[70] Baran Doda and Luca Taschini, Grantham Research Institute on Climate Change and the Environment Working Paper No. 208, and Centre for Climate Change Economics and Policy Working Paper No. 234, *Carbon dating: When is it beneficial to link ETSs?* September 2015. www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2015/09/Working-Paper-208-Doda-and-Taschini.pdf

[71] Dave Sawyer, Jotham Peters, and Seton Stiebert, EnviroEconomics, summary report, *Impact Modelling and Analysis of Ontario's Proposed Cap and Trade Program*, May 27, 2016. drive.google.com/file/d/0B9FT5KrVwYmwZHV2M1RZbnZmUGM/view (This model did not assess the effects of the Action Plan as discussed in Chapter 6.)

[72] Institute for Competitiveness and Prosperity, working paper, *Towards a Low-Carbon Economy: The costs and benefits of cap-and-trade*, p.29, April 2016. www.competeprosper.ca/work/working_papers/working_paper_25

[73] ICF International, presentation to the Environmental Commissioner of Ontario, *Ontario Cap and Trade: Overview and Allowance Price Outlook*, May 4, 2016.

[74] Supplemental appellate brief by the California Air Resources Board to the California Court of Appeal, *California Chamber of Commerce et al. v. California Air Resources Board et al. Case No. C075930*, and *Morning Star Packing Company et al. v. California Air Resources Board et al. Case No. C075954*, p.8, May 23, 2016. www.edf.org/sites/default/files/content/arbsuppbrief.pdf

[75] There has been some controversy about whether the California cap has actually reduced GHG emissions from out-of-state coal-fired electricity, or merely created "resource shuffling" whereby coal-fired electricity formerly sold into California is now sold to other U.S. states which do not cap GHG gas emissions. The California Air Resources Board has rules to prohibit resource shuffling, and has proposed further amendments to them. (California Air Resources Board, staff report, *Proposed Amendments to the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms Regulation*, p.156, August 2, 2016. www.arb.ca.gov/regact/2016/capandtrade16/appa.pdf)

[76] The CARB has proposed to move unsold allowances to the Allowance Price Containment Reserve, if they remain unsold for two years. This would dramatically increase their price, and therefore could eliminate the overhang. (California Air Resources Board, staff report, *Proposed Amendments to the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms Regulation*, p.241, August 2, 2016. www.arb.ca.gov/regact/2016/capandtrade16/appa.pdf)

[77] Auditor General of Québec, report to the National Assembly for 2016-2017, *Report of the Sustainable Development Commissioner*, Chapter 4: Carbon Market: Description and Issues (English Translation), p.31, Spring 2016. www.vgq.gouv.qc.ca/fr/fr_publications/fr_rapport-annuel/fr_2016-2017-CDD/fr_Rapport2016-2017-CDD-Chap04.pdf

[78] ICF International, presentation to the Environmental Commissioner of Ontario, *Ontario Cap and Trade: Overview and Allowance Price Outlook*, May 4, 2016.

[79] 60,415,951 in May 2016 and 56,257,299 in August 2016 for a total of 116,673,250.

[80] California Chambers of Commerce and Morning Star Packing Company separately appealed the Sacramento County Superior Court's decision (Case Nos. 34201280001313 and 34201280001464) to uphold the California Air Resource Board's (CARB) authority to generate revenues through the sale of greenhouse gas emissions allowances through a cap-and-trade auction program. The California Court of Appeal, Third Appellate District, is carefully scrutinizing the issues on appeal.

The appellate court will decide whether the trial court correctly upheld CARB's regulations on its sale of carbon allowances through the cap-and-trade auction program. Appellants challenge the legality of the regulations on three grounds:

(1) that the auction exceeds the authority granted to CARB by the state's climate change initiative (AB 32);

(2) that the auction constitutes an invalid regulatory fee under *Sinclair Paint Co. v. State Board of Equalization*, 15 Cal.4th 866 (1997); and

(3) that revenue from the auction sales results in an unconstitutional tax. (For a brief overview of the case see: Amy Quinton, Capradio.org, *California Appeals Court Questions Don't Bode Well for Cap-And-Trade*, April 18, 2016. www.capradio.org/articles/2016/04/18/california-appeals-court-questions-dont-bode-well-for-cap-and-trade/)

[81] All briefs in the case are posted at: www.edf.org/climate/california-cap-and-trade-auction-legal-resources

[82] Another issue in the lawsuit is that the California law's express purpose is to reduce California's emissions to 1990 levels by 2020. Much of the auction money is being spent on projects that will reduce emissions later than 2020. For example, 25% of the auction revenues are being spent on a bullet train, whose construction entails substantial greenhouse gas emissions. The train is not expected to cause a net reduction in emissions until after 2020, since it will not start to operate until at least 2022. (See: California Legislative Analyst's Office, presentation to Senate Transportation and Housing Committee, *Funding for the High-Speed Rail Project*, March 27, 2014. www.lao.ca.gov/handouts/transportation/2014/Funding-HSRA-032714.pdf)

[83] Québec, Ministry of Sustainable Development, Environment and the Fight against *Climate Change, report, California Cap-and-Trade Program and Québec Cap-and-Trade Program May 2016 Joint Auction #7 Summary Results Report*, May 2016. www.mddelcc.gouv.qc.ca/changements/carbone/ventes-encheres/resultats-vente20160518-en.pdf

[84] Québec, Ministry of Sustainable Development, Environment and the Fight against Climate Change, report, *California Cap-and-Trade Program and Québec Cap-and-Trade Program August 2016 Joint Auction #8 Summary Results Report*, August 2016. www.mddelcc.gouv.qc.ca/changements/carbone/ventes-encheres/2016-08-16/resultats-en.pdf

[85] Chris Megerian and Ralph Vartabedian, Los Angeles Times, *California's cap-and-trade program faces daunting hurdles to avoid collapse*, June 14, 2016. www.latimes.com/politics/la-pol-sac-climate-change-challenges-20160614-snap-story.html

[86] California Air Resources Board, report, *California Cap-and-Trade Program: August 2016 Joint Auction #8: California Post Joint Auction Public Proceeds Report*, August 2016. www.arb.ca.gov/cc/capandtrade/auction/auction.htm#auction

[87] The Account received only $8,387,909.54 from the August 2016 auction, and only because buyers took 7% of the 2019 allowances. Out of the 35,610,823 vintage 2016 allowances that the California Air Resources Board offered for sale, not a single one was purchased. In the previous year, the California GGRA had received $457,283,625 from each quarterly auction.

[88] Anshu Siripurapu, The Sacramento Bee, *California Assembly approves climate change law*, August 23, 2016. www.sacbee.com/news/politics-government/capitol-alert/article97383292.html

[89] California Air Resources Board, report, *Preliminary Draft Proposed Regulation Order and Staff Report*, July 2016. www.arb.ca.gov/cc/capandtrade/draft-ct-reg_071216.pdf; Debra Kahn, Environment and Energy Publishing, *State releases plan to extend cap and trade through 2050*, July 13, 2016. www.eenews.net/stories/1060040202

[90] SB 32, Chapter 249, *California Global Warming Solutions Act 2006: emissions limit*; and AB 197, Chapter 250 , *State Air Resources Board: greenhouse gases: regulations, 2016*. www.legislature.ca.gov/port-bilinfo.html

[91] Statistics Canada, *Report on Energy Supply and Demand in Canada, 2014 Preliminary*, Table 1-8 (net imports = "imports" + "inter-regional transfers" - "exports").

[92] Ministry of Finance, budget papers, *Jobs for Today and Tomorrow: 2016 Ontario Budget*, p.29, 2016. www.fin.gov.on.ca/en/budget/ontariobudgets/2016/papers_all.pdf

[93] **Example 1: LFE, no GHG reductions, proportional free allowances.**

Assume:

• GHG emissions steady at 100,000 tonnes of GHG/ year (0.1Mt)) (i.e. no emission reductions)

• Total allowances required for 2017-2020 compliance period, to be turned in in 2021, (no annual compliance obligation): 400,000 allowances

• Free allowances to be issued by ON govt 2017-2020: assume 375,176 allowances (proportional decrease)

• Allowances / credits needed for 2017-2020: 24,824, if GHG emissions are not reduced

• Maximum permitted offset credits: 32,000

• Cost at floor price ($12.86): $319,237

• Options for obtaining allowances / credits:

What	Where	Proceeds to GGRA	Limits	Supply available?	GHG reductions in ON 2017-2020?
Offset credits	Ontario	$0	32,000	Not yet	yes
Offset credits	CA/ Que	$0		Yes, in CA/ Que. Officially available in ON starting in 2018	no
Early reduction credits	Ontario	$0	none	Not yet	no
Secondary allowance market	ON	$0	none	Not yet	Contributes to market signal for future reductions
Secondary allowance market	CA/ Que	$0	none	Yes, in CA/ Que. Officially available in ON starting in 2018	No
Gov't auction	ON	Auction clearing price (minimum is floor price)	ON gov't cap on allowance sales	Yes	Contributes to market signal for future reductions, helps to fund GGRA
Gov't auction	CA/ Que/ ON	Ontario's share of auction clearing price (minimum is floor price)	For practical purposes, none, because CA/ Que allowance cap is very large, and market is currently saturated	Expected in 2018	Slight contribution to market signal for future reductions, and to GGRA

Conclusion: GGRA may receive no revenue, emission reductions during the compliance period are uncertain

Example 2: Fuel distributor, no GHG reductions, no free allowances

Assume:

• GHG emissions steady at 100,000 tonnes of GHG/ year (0.1Mt)) (i.e. no emission reductions)

• Total allowances required for 2017-2020 compliance period, to be turned in in 2021, (no annual compliance obligation): 400,000 allowances

• Allowances / credits needed for 2017-2020: 400,000

• Maximum permitted offset credits: 32,000

• Cost at floor price ($12.86): $5,144,000

• Options for obtaining allowances / credits:

What	Where	Proceeds to GGRA	Limits	Supply available?	GHG reductions in ON 2017-2020?
Offset credits	Ontario	$0	32,000	Not yet	yes
Offset credits	CA/ Que	$0		Yes, in CA/ Que. Officially available in ON starting in 2018	no
Early reduction credits	Ontario	$0	none	Not yet	no
Secondary allowance market	ON	$0	none	Not yet	Contributes to market signal for future reductions
Secondary allowance market	CA/ Que	$0	none	Yes, in CA/ Que. Officially available in ON starting in 2018	No
Gov't auction	ON	Auction clearing price (minimum is floor price)	ON gov't cap on allowance sales	Yes	Contributes to market signal for future reductions, helps to fund GGRA
Gov't auction	CA/ Que/ ON	Ontario's share of auction clearing price (minimum is floor price)	For practical purposes, none, because CA/ Que allowance cap is very large, and market is currently saturated	Expected in 2018	Slight contribution to market signal for future reductions, and to GGRA

Conclusion: Revenue to GGRA and ON emission reductions 2017-2020 are difficult to predict.

[94] European Court of Auditors, report, *The integrity and implementation of the EU ETS, 2015*. www.eca.europa.eu/Lists/ECADocuments/SR15_06/SR15_06_EN.pdf

[95] O. Reg. 144/16 (The Cap and Trade Program) made under *Climate Change Mitigation and Low-carbon Economy Act, 2016*.

[96] Ontario Ministry of Environment and Climate Change, briefing to the ECO, February 26, 2016.

[97] Environmental Commissioner of Ontario, 2013/2014 Annual Report, *Managing New Challenges*, p.111, 2014.

[98] Ontario Securities Commission, news release, *OSC Announces Office of the Whistleblower Launch Date and Appoints Chief*, June 16, 2016. www.osc.gov.on.ca/en/NewsEvents_nr_20160616_osc-announces-whistleblower-launch-date-appoints-chief.htm

[99] University of Toronto's Environmental Finance Advisory Committee, *Submission to EBR Registry Number 012-6844*, March 24, 2016.

[100] ICF International, presentation to the Environmental Commissioner of Ontario, *Ontario Cap and Trade: Overview and Allowance Price Outlook*, May 4, 2016.

[101] Climate & Us, website, *What is the Climate Change Act 2008?*, accessed October 2016. climateandus.com/climate_action/what_is_climate-change-act-2008

[102] www.theccc.org.uk/

[103] Committee on Climate Change, report presented to the UK Secretary of State pursuant to s.34 of the *Climate Change Act 2008, The fifth carbon budget – The next step towards a low-carbon economy*, November 2015. www.theccc.org.uk/publication/the-fifth-carbon-budget-the-next-step-towards-a-low-carbon-economy/

[104] Ministry of Finance, budget papers, *Jobs for Today and Tomorrow: 2016 Ontario Budget*, p.27, 2016. www.fin.gov.on.ca/en/budget/ontariobudgets/2016/papers_all.pdf

[105] Ontario Energy Board, letter to all participants in EB-2015-0363, *Cap and Trade Framework for Natural Gas Utilities –Early Determination regarding Billing of Cap and Trade Related Costs and Customer Outreach - File No.: EB-2015-0363*, July 28, 2016. www.ontarioenergyboard.ca/oeb/_Documents/EB-2015-0363/OEB_Determination_Billing_Outreach_20160728.pdf

[106] Geoff Zachodne, QP Briefing, article, *Cap and trade likely to cause higher electricity prices, power producers say*, May 12, 2016; Ontario Government, speech, *Speech from the Throne*, September 12, 2016. news.ontario.ca/opo/en/2016/09/speech-from-the-throne.html; Ontario government, backgrounder, *Keeping Clean, Reliable Electricity Affordable and Lowering People's Bills*, September 12, 2016. news.ontario.ca/opo/en/2016/09/keeping-clean-reliable-electricity-affordable-and-lowering-peoples-bills.html

[107] Ecofiscal Commission, report, *Choose Wisely: Options and Trade-offs in Recycling Carbon Pricing Revenues*, p.19, April 2016. ecofiscal.ca/wp-content/uploads/2016/04/Ecofiscal-Commission-Choose-Wisely-Carbon-Pricing-Revenue-Recycling-Report-April-2016.pdf

[108] Dave Sawyer, Jotham Peters, and Seton Stiebert, EnviroEconomics, summary report, *Impact Modelling and Analysis of Ontario's Proposed Cap and Trade Program*, May 27, 2016. drive.google.com/file/d/0B9FT5KrVwYmwZHV2M1RZbnZmUGM/view

Cap and trade is expected to produce additional emission reductions after 2020, although no estimates have been released. The tighter the supply of allowances, the higher the price will be. The higher the price, the more reductions they will produce.

Chapter 5

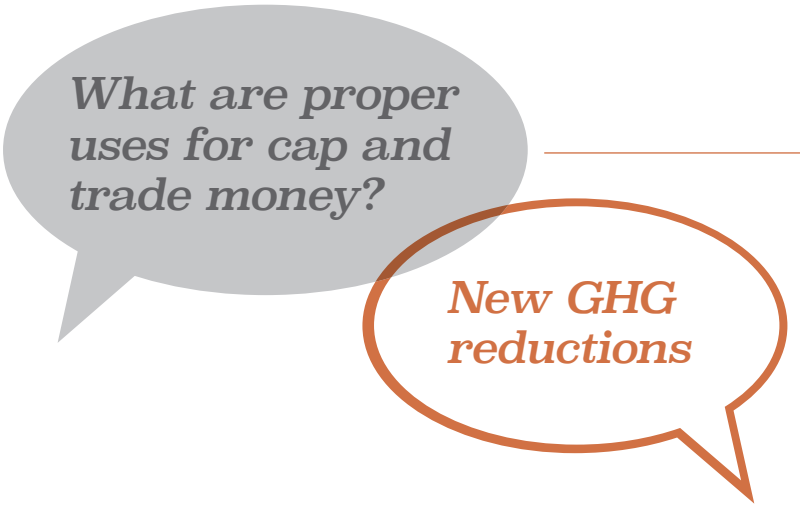
Spending the Money Well

ABSTRACT

As shown in Chapter 4, Ontario's cap and trade program will only provide a small share of the greenhouse gas (GHG) reductions needed to meet the 2020 GHG reduction target. Ontario estimates that a much larger portion of the domestic reductions will come from its Climate Change Action Plan (discussed in Chapter 6), to be funded by cap and trade revenues through the Greenhouse Gas Reduction Account (GGRA).

This chapter examines:

1. the province's justification for putting cap and trade revenues in the GGRA, instead of returning them to Ontarians, and
2. the challenges of ensuring that the money is actually used to produce additional emission reductions, instead of being directed to other purposes or used as part of general government revenue.



5.1 Keep the Money or Return It?

One of the key questions in the design of any carbon pricing program is what to do with the revenue that the government collects by charging businesses and individuals for their carbon emissions. Carbon pricing programs can be revenue neutral. For example, some jurisdictions, such as British Columbia which has adopted a carbon tax, offset the carbon pricing revenue with cuts in other taxes for individuals and corporations. An alternative approach – a carbon fee and dividend – returns funds collected from any carbon pricing program directly back to the citizens to use as they see fit.[1]

Ontario has chosen, instead, a *cap and invest* approach. The government will put the proceeds from its emission allowance auctions into a Greenhouse Gas Reduction Account (GGRA), a notional (not separate) account within the Consolidated Revenue Fund, and will control how these proceeds are spent.[2] There are legitimate concerns about how the government will spend this large amount of new money. Will it be genuinely used for emission reductions and kept separate from general government revenues and expenses? Unsurprisingly, there are enormous political pressures to divert the GGRA money to any number of government and stakeholder priorities. In Quebec, the Quebec Commissioner of Sustainable Development documented a number of dubious uses of the provincial Green Fund, together with a pervasive lack of appropriate administrative controls to prevent such uses.[3]

Will GGRA funds be genuinely used for emission reductions and kept separate from general government revenues and expenses?

Two main justifications have been put forward for putting the proceeds in the GGRA, one constitutional, and one based on emissions:

1. The constitutional law claim is that Ontario, as a province, only has the constitutional law power to impose a price on carbon if the price is a regulatory charge, not an indirect tax, and if the proceeds are kept separate from general government revenues and used specifically for the purposes of the specific regulatory scheme that creates the regulatory charge. Because the regulatory scheme – the *Climate Change Mitigation and Low-carbon Economy Act, 2016* (the "*Climate Act*") – is intended to reduce greenhouse gas emissions, the province argues that it can only use the proceeds to reduce greenhouse gas emissions, and cover the costs of administering the scheme.[4] If the government used the money for other purposes, or as part of its general revenues, the entire cap and trade program might be more vulnerable to a legal attack.

   In the ECO's view, this is a reasonable concern. Environmental charges have been struck down on somewhat similar grounds in both Ontario and California,[5] and the California cap and trade program is facing a serious legal challenge now (see Chapter 4). However, reasonable lawyers may differ on the scope of the regulatory scheme, and on which expenditures fall within it. The government has not released any legal opinion on which it relies. Ontario could also have chosen to levy a direct carbon tax, which is within its constitutional authority.

The constitutional law argument is also the principal reason why the government has told us it must use all of the cap and trade proceeds only for greenhouse gas mitigation (reducing emissions) and not for adaptation (coping with and preparing for the damage that climate change will bring).

2. The climate-based claim is that a price on carbon alone is not expected to produce significant reductions in greenhouse gas emissions unless the carbon price is raised to a very high level, much higher than Ontario is proposing to achieve, especially in the next few years.[6] [7] Recycling revenues in a revenue neutral system, i.e. through tax cuts or returning revenues directly to citizens, would not incent additional reductions in greenhouse gas emissions.[8] Instead, the government claims that it can (and can only) achieve significant additional reductions in emissions by using the proceeds to subsidize initiatives that will reduce emissions.[9]

   The ECO agrees that, as currently planned, cap and trade alone is not likely to reduce Ontario's domestic emissions enough to meet the 2020 target in section 6 of the *Climate Act*. In addition to the option of achieving additional reductions by regulation, the province can likely produce some emission reductions through carefully chosen incentives and subsidies.

Cap and trade alone is not likely to reduce Ontario's domestic emissions enough to meet the 2020 target.

5.2 Ontario Has a Big Reduction Challenge

As shown in Chapter 2, there is a huge gap between Ontario's current greenhouse gas emissions and the greenhouse gas emission targets in the *Climate Act*. How can Ontario reduce its economy-wide emissions 15 Mt (from 170 to 155 Mt) in just four years, in order to meet the 2020 target, while simultaneously growing the population and the economy?

Chapter 2 shows Ontario met its first and easiest reduction target, a 6 percent reduction from 1990 by 2014, largely because the government directed Ontario Power Generation to close its coal-fired power generating stations. These changes had significant environmental and health benefits, including contributing to Ontario's first year without smog days since recordkeeping began, and a dramatic reduction in emissions of toxic mercury. The price: eliminating coal-fired power (and replacing it with cleaner forms of generation) has contributed to the increase in electricity rates across the province.[10] Ontario's residential electrical rates are now average, instead of low, relative to the rest of North America.[11]

Achieving future emission reductions in Ontario is likely to be even more challenging, although equally worthwhile. Ontario expects a 50 per cent increase in

the population of the Greater Golden Horseshoe region within the next 25 years.[12] This alone would require existing residents to cut their emissions about a quarter just to keep total emissions from increasing. Modelling done for the Ministry of the Environment and Climate Change (MOECC) forecasts that business-as-usual emissions would be 173.5 Mt by 2020,[13] and growing, if not for the *Climate Act*. Existing conservation programs such as the 2013 Conservation First Framework, and the 2015 to 2020 Energy Efficiency Programs funded by electricity and natural gas ratepayers under the supervision of the Ontario Energy Board, are already baked into this forecast. There is no single *big bang*, comparable to closing the coal plants, to achieve future emission reduction targets.

Achieving the 2020 target may be more difficult for Ontario than it will be for our Western Climate Initiative partners, California and Quebec.[14] The lack of carbon pricing in most U.S. states means that most U.S. businesses do not pay anything for the carbon dioxide they deposit in our shared atmosphere. This uneven playing field may make it more difficult for some Ontario companies to compete once they do start paying for their carbon pollution. The government has chosen to address some of these competitiveness concerns by providing free allowances to industry during the first, four-year compliance period, but most investment decisions have a longer planning period than four years.

Innovation and low carbon investment by Ontario companies may also be hampered by the difficulty, expense and delay entailed in obtaining environmental approvals, for example, to alter combustion equipment, under section 9 of the *Environmental Protection Act*. In 2015, the average delay to obtain an industrial air approval from the MOECC was approximately 650 days, and 10 per cent of approval applications were still outstanding after 1,250 days.[15] While the first compliance period is four years long, approval delays could consume much of this time. Some sectors are facing simultaneous demands to install energy-intensive enhanced pollution controls, which will drive up energy use and therefore GHG emissions.[16]

Ontario needs complementary emission reduction measures, such as regulations, a carbon tax on sectors not covered by cap and trade, and/or subsidies and incentives.

Financing difficulties can also hamper emission reductions. Canadian businesses find it exceptionally difficult to grow capital-intensive clean-tech and green-tech intellectual property into successful companies.[17] Canadian investors are notoriously risk averse, especially compared to U.S. investors, and our innovation policies are poorly co-ordinated.[18] (See Chapter 6 for a discussion of clean tech financing by government). For all of these reasons, transitioning the Ontario economy from its current 80 percent fossil-fuel energy dependency[19] to a low emission future by any of the target dates will be an enormous challenge.

The ECO agrees that putting a price on carbon, by itself (whether through a carbon tax or through a cap and trade program) would not be enough to achieve Ontario's reduction targets, unless the price were very high. As in other jurisdictions, Ontario needs complementary emission reduction measures, such as regulations, a carbon tax on sectors not covered by cap and trade, and/or subsidies and incentives. California, for example, expects complementary measures, such as its Low Carbon Fuel Standard, to produce about 75 per cent of its reductions to 2020.

In addition to some regulations, the government has chosen subsidies and incentives as its complementary measures, to be funded from the GGRA. The details are set out in the Climate Change Action Plan discussed in Chapter 6.[20]

5.3 What Can GGRA Money be Used For?

In a sense, section 71 (2) of the *Climate Act* is very broad. It allows funds in the GGRA to be used for any initiative that is reasonably likely to reduce or support the reduction of greenhouse gases, or for related government expenditures. These initiatives may or may not be listed on Schedule 1 of the Act, which provides a long laundry list of the types of emission reduction initiatives from every major sector that may be funded, including:[21]

1. energy
2. land use and buildings
3. transportation
4. industry
5. agriculture, forestry and natural systems
6. waste, and
7. financial models and services.

Each initiative can include:

1. research, development and technology
2. education and training
3. public information
4. innovation, and
5. that popular basket clause, *other*.

As noted by the California Legislative Analysts' Office about the parallel requirement in California:

The requirement to spend on GHG reductions limits the Legislature's flexibility to use the revenue in ways that could achieve other goals, such as (1) offsetting higher costs for households and businesses associated with higher energy prices; (2) promoting other climate-related policy goals, such as climate adaptation activities; or (3) promoting other legislative priorities unrelated to climate policy.[22]

These other goals must be funded in some way, i.e., not from cap and trade proceeds.

5.3.1 Choosing what to fund

The provincial government's decision to fund an initiative with GGRA money must come after a formal evaluation of the initiative by the Minister of the Environment and Climate Change, who must consider[23] :

1. its potential to reduce emissions;
2. how it will contribute to achieving Ontario's GHG reduction targets;
3. its relationship to other initiatives;
4. its relationship to the Climate Change Action Plan (see Chapter 6);
5. whether it will assist low-income households and vulnerable communities transition to a low-carbon economy; and
6. such other matters as the Minister considers appropriate.

Notable omissions from this list of evaluation criteria include:

- cost effectiveness (i.e., will this initiative provide the best emission reduction bang for the buck?);[24]
- whether the reductions will be permanent and verifiable;
- impacts on low-income households and vulnerable communities, other than their transition to a low-carbon economy;
- impact on Ontario's economy or employment;
- environmental or health co-benefits, such as cleaner air, protecting water supplies or biodiversity; and
- environmental or health disadvantages of an initiative, such as hazardous waste.

Although these criteria are not explicitly mentioned in the *Climate Act*, the ECO has been advised by MOECC and Treasury Board that the evaluation framework to be used by the government will include an assessment of these criteria.[25]

California's criteria

California's Health and Safety Code lays out nine guidelines that the Air Resources Board must consider when implementing its cap and trade program, including investing the cap and trade proceeds. Those most relevant to spending the money include: the impact on low-income communities, cost-effectiveness, and co-benefits.[26] California identifies its investment priorities through public input, staff recommendations, legal requirements and its broader climate change strategy.[27]

Different criteria may, however, be difficult to reconcile. For example, there is an obvious tension between assisting low-income households and choosing the most cost-effective emission reductions. In Ontario's energy efficiency experience, programs for low-income and vulnerable communities frequently cannot pass cost-effectiveness tests.[28] Low income energy efficiency programs also do not always reduce emissions. For example, a program that improves the insulation and airtightness of low income housing may result in residents that are more comfortable for a given degree of energy use, rather than in reduced energy consumption. There is also an obvious tension between short-term initiatives to reduce emissions a little now, and longer-term initiatives to reduce emissions substantially later. GGRA funding tradeoffs should be explicit and transparent.

The Minister's evaluation must be provided to Treasury Board, but is not required to be available to the public; the only public reporting requirement is that the Minister report annually on the evaluations that have been submitted to Treasury Board.[29] The lack of detailed, transparent criteria for eligible initiatives and expenditures could threaten the cap and trade program's integrity and effectiveness and open the door to using cap and trade proceeds as general public funds.

GGRA funding tradeoffs should be explicit and transparent.

Recommendation: The Ministry of the Environment and Climate Change should publicly adopt a complete set of evaluation criteria for proposed GGRA expenditures and an explicit policy on how it allocates GGRA funds between competing objectives.

5.3.2 Must the GHG reductions funded through the GGRA occur in Ontario?

The *Climate Act* is not clear on whether emission reductions funded through the GGRA must occur in Ontario. Section 71, which governs the use of GGRA funds, is not expressly limited to reductions "in Ontario".[30] However, section 71(3) requires the Minister to evaluate how a proposed GGRA expenditure relates to the achievement of Ontario's emission reduction targets.

The Action Plan, discussed in Chapter 6, does not explicitly propose any initiatives outside Ontario. However, some proposals, such as support for clean technology companies, might produce emission reductions that occur primarily outside Ontario.

Emission reductions in other jurisdictions, particularly outside our WCI partners, clearly do not contribute to reductions in Ontario's emissions, and therefore would not contribute to achieving Ontario's emission reduction targets.

Since carbon pollution in any jurisdiction adversely affects our shared atmosphere and our shared climate, Ontario would benefit from emission reductions that occur anywhere in the world. However, for every tonne of CO_2 reduced outside our borders (that could have occurred here), Ontario misses out on the co-benefits of reducing emissions (e.g., reducing local pollution, transitioning to a low-carbon economy).

It is the ECO's view that, if GGRA funds are to be spent on reductions outside Ontario, the government should have an explicit policy on how it allocates GGRA funds between emission reductions that are in Ontario or elsewhere.

5.3.3 How direct must the reductions be?

Is everything eligible for GGRA support, as long as there is some impact, however minor or indirect, on GHG emissions? Fossil fuels make up 80 per cent of Ontario's energy use,[31] so most forms of economic activity have *some* impact on greenhouse gas emissions. Unless the government insists on a strong, direct, primary connection between GGRA funding and GHG emission reductions, Ontario risks having the GGRA funds frittered away without achieving significant reductions.

During debates on Bill 172, which became the *Climate Act*, the government promised that GGRA funds would be used only for direct GHG reductions. For example:

> *I think it's very clear that the monies being raised here would not go into purposes other than direct greenhouse gas reductions.*[32]

However, not every expenditure proposed in the Action Plan will produce direct greenhouse gas reductions; see Chapter 6. The government has also given itself the right to take GGRA funds for its own past and future expenditures, even if they are only *indirectly* related to *supporting* GHG reductions.[33] In the ECO's view, this would reduce Ontario's prospects of meeting its *Climate Act* targets.

Ontario risks having the GGRA funds frittered away.

5.3.4 Will the reductions be additional?

The critical question is: will initiatives funded through the GGRA create (or support) **additional** reductions in greenhouse gas emissions, as compared to those emissions that would have occurred without the GGRA? In our view, it is the public policy need for *additional* GHG reductions in order to achieve the ambitious targets set out in section 6 of the Act that justifies the creation of the GGRA. This was also the justification that the government gave the public during debates on Bill 172, which became the *Climate Act*. The government did not publicly justify the *Climate Act* as a method to raise revenue in order to replace funding for existing programs previously funded from general tax revenues.[34]

The ECO therefore believes it would not be a proper use of the GGRA to pay for reductions that would have occurred anyway, under existing commitments and programs, if the Act had not been passed. These reductions are not additional; instead, they form part of the baseline against which the use of the GGRA must be compared. For the same reason, GGRA

It would not be a proper use of the GGRA to pay for reductions that would have occurred anyway.

initiatives should produce additional reductions on top of those that will be incented by the cap and trade portions of the Act. Such reductions would occur even if the GGRA did not exist, i.e., if cap and trade revenues were returned to the public.

Thus, in our view, the appropriate 'baseline' for funding a GGRA initiative is the level of GHG emissions that would have occurred without the initiative, but including any GHG reductions triggered by existing programs, the cost of emission allowances that entities must purchase under cap and trade, and the effect of any initiatives that have already been funded through the GGRA. The expansion of existing programs (e.g., increasing the subsidy for the purchase of electric vehicles) would pass this test, as the parameters of the program have changed and will produce additional emission reductions.

In contrast, it appears to be the government's view that it can use GGRA money for anything that reduces emissions that might under some circumstances have occurred, including existing and previously announced government programs and promises. This approach could undermine public support for the *Climate Act*.

Recommendation: The Greenhouse Gas Reduction Account should only be used to pay for new or expanded initiatives that will directly produce emission reductions on top of those that will be created by existing programs, by the cap and trade program and by initiatives already funded through the Greenhouse Gas Reduction Account.

5.4 Will the GGRA be Needed Indefinitely?

The GGRA may be best used as a transitional tool, not as a permanent feature of the *Climate Act*. The emission reduction justification for the government using all cap and trade proceeds for incentives and subsidies might become wholly or partly obsolete after an initial pulse of investment in public infrastructure, in clean technology and in industrial transition, especially once the cost of allowances becomes significant. At some point, it might be better public policy to return some or all of the proceeds to Ontarians, by direct transfers and/or by reducing other taxes, but the threshold for making such a policy shift would need to be high.

5.5 Transparency and Documentation

After the money is spent, the MOECC will publish an annual report.[34] The report is to show how much money the province put into the GGRA, how much it took out, and a description of what the money was used for. The *Climate Act* does not specify how much detail must be included in the *description*. In particular, the public will not know whether the MOECC Minister recommended funding a particular initiative out of the GGRA, as this is considered to be a Cabinet secret. Another area of uncertainty is how payments out of the GGRA to the Green Bank will be documented and reconciled with payments out of the Green Bank (see Chapter 6).

The people of Ontario deserve a better accounting of how cap and trade revenues will be used.

The people of Ontario deserve a better accounting of how cap and trade revenues will be used, and what public benefits will be achieved as a result.

In order to comply with the Act, and in light of the high degree of public concern about appropriate use of cap and trade proceeds, the government should keep detailed records of the analysis that justifies each GGRA expenditure. The ECO expects that this justification should include at least the information set out below. The ECO proposes that all such information should be included in a separate appendix which can be readily severed from any confidential Cabinet documents, so that officers of the Legislature can effectively review their sufficiency, prudence and completeness.

For each major expenditure from the GGRA, the government should record at least the following information:[36]

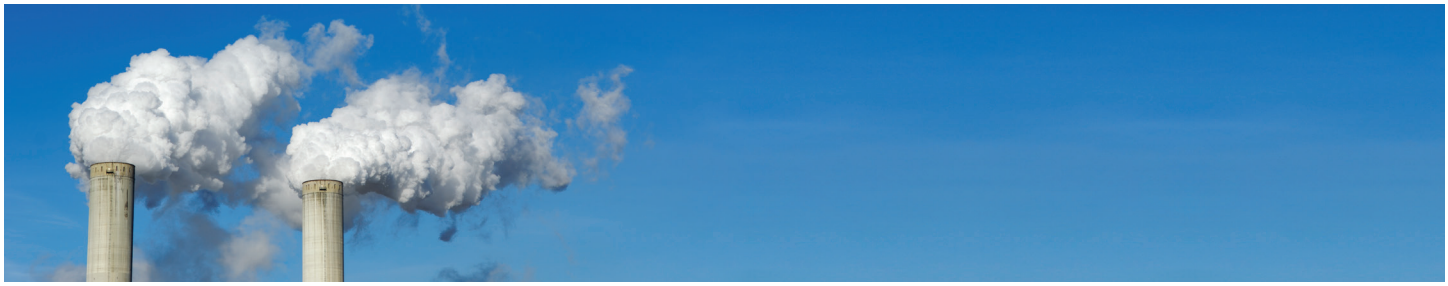
1. General:
    a. Description of initiative
    b. Relevant paragraph of Schedule 1 of the Act, if applicable
    c. Relevant paragraph of the Climate Change Action Plan, if applicable
    d. Proposed GGRA funding, amount and timing

2. Emission Reduction Effectiveness: Additionality
    a. The baseline:
        i. Evidence, methodology and assumptions[37] used to calculate Business-as-Usual emissions (including the impact of the cost of emission allowances)
    b. The additional reductions attributable to the initiative:
        i. Predicted quantity and timing of reductions, whether before or after 2020
        ii. Mechanism by which the initiative will produce reductions
        iii. Evidence, methodology and assumptions used to calculate the additional reductions
        iv. How the government will ensure that the reductions will count towards Ontario's section 6 targets
        v. How the government will ensure that the reductions are permanent/persist
    c. Any third party validation or verification of the above[38]
    d. Other anticipated environmental benefits of the initiative

3. Governance / Accountability
    a. Output and outcome metrics and indicators (where possible) that will be used to track the effectiveness of the initiative, including progress towards GHG reductions and other program goals, including:
        i. Data collection and quality control
            1. Who will gather what data to measure the effectiveness of the initiative? When? For how long?
        ii. Progress reporting
            1. How will the government know whether the initiative produces the predicted reductions? When?
            2. How and when will that data and analysis be made available to the public?
    b. Accountability framework (including who in government is responsible for these systems and reports)
        i. What will the consequences be if the initiative does not produce the predicted reductions?
    c. For any initiative that was funded in a previous year, progress achieved to date, if any

4. Cost Effectiveness
    a. Claimed cost per tonne
    b. Percent of total initiative funding to come from the GGRA
    c. Why GGRA funding is necessary

If the ECO receives appropriate documentation, our office will strive to provide appropriate public transparency and accountability on GGRA initiatives. The Financial Accountability Officer and the Auditor General are likely to provide accountability on the accounting and financial aspects of GGRA expenditures; our office expects to focus on whether, to what extent and (if possible) at what cost per tonne, initiatives funded through the GGRA are likely to reduce, or support the reduction of, greenhouse gas emissions.



Recommendation: The government should keep detailed records of the justification for each Greenhouse Gas Reduction Account expenditure, in a form that can readily be provided to the Legislative Officers.

The MOECC Minister's annual public report on the GGRA should include:

1. A summary of the justification for each initiative funded, including:
   a. the name and sector of the recipient;
   b. the amount received;
   c. any matching funds;
   d. the anticipated additional GHG reductions;
   e. how and when it will achieve these reductions;
   f. the cost-effectiveness of the reductions; and
   g. other material health, safety, environmental, social and economic consequences of the initiative;
2. Analysis of the total funds spent, by sector;
3. Analysis of the total GHG reductions and other public benefits achieved, by year and by sector, as a result of the GGRA investment;
4. Administrative costs funded, by agency/ministry;
5. How long-term transformative change is being balanced with the need for short-term reductions; and
6. Recommendations for improvements for subsequent years.

Detailed records of the justification for each GGRA expenditure.

The ECO is pleased to learn[39] that the government has accepted this recommendation, and will keep detailed records of the justification for each GGRA expenditure. The ECO looks forward to receiving the appropriate documentation in a timely fashion.

5.5.1 Starting on the right foot?

Before the Climate Change Action Plan was released, and well before any revenues had materialized from the cap and trade program, the Ontario government had already committed to spend over $325 million of the cap and trade auction proceeds, through a temporary vehicle called the Green Investment Fund. According to the 2016 Budget, the deployment of these funds is already underway.[40] Most of these promises were repeated in the budget, and, with variations, in the Climate Change Action Plan discussed in Chapter 6. These announcements included:[41]

Date announced	Amount promised (in millions)	Initiative	Expected reductions
December 15, 2015 and April 28, 2016	**$20**[42]	**Electric vehicle (EV) charging stations**[43]	**Unspecified**
February 4, 2016	**$100**[44]	**Home energy audits and retrofits**[45]	**Unspecified**
February 12, 2016	**$92**[46]	**Social housing retrofits**[47]	**3,600 tonnes (over 20 years)**
February 17, 2016	**$99**[48]	**Cleantech innovation for industry**[49]	**Unspecified**
February 22, 2016	**$1**	**Kitchener's Sustainability CoLab network**[50]	**Unspecified**
March 17, 2016	**$13**[51]	**Empowering First Nations to take climate action**[52]	**Unspecified**
TOTAL	**$325 + EV incentives**	**Total**	**3.6 kt + Unspecified**

The ECO is not aware of appropriate documentation justifying the use of cap and trade revenues for any of these programs. Government expenditures incurred on or after November 1, 2015, but before the *Climate Act* came into force on May 18, 2016, "that are reasonably likely to reduce or support the reduction of greenhouse gases" are eligible for reimbursement from the Greenhouse Gas Reduction Account[53], only if:

- The Minister has provided an evaluation of the initiative to Treasury Board[54], and
- the reimbursement occurs before the books of the Government of Ontario are closed for the fiscal year in which the expenditures are incurred.[55] The 2016/2017 fiscal year ends on March 31, 2017. The books typically close two to three months later.

The ECO is not aware of the Minister providing an evaluation of any of these initiatives to Treasury Board, as of October 7, 2016.

5.6. Recommendations

Recommendation: The Ministry of the Environment and Climate Change should publicly adopt a complete set of evaluation criteria for proposed GGRA expenditures and an explicit policy on how it allocates GGRA funds between competing objectives.

Recommendation: The Greenhouse Gas Reduction Account should only be used to pay for new or expanded initiatives that will directly produce emission reductions on top of those that will be created by existing programs, by the cap and trade program and by initiatives already funded through the Greenhouse Gas Reduction Account.

Recommendation: The government should keep detailed records of the justification for each Greenhouse Gas Reduction Account expenditure, in a form that can readily be provided to the Legislative Officers.

The MOECC Minister's annual public report on the GGRA should include:

1. **A summary of the justification for each initiative funded, including:**
   - **a. the name and sector of the recipient;**
   - **b. the amount received;**
   - **c. any matching funds;**
   - **d. the anticipated additional GHG reductions;**
   - **e. how and when it will achieve these reductions;**
   - **f. the cost-effectiveness of the reductions; and**
   - **g. other material health, safety, environmental, social and economic consequences of the initiative;**
2. **Analysis of the total funds spent, by sector;**
3. **Analysis of the total GHG reductions and other public benefits achieved, by year and by sector, as a result of the GGRA investment;**
4. **Administrative costs funded, by agency/ministry;**
5. **How long term transformative change is being balanced with the need for short term reductions; and**
6. **Recommendations for improvements for subsequent years.**

ONTARIANS TAKING ACTION

Sobeys

As a major Canadian retailer with over 1,800 food stores across the country, Sobeys has a large need for refrigeration. Traditional refrigerant systems rely on hydrofluorocarbon (HFC) gases. When these gases leak into the atmosphere, not only are these gases harmful to the ozone layer, they have an extremely high capacity to trap heat and contribute to climate change. In an effort to reduce its carbon footprint, Sobeys has switched from using HFC gas to carbon dioxide as a refrigerant for all its new buildings as well as major retrofits. Approximately 100 stores nationally, and five within Ontario, now use carbon dioxide; these efforts have reduced the climate change impacts of normal operating leaks by over 99 per cent. As refrigerators also emit a lot of heat, the company has installed systems that capture this heat and circulate it to other parts of the building, reducing the amount of fossil fuel consumed for heating.

ONTARIANS TAKING ACTION

Moose Cree First Nation and Ontario Power Generation

The Moose Cree First Nation and Ontario Power Generation signed an agreement for the construction of the Lower Mattagami hydro project. This renewable energy project doubled energy output through increased efficiencies, without damming more rivers. The agreement provided the First Nation with a 25% share in the $2.6 billion project. During construction the First Nation benefited from $300 million in contracts and provided meaningful employment to 250 First Nation and Metis workers. The hydro project is estimated to displace about 1.5 million tonnes of GHGs annually.

Endnotes

[1] Citizens' Climate Lobby, website, Carbon Fee and Dividend Policy and FAQs, accessed September 2016. citizensclimatelobby.org/carbon-fee-and-dividend/

[2] Section 71 of the *Climate Act* does not require the GGRA to be a separate account. The former section 176.1 (6) of the *Environmental Protection Act*, enacted by the *Environmental Protection Amendment Act* (Greenhouse Gas Emissions Trading), 2009, would have created a separate account, however this section is repealed by section 80(2) of the *Climate Act*.

[3] Commissaire au développement durable, report, Rapport du Vérificateur général du Québec à l'Assemblée nationale pour l'année 2014-2015, Fonds vert: gestion et aide financière, Spring 2014. www.vgq.gouv.qc.ca/fr/fr_publications/fr_rapport-annuel/fr_2014-2015-CDD/fr_Rapport2014-2015-CDD.pdf

[4] Government of Ontario, PowerPoint presentation, Cap and Trade Program Design Options, Slide 42, November 2015. www.owma.org/Portals/2/Cover_Page_Image/PT%20Cap%20and%20Trade.pdf

[5] *Angus v Corporation of the Municipality of Port Hope*, 2016 ONSC 3931 (CanLII), canlii.ca/t/gs3r8; Morning Star Co. v. Bd. of Equalization (2011) 201 Cal.App.4th 737.

[6] According to the IPCC, a carbon price of US$50/tonne CO2e would leverage global emission reductions of 20–35% below business-as-usual emission levels by 2030 in a scenario of rapid economic growth, or reductions of 27–52% below business-as-usual levels in a lower-growth scenario. Even those reduction levels still fall significantly short of the minimum reductions needed to have a good chance of avoiding dangerous climate change. (IPCC Working Group 3 Summary for Policymakers (Climate Change 2007: Mitigation of Climate Change), p.9-12, 29. www.ipcc.ch/SPM040507.pdf)

[7] M.K. Jaccard, et al, report, Exploration of two Canadian greenhouse gas emissions targets: 25% below 1990 and 20% below 2006 levels by 2020, October 18, 2009.

www.davidsuzuki.org/publications/downloads/2009/MK_Jaccard_GOV_and_ENGO_Climate_Targets_Report_-_Oct_18_2009.pdf

[8] Ecofiscal Commission, report, Choose Wisely, Options and Trade-offs in Recycling Carbon Pricing Revenues, p.10-12, April 2016. ecofiscal.ca/wp-content/uploads/2016/04/Ecofiscal-Commission-Choose-Wisely-Carbon-Pricing-Revenue-Recycling-Report-April-2016.pdf

[9] The estimated GHG emissions reductions outlined in Ontario's 2016 Climate Change Action Plan indicate the relatively small proportion of reductions expected from the cap-and-trade program by 2020 (2.8 Mt) as opposed to the more significant reductions (9.8 Mt) estimated to come from the initiatives funded by the cap-and-trade revenue.

[10] Sustainable Prosperity, report, What Is Happening to Ontario Electricity Prices? p. 3, March 2012. www.sustainableprosperity.ca/sites/default/files/publications/files/What%20is%20Happening%20to%20Ontario%20Electricity%20Prices%20March%207%202012_FINAL.pdf.

[11] Hydro Quebec, report, Comparison of Electricity Prices in Major North American Cities, 2015. www.hydroquebec.com/publications/en/corporate-documents/comparaison-electricity-prices.html

[12] Ministry of Municipal Affairs, report, Performance Indicators for the Growth Plan for the Greater Golden Horseshoe, 2006, p. 2. www.mah.gov.on.ca/AssetFactory.aspx?did=10849

[13] Dave Sawyer, Jotham Peters, Seton Stiebert, report, Impact Modelling and Analysis of Ontario Cap and Trade Program, May 2016. www.enviroeconomics.org/single-post/2016/05/17/Impact-Modelling-and-Analysis-of-Ontario%E2%80%99s-Proposed-Cap-and-Trade-Program

[14] Ontario Ministry of Finance, website, Ontario Fact Sheet August 2016, accessed September 2016. www.fin.gov.on.ca/en/economy/ecupdates/factsheet.html

[15] Based on a graph the ECO received from stakeholders. It shows the length of time between proposed environmental compliance approvals (air) being posted on the Environmental Registry and the date the final decision is posted on the Registry. We know that both sets of dates are approximate, since quite a bit of time can go by before an application or decision is posted on the Registry. Even with this inaccuracy, the overall conclusion is that it takes about 650 days to get an air approval on average and that this period has been getting longer.

[16] See, for example, requirements in O. Reg. 419/05, Air Pollution – Local Air Quality, made under the *Environmental Protection Act*.

[17] Tyler Hamilton, Toronto Star, article, Province to help fledgling tech companies raise capital, March 18, 2009. www.thestar.com/news/2009/03/18/province_to_help_fledgling_tech_companies_raise_capital.html. See also Chapter 6.

[18] CBC news, article, Canadians hold record $75B in cash as they wait out volatile markets, January 26, 2016. www.CBC.ca/news/business/cash-investors-cibc-1.3419271; Mitacs, report, Leveraging Canada's Innovation Ecosystem, p.3, p.11-12, January 2016. www.mitacs.ca/sites/default/files/uploads/newsroom/leveraging_canadas_innovation_ecosystem_jan2016.pdf

[19] That is, 80 per cent of Ontario's total energy consumption is provided by fossil fuels. (Environmental Commissioner of Ontario, report, Conservation: Let´s Get Serious Annual Energy Conservation Progress Report – 2015/2016, p.11, 2016.)

[20] Center for Climate and Energy Solutions, report, California Cap-and-Trade, Figure 4, January 2014. www.c2es.org/us-states-regions/key-legislation/california-cap-trade

[21] *Climate Change Mitigation and Low-carbon Economy Act, 2016*, Schedule 1.

[22] Mac Taylor, Legislative Analyst's Office, report, Cap-and-Trade Revenues: Strategies to Promote Legislative Priorities, January 21, 2016. www.lao.ca.gov/reports/2016/3328/cap-trade-revenues-012116.pdf

[23] *Climate Change Mitigation and Low-carbon Economy Act, 2016*, s.71(3).

[24] In contrast, this is an express objective of the federal Low Carbon Economy Fund. As outlined in Chapter 4 of the 2016 federal budget, "resources will be allocated towards those projects that yield the greatest absolute greenhouse gas reductions for the lowest cost per tonne." www.budget.gc.ca/2016/docs/plan/ch4-en.html

[25] Ontario Ministry of the Environment and Climate Change as well as Ontario Treasury Board, information provided to the ECO, September 25 and 26 (respectively), 2016.

[26] California Health and Safety Code, s.38562. codes.findlaw.com/ca/health-and-safety-code/hsc-sect-38562.html

[27] State of California, report, Cap-and-Trade Auction Proceeds Draft Second Investment Plan:

Fiscal Years 2016-17 through 2018-19, p.1, October 27, 2015. www.arb.ca.gov/cc/capandtrade/auctionproceeds/draft-second-investment-plan.pdf

[28] Environmental Commissioner of Ontario, report, Conservation: Let´s Get Serious Annual Energy Conservation Progress Report – 2015/2016, p.125, 2016.

[29] Under section 71(4) of the *Climate Change Mitigation and Low-carbon Economy Act, 2016*, however, the Minister is required to report publicly on an annual basis about the evaluations that have been provided to Treasury Board.

[30] As well, Section 2 – the purpose section - does not specify that the purpose of the Act is to reduce emissions in Ontario.

[31] Environmental Commissioner of Ontario, report, Conservation: Let´s Get Serious Annual Energy Conservation Progress Report – 2015/2016, p.11, 2016.

[32] Mr. Potts, Hansard, Committee on General Government, April 4, 2016. www.ontla.on.ca/web/committee-proceedings/committee_transcripts_details.do?locale=en&Date=2016-04-04&ParlCommID=8998&BillID=3740&Business=&DocumentID=30333

[33] *Climate Change Mitigation and Low-carbon Economy Act, 2016*, section 71(2), (5). Past expenditures must have occurred on or after November 1, 2015.

[34] Note: In the California cap and trade litigation, the Court of Appeal specifically requested submissions from the litigants on "What standards should the judiciary apply in reviewing expenditures that are alleged to be replacements for general revenue expenditures?" See: www.edf.org/climate/california-cap-and-trade-auction-legal-resources

[35] *Climate Change Mitigation and Low-carbon Economy Act, 2016*, section 71(7).

[36] We recognize that it may not be practical, or economically reasonable, for the government to do a full in-depth analysis of these questions for each individual initiative, and that some may be designed to work together to provide complementary or synergistic effects. In such cases the government may properly evaluate such initiatives in appropriate groups, rather than individually. We would also expect some threshold of materiality for a full-scale review, recognizing that it may be appropriate to fund small experimental or pilot projects without such detailed data.

[37] The ECO will expect to see consideration of factors such as: economic uncertainty (e.g. GDP changes), range of estimates, interactions with federal and other provincial initiatives, etc.

[38] Especially of data quality, control processes and acceptability of assumptions.

[39] Ontario Ministry of the Environment and Climate Change, information provided to the ECO, September 25, 2016.

[40] Ministry of Finance, report, 2016 Ontario Budget: Cap and Trade — Cost to Energy Consumers, 2016. www.fin.gov.on.ca/en/budget/ontariobudgets/2016/ch1a.html#s9

[41] The Green Investment Fund is a down payment on cap-and-trade revenue. (Patrick DeRochie, Environmental Defence, Blog, Ontario's Green Investment Fund: a Down Payment on Climate Action, March 29, 2016. environmentaldefence.ca/2016/03/29/ontarios-green-investment-fund-payment-climate-action/) All Green Investment Fund commitments are outlined on the following Ontario Government website: www.ontario.ca/page/green-investment-fund.

[42] In the CCAP, the province commits $80 million for charging stations (p.61), plus another $500,000 to $2 million for EV charging stations in government locations (p.80). The CCAP did not say whether this included the $20 million in the two earlier announcements.

[43] Ontario Government, news release, Ontario Building More Electric Vehicle Charging Stations, April 28, 2016. news.ontario.ca/mto/en/2016/04/ontario-building-more-electric-vehicle-charging-stations.html?utm_source=ondemand&utm_medium=email&utm_campaign=p; The Ontario Government made a similar announcement on December 8, 2016 (see: news.ontario.ca/opo/en/2015/12/more-electric-vehicle-charging-stations-on-the-way.html). It is unclear whether these two separate news releases are referring to the same $20 million.

[44] CCAP commits $500-600 million for home energy efficiency upgrades, and $200-250 million for energy audits (p.68).

[45] Ontario Government, news release, Ontario Investing $100 Million to Create Jobs and Help Homeowners Save Energy, February 4, 2016. news.ontario.ca/mei/en/2016/02/ontario-investing-100-million-to-create-jobs-and-help-homeowners-save-energy.html

[46] CCAP commits $380-500 million (p.65).

[47] Ontario Government, news release, Ontario Investing $92 Million to Create Jobs and Retrofit Social Housing, February 12, 2016. news.ontario.ca/mah/en/2016/02/ontario-investing-92-million-to-create-jobs-and-retrofit-social-housing.html

[48] CCAP commits $140-235 million (p.74).

[49] Ontario Government, news release, Ontario Invests Nearly $100 Million to Boost Cleantech Innovation and Create Jobs, February 17, 2016. news.ontario.ca/opo/en/2016/02/ontario-invests-nearly-100-million-to-boost-cleantech-innovation-and-create-jobs.html

[50] Ontario Government, news release, Ontario Investing in Kitchener's Sustainability CoLab to Help Fight Climate Change, February 22, 2016. news.ontario.ca/ene/en/2016/02/ontario-investing-in-kitcheners-sustainability-colab-to-help-fight-climate-change.html

[51] CCAP commits $85-96 million to "collaboration with Indigenous communities" (p.73).

[52] Ontario Government, news release, Ontario Partnering With First Nations to Address Climate Change, March 17, 2016. news.ontario.ca/maa/en/2016/03/ontario-partnering-with-first-nations-to-address-climate-change.html

[53] S. 71(5) of *Climate Act*

[54] s. 71(3) of *Climate Act*

[55] s. 71(6) of *Climate Act*

Chapter 6

Climate Change Action Plan

ABSTRACT

The province plans to fund its multi-ministry Climate Change Action Plan (CCAP) with the Greenhouse Gas Reduction Account (GGRA), discussed in Chapter 5. It estimates the Action Plan will result in approximately 9.8 Mt of reductions in Ontario in 2020, and 20 Mt by 2030. The 2020 claim appears overly optimistic. The ECO does not have enough information to evaluate the 2030 claim.

The Action Plan contains valuable initiatives with good longer-term potential. However, the Action Plan does not generally contain adequate information to allow the ECO to evaluate its specific claims for emission reductions or for cost per tonne of reduction. Some of its emission reduction claims for 2020 would have happened anyway as a result of existing programs.

The Action Plan contains no methodology to prioritize GGRA expenditures if cap and trade revenues prove to be less than predicted.

Will the Action Plan create new GHG reductions in Ontario?

Yes, but not enough for 2020

6.1 The Action Plan in Context

As discussed in Chapter 2.1.2, the *Climate Change Mitigation and Low-carbon Economy Act, 2016 ("Climate Act")*, sets a target for 2020 of a 15 per cent greenhouse gas (GHG) reduction, i.e., to an economy-wide total of 155 Mt.[1] Since "business as usual" emissions are predicted to be 173.5 Mt, meeting this target requires an economy-wide reduction in emissions of 18.5 Mt.

The cap and trade program, by itself, is not expected to enable Ontario to achieve its targeted greenhouse gas emission reductions in Ontario. Modelling carried out for the Ministry of the Environment and Climate Change (MOECC) estimated that domestic reductions resulting from the cap and trade program would total 2.8 Mt by 2020. At best, this would leave Ontario about 15.7 Mt short of the 2020 target. The emission reductions that the Climate Change Action Plan proposes to achieve would contribute to filling this gap.

The Ontario government proposes to use its cap and trade revenues, via the Greenhouse Gas Reduction Account discussed in Chapter 5, to fund an Action Plan to produce additional emission reductions, some over the longer term and some by 2020.

The Action Plan outlines policies and programs in all major emission sectors. Most of the impacts from the actions will occur later than 2020. The province estimates that the Action Plan will result in 9.8 Mt of reductions in 2020 and 20 Mt in 2030.[2] For the reasons set out in this chapter, the ECO believes this 2020 estimate is too optimistic. But even in the most optimistic possible scenario, there would still be a further gap of 5.9 Mt against the 2020 target (15.7 Mt – 9.8 Mt).

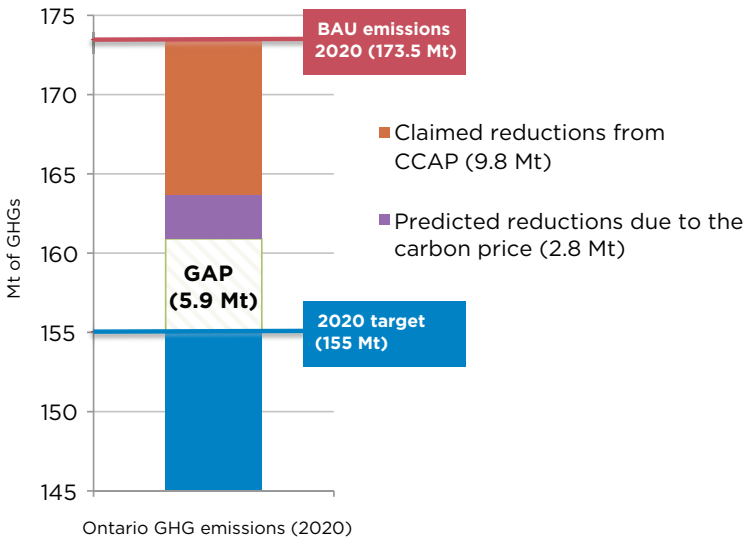


Figure 1: Gap to 2020 target for Ontario's GHG emissions, according to modelling undertaken for the Ministry of Environment and Climate Change in 2016

Source: Adapted from: Dave Sawyer, Jotham Peters, and Seton Stiebert, EnviroEconomics, summary report, *Impact Modelling and Analysis of Ontario's Proposed Cap and Trade Program*, May 27, 2016; Ontario Government, *Climate Change Action Plan*, June 2016.

Note to reader: The ECO's analysis of the first Action Plan is preliminary and limited. The government's Action Plan is a high level, aspirational document with little detail and none of the documentation recommended in Chapter 5 of this report. The Action Plan does not generally contain adequate information to allow the ECO to evaluate its specific claims for emission reductions or for cost per tonne of reduction. While the Action Plan indicates that it will serve as the basis upon which annual investment decisions will be made, it gives no indication how the government will prioritize spending if cap and trade revenues are less than expected (see Chapter 4). The ECO will update our analysis in future years as more information becomes available.

The Action Plan does not generally contain adequate information to allow the ECO to evaluate its specific claims.

6.2 Overview of Action Plan

Section 7 of the *Climate Act* requires the government to have a Climate Change Action Plan (Action Plan).[3] In June 2016, the province released its first Action Plan. The Action Plan is the result of intense negotiations between multiple ministries and many stakeholders, and should not be considered solely an MOECC document. Most of its initiatives must be delivered by other ministries. The plan can be revised at any time but must be reviewed at least every 5 years.

If a First Nation or Metis community offers traditional ecological knowledge, the Minister must take it into consideration. The plan also must consider the impact of the cap and trade program on low-income households and include actions to assist those households with the transition to a low-carbon economy. The plan must include a timetable for each action, each action's potential GHG reductions, cost per tonne of CO_2 emission reductions and, if the action could be funded from the GGRA, an estimate of the amount that may be considered. The government must also release a progress report every year on the status of every action.

Some key components of the Action Plan include:

- **Transportation** – Increasing the use and availability of lower carbon fuels, providing incentives for electric vehicles (EVs), installing more EV charging stations, investing in GO Regional Express Rail and active transportation infrastructure.
- **Buildings** – Bolder low-carbon technology and energy efficiency programs with an emphasis on emission reductions, low-interest financing for low-carbon technology and energy efficiency, clean energy and storage, retrofits for social housing and apartments, a renewable content requirement for natural gas and stricter building codes for new construction.
- **Land Use** – Making climate change a matter of provincial interest and mandatory content in municipal official plans, empowering municipalities to set green development standards, and eliminating minimum parking requirements.
- **Industry and Business** – Rewarding innovation, creating investment opportunities, offsetting the cost of implementing low-carbon technologies, and supporting research and development (R&D).

The ECO has been calling for action on climate change for many years, and applauds the Action Plan's broad scope and high level of ambition. Nearly half of the recommendations made by the ECO in *Conservation: Let's Get Serious* have been addressed, in some fashion, by the initiatives in the Action Plan.

For example:

Table 1: Select ECO Energy Conservation Report recommendations compared with Action Plan items

ECO Let's Get Serious Recommendations (2015/2016 Energy Conservation Report)	2016 Action Plan Item
The Ontario Energy Board and utilities should encourage electric vehicle charging during off-peak hours, through enhanced time of use rates and load control technology.	Transportation: 2.3: Free overnight EV charging (p.21)
Implement *Green Energy Act, 2009* provisions that protect consumers by mandating home energy use disclosure prior to sale.	Buildings and Homes: 7.1: Provide free energy audits and require Home Energy Rating Disclosure for pre-sale homes, mandated prior to listing a new or existing single-family home for sale by 2019 (p.29)
Require large private sector buildings to disclose their energy intensity.	* Actions not featured in plan, p.83: • Require energy reporting and benchmarking for multi-unit residential buildings, large commercial, and some industrial buildings to help owners make informed decisions about energy management and conservation
The Minister of Finance should redirect tax breaks from supporting fossil fuel consumption to activities that contribute to the public good.	Government: 1.8: Ontario will reform existing policies and programs that support fossil fuel use and fossil fuel intensive technologies (p.49)[4]

Source: Environmental Commissioner of Ontario, report, *Conservation: Let´s Get Serious Annual Energy Conservation Progress Report – 2015/2016*, 2016, and Government of Ontario, *Climate Change Action Plan*, June 2016.

But will the Action Plan produce substantial *additional* GHG reductions? (See Chapter 5) Research suggests that policies intended to drive down emissions to complement a cap and trade program should:

1. address a market failure,
2. incentivize behavioural or technological change, and/or
3. address emissions from uncapped sources.[5]

It is not clear that all the elements of the Action Plan meet these criteria.

6.3 Promising Longer Term Initiatives

The Action Plan includes some promising initiatives that, if well designed and implemented, have the potential to eventually achieve transformational changes. Three Action Plan initiatives with high potential to deliver large GHG reductions over the longer term include:

- Green Bank (delivery mechanism for home and commercial building retrofits),
- Low-carbon transportation, and
- Clean tech.

6.3.1 Green Bank – Building Retrofits

Energy conservation in existing buildings is an important public priority. In 2014, approximately 37 per cent of Ontario's energy was consumed in buildings, from single-family homes to office towers. Most of this energy demand was met from fossil fuels, primarily natural gas, used for comfort and water heating. Buildings also use electricity for lighting, cooling, powering office equipment, etc.[6]

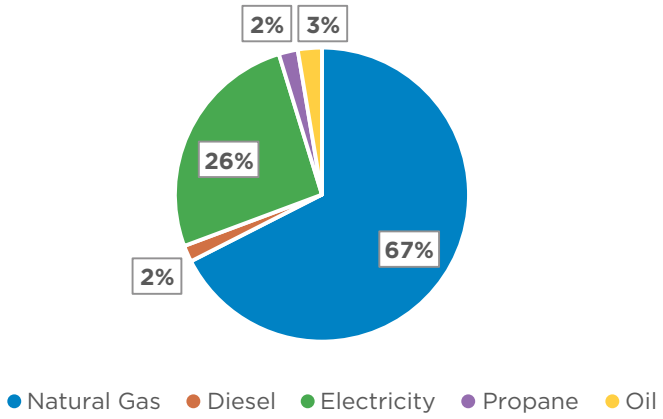


Figure 2: Ontario buildings' energy use by fuel type in 2014

Source: Statistics Canada – Catalogue no.57-003-X (2014 preliminary data) and IESO.

According to the Action Plan, the province will, "[establish] a green bank that would help homeowners and businesses access and finance energy-efficient technologies to reduce greenhouse gas pollution from buildings."[7] The green bank will act as an intermediary between homeowners and businesses, to help them access financing and connect them with service providers for energy efficiency projects whose scope it also will help determine.[8]

The green bank is one of the key commitments in the Action Plan. While the program design is not yet determined, it is the likely delivery mechanism for many of the Action Plan's programs, as shown in Table 2.

Table 2: Action Plan items that may be delivered via the green bank

Action Plan Item	Intended GGRA Funding (in millions)	Estimated GHG reduction in 2020	Start Date
Provide incentives for apartment retrofits	$300-400	Some portion of 99,000 tonnes	2017
Boost low-carbon technology in homes	$500-600	Some portion of 180,000 tonnes	2017/2018
Net zero home incentive	$180-220	Some portion of 180,000 tonnes	2017/2018
Increase business adoption of low-carbon technology	$875-1,100	2.5 Mt	2018
Total Funding Range	$1.9- 2.3 billion		

Source: Government of Ontario. June 2016. *Climate Change Action Plan*, www.ontario.ca/page/climate-change-action-plan.

Many jurisdictions around the world are using some form of a green bank model to accelerate investment in such opportunities.[9] Ontario's green bank is intended to be a hybrid of the Efficiency Vermont and New York Green Bank models,[10] with some elements from Connecticut.

Efficiency Vermont delivers a comprehensive suite of services to homeowners and businesses, including energy audits, financing, advice and education, and connecting clients to installers and service providers.[11] The New York Green Bank is focused on financial market transformation, namely unblocking barriers, changing risk perceptions, and providing innovative financial solutions for larger scale clean energy and energy efficiency projects.[12] The Connecticut Green Bank partners with private-sector investors to create low-cost, long-term financing to implement green energy measures in the residential, commercial, industrial, institutional and infrastructure sectors.[13]

The ECO generally supports the green bank concept, which could fill an important public policy gap. In *Let's Get Serious*, the ECO showed the huge environmental and economic potential in improving the energy efficiency of existing buildings. Just within the 17 per cent of commercial and institutional space occupied by public buildings, energy use could be slashed by 35 per cent, saving 1 Mt of GHGs and about $450 million every year, if all Ontario broader public sector buildings became as efficient as the top quartile performers in their category.[14] Inefficient public buildings can now be readily identified on the ECO's map.[15] Similar information will gradually become available for large private-sector buildings, as *Green Energy Act* energy disclosure obligations are rolled out.

The green bank could fill an important public policy gap.

But, as the ECO described in *Let's Get Serious*, both private and public sector building owners often need information, assistance and financial support to realize these substantial environmental and financial benefits. The green bank could provide these supports.

However, green banks are not easy to pull off successfully. In Ontario, energy conservation or retrofit programs are currently offered by the electric and natural gas utilities[16] and some municipalities (e.g., Toronto's Home Energy Loan Program),[17] so one key issue will be for the green bank to effectively collaborate with existing programs.

In the United Kingdom, an effort to transfer energy efficiency programs from ratepayers to taxpayers, via a green bank, did not go well. The National Audit Office concluded that the UK green bank, the Green Deal and Energy Company, did not achieve value for money. In the UK, as in Ontario, "improving household energy efficiency is central to government achieving its aims of providing taxpayers with secure, affordable and sustainable energy", and there was a demand to remove costs from electrical bills. However,

> the Department of Energy and Climate Change's ambitious aim to encourage households to pay for measures looked good on paper, as it would have reduced the financial burden of improvements on all energy consumers. But in practice, its Green Deal design not only failed to deliver any meaningful benefit, it increased suppliers' costs – and therefore energy bills...
>
> The scheme, which cost taxpayers £240 million including grants to stimulate demand, has not generated additional energy savings. This is because DECC's design and implementation did not persuade householders that energy efficiency measures are worth paying for.[18]

While the UK Department achieved its target to improve 1 million homes, it saved substantially less CO_2 than a previous program funded by ratepayers through utility bills. Demand for Green Deal loans was well below the government's expectations. As a direct result, the green bank could not cover its operating costs. It was unable to repay its £25 million stakeholder loan to the government, plus £6 million of accrued interest.

After studying green banks around the world, the OECD identified four key principles for success in establishing a green bank:[19]

- Ensure the green bank has a stable funding source that is sufficient and predictable over time (e.g., a mix of an initial capitalization, cap and trade revenues, utility bill surcharge, and green bond issuances).
- Conduct extensive market research and stakeholder engagement up front.
- Ensure the proper legal structure is in place to enable the green bank to fulfill its objectives.
- Ensure the bank is led and staffed by people with the right training and background in place to deliver results.

The Ontario government has not yet indicated how it will do any of these things. It is not clear whether the green bank will be funded solely through the GGRA, or whether it will have other revenue sources and/or be allowed to borrow. Nor has it yet clarified where financial and emission reduction accountability will lie, whether any quantifiable targets will be established for assessment purposes in the relationship between the government, the GGRA and the green bank.

Recommendation: In developing the green bank, the Ontario government should:

- **follow the four OECD principles,**
- **require the green bank to achieve additional emission reductions in Ontario, and**
- **ensure accountability and transparency for its financial and emissions reduction results.**

6.3.2 Low-Carbon Transportation

As noted in Chapter 2, transportation is Ontario's highest and fastest growing source of emissions, having increased over 27 per cent since 1990.[20] Reducing transportation emissions must, therefore, be Ontario's highest climate change priority.

In theory, transportation-related GHGs can be reduced in many ways, including: reducing personal vehicle kilometers travelled (e.g., driving less, changing travel patterns or shifting to other modes such as cycling or transit) and reducing the GHG emissions associated with freight or with vehicles (e.g., through enhanced fuel efficiency or substituting lower-carbon fuel and/or electricity – See *Renewable Fuel Standard*, below).

> Reducing transportation emissions must be Ontario's highest climate change priority.

But none of these is simple, especially after half a century of planning land use around the car, and while anticipating a population increase of almost 50 per cent in 25 years in the Greater Toronto and Hamilton area (GTHA).[21] As described in Chapter 3 of *Let's Get Serious*, real reductions will require more transit, zero- and low-carbon fuels and vehicles, a fundamental transformation in how people and goods move around, and how urban form is designed and developed.[22]

The Action Plan outlines a wide range of initiatives that promote low-carbon mobility, as shown in Table 3 below. Most of these transportation initiatives will take years to make a significant impact on Ontario's emissions. Capital investments in transit, for example, take a long time to design and build, but may then deliver low emission transportation for decades. They are important to Ontario's long-term emissions profile, but are unlikely to contribute significantly to the 2020 target.

> We require more transit, zero- and low-carbon fuels and vehicles, and a fundamental transformation in how people and goods move around.

Table 3: Action Plan items that promote low-carbon mobility

Category	Action Plan Item	Intended GGRA Funding (in millions)	Estimated GHG reduction in 2020	Start Date
Reducing the carbon content of fuels	Renewable Fuels Standard		2 Mt	2017/2018
	Assisting fuel distributors for high-blend sustainable biofuels and infrastructure upgrades	$100-155		2017/2018
	Pilot waste and agricultural methane as a fuel source	$15-20		2017
Electrifying transportation	Incentives for EV purchases	$140-160	50,000 Tonnes	2017
	Eliminate HST on zero emission vehicles			2017/18
	Free overnight EV charging	$15		2017
	Rebate to replace older vehicles	$10-20		2017/18
	More EV charging stations	$80		Ongoing
	EV-ready homes and workplaces			2018
	Electric and Hydrogen Vehicle Advancement Program			2017
	Increase public awareness of EVs	$1.75-2		2017/18
	Electric Vehicle Charging Stations In Government Locations	$.5-2		2017
	Establish EV Requirements For Existing Condominiums And Apartment Buildings			2017/18
	Permanent Green Licence Plate Program			Ongoing
	EV Educational campaign	$10-20		2017/18
	Partner And Dealership Programs for EVs			2017
	Private Fleet Awareness Campaign			2017/18
	Electric School Bus pilot program	$10		2017
Active transportation	Improve commuter cycling networks	$150-225	None attributed	Ongoing
	Increase urban cycling facilities			Ongoing
	Increase bike parking at transit stations and provincially owned facilities			Ongoing
	Revise provincial road and highway policies			Ongoing
	Provide information on benefits of active transport			2017/18

Category	Action Plan Item	Intended GGRA Funding (in millions)	Estimated GHG reduction in 2020	Start Date
Low-emissions vehicles	Green Commercial Vehicle Program	$125-170	400,000 Tonnes	2017/18
	Build a network of low-emission fuelling stations	$75-100		2017/18
	Create a Global Centre for Low Carbon Mobility	$100-140		2017
	Green-up government vehicles			2017/18
Railways and transit	Improve competitiveness of short-line railways	$15-20	None attributed	2017
	Accelerate Regional Express Rail Deployment	$355-675		Ongoing
Addressing barriers	Reform fossil fuel policies		None attributed	2017
	Eliminate minimum parking requirements			2017/18
Congestion Management and Low Vehicle Occupancy	Tools for municipalities to pilot congestion management plans and "low emission zones."		None attributed	2017
	Grants to municipalities and large private employers to reduce low vehicle occupancy	$10-20		2017/18
Total Funding Range	**$1.21-1.73 billion**			

Source: Government of Ontario. June 2016. *Climate Change Action Plan*.

Several of these proposed initiatives are Ministry of Transportation programs that have been resurrected (such as the Green Commercial Vehicle Program[23]) or were already underway, such as the cycling initiatives and electric vehicle incentives. What is new is the proposed level of additional funding through the GGRA for a few programs. For example, under the 2014 #CycleON Action Plan 1.0, $25 million was earmarked to improve provincial and municipal cycling infrastructure. In the Action Plan, the intended GGRA funding to expand cycling facilities in urban areas ranges from $150-$225 million. Such a significant increase could materially boost cycling as a zero-emission method of transportation. The Action Plan also proposes to provide electric vehicle owners with four years of free overnight charging, which could help encourage the uptake of electric cars.

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The largest amount of intended GGRA funding within the transportation sector has been allocated to accelerate the rollout of the government's Regional Express Rail (RER), Metrolinx's enhancement of rapid rail services across the GTHA. Within five years of completing RER, Metrolinx expects ridership to almost double.[24] The $355 - $675 million of additional GGRA funding is a small addition to the $13.5 billion already committed towards the RER by the province.[25] The Action Plan does not show how this GGRA funding will achieve additional GHG reductions.

One component of RER is the electrification of parts of certain GO Train lines.[26] Given Ontario's low-carbon electricity system, switching diesel engines to electric ones can both reduce GHGs and improve local air quality.[27] If more people choose to take the train instead of driving gasoline-powered cars, this can provide further reductions. However, the exact amount of GHG reductions depends on a complex interaction with Ontario's future electricity system. The GHG benefits of electrifying transportation are highly sensitive to the time and day of week, given that the GHG emissions associated with Ontario's electricity occur primarily during on-peak hours.[28] Electricity demand by commuter rail at peak hours may require increased use of natural gas-fired generation, which creates its own emissions, especially since the government has just suspended its Large Renewable Procurement Process for renewable electricity supply.

Copyright Queen's Printer for Ontario. Photo source: Ontario Growth Secretariat

Surprisingly, the RER funding (less than 10 per cent of the projected total GGRA funding) is the only amount that the Action Plan allocates for public transit, despite the enormous funding shortfall faced by many projects in the regional transportation plan, the Big Move.[29] Metrolinx projects that by 2031, public transit will still provide only 20 per cent of all trips taken in the GTHA.[30] Under Quebec's cap and trade program, in contrast, two-thirds of the revenue is earmarked for transit improvements.[31]

The Action Plan contains other helpful initiatives, such as municipal and employer transportation demand management plans, enhanced cycling infrastructure, and changing land-use planning policies. In total, the Action Plan contains a good start on low-carbon mobility. However, to have a major impact on Ontario's massive transportation emissions, the government will need to do more to discourage, and to make unnecessary, personal travel and goods transport by petroleum-fueled vehicles. Areas for immediate consideration include road pricing (at least until carbon prices are much higher) and

To have a major impact on Ontario's massive transportation emissions, the government will need to do more.

parking policies, as well as more funding of transit that supports dense, complete communities. The government should also stop supporting projects that encourage urban sprawl, such as funding major new public facilities in greenfield areas. Sprawl can lock in long-term transportation demand dependant on individual vehicles, thus hampering GHG reductions for many years to come.

For a more detailed discussion of options to reduce transportation fuel demand in Ontario, see the Transportation chapter in *Let's Get Serious*.

Recommendation: The government should do more to discourage, and to make unnecessary, travel by petroleum-fueled vehicles. It should also prioritize funding for projects and transit that support dense, complete communities.

6.3.3 Clean Technology

Clean technology – also known as 'clean tech'– refers to products, services and processes designed to greatly reduce or eliminate negative environmental impacts, using fewer natural resources.[32] In Canada, clean tech companies mainly fall into the sectors shown in Table 4.

Table 4: Clean Tech segments in Canada

Upstream Segment	Downstream Segment	Water and Agriculture Segment
• Biofuels and Bioenergy • Power Generation	• Energy Infrastructure / Smart Grid • Remediation and Soil Treatment • Transportation • Recycling & Recovery • Energy Efficiency • Industrial Processes	• Water and Wastewater • Agriculture

Source: Analytica Advisors, *Canadian Clean Technology Industry Report Synopsis* (2015).

Clean technologies, if widely adopted, can contribute significantly to emission reductions.[33] The Ecofiscal Commission suggests that investing Ontario's carbon revenues in clean technology should be the province's highest priority.[34] It highlighted the GHG reduction potential of using carbon revenue:

> to invest in research and development related to new technologies and production processes; or the funds could be invested to improve the adoption of superior technologies. These approaches can complement an existing carbon price by targeting specific barriers and easing firms' adjustment to the carbon price.[35]

Over the long run, investments in clean tech can help reduce the cost of emission reductions for all sectors.[36] Such investments can also help build a low-carbon green economy and contribute to the development of high-quality jobs in communities across the province.

Ontario has a thriving clean tech sector, with 35 per cent of Canada's clean tech companies, and revenues and exports each worth over a billion dollars a year.[37] In 2014, almost half of all clean tech investment in Canada happened in Ontario, worth $4.5 billion.[38] The TSX Venture Exchange is also one of the world's largest clean tech markets, having helped clean tech firms raise $2.4 billion of equity capital in 2015 alone.[39]

Despite this growth, the industry still faces significant barriers. Clean tech companies face a large funding gap between the early stage of research and development and market entry, especially for capital-intensive companies. As shown in Figure 3 below, this phase is known as the "valley of death" because so many companies do not survive it. There is a lack of investor appetite to fund the large capital needs of the demonstration projects and/or scaling up manufacturing that characterize this phase.[40]

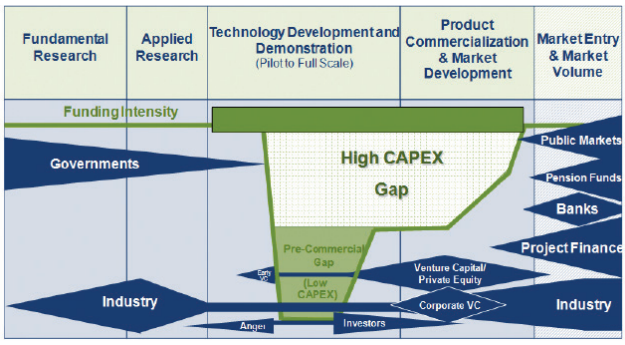

Figure 3: The funding flow for clean tech innovation

Source: Vicky Sharpe, Corporate Director and Founding President & CEO, Sustainable Development Technology Canada (SDTC)

Industry experts have consistently called for government support, particularly to stimulate local demand, support the demonstration and commercialization process and provide early stage risk capital, to help the industry survive the "valley of death".[41] The lack of alternatives suggests that this is an important role for the government.

Ontario has strong precedents for such support, such as the Ontario Emerging Technologies Fund[42] and Ontario Venture Capital Fund.[43] The MaRS centre, heavily supported by the Ontario government,[44] also supports clean tech entrepreneurs with advice, education and funding, notably through its Investment Accelerator Fund.[45] WaterTap does the same for water innovation companies. Ontario also has past experience with funding clean tech innovation through the (now paused) Innovation Demonstration Fund,[46] whose design and lessons learned may inform the way the province funds clean tech through the Action Plan.

However, current programs are not adequate to accelerate GHG reduction technology companies to produce meaningful emission reductions. First, there is inadequate funding, especially to assist companies through the "valley of death". Second, current programs are often poorly designed for the significant majority of the firms in this sector, which are small with revenues of $5 million or less and relatively few employees.[47] While these firms have a definite opportunity to scale up their operations, they report that traditional government programs impose a prohibitive *opportunity cost* that prevents them from benefitting from the programs to the extent they should.[48] Put simply, firms report that support programs often force them to complete onerous paperwork for a modest potential reward and that this workload-to-potential benefit ratio most negatively impacts the smaller firms it is intended to benefit, shutting them out of the process.

Third, clean tech firms also report that government investments in innovation often bias towards research conducted in universities and not within established companies, noting that academic research often takes decades to make its way into the marketplace where it can affect emissions.[49]

The Action Plan outlines several ways the cap and trade revenues will be used to support the clean tech sector, as shown in Table 5 below.

Table 5: Action Plan items that support the clean tech sector

Action Plan Item	Intended GGRA Funding (in millions)	Estimated GHG reduction in 2020	Start Date
Strengthen the low-carbon clean-tech sector	$140-235	None attributed	2017
Explore R&D tax credits			2017/18
Consider accelerated capital cost allowance	$0-1		2017/18
Update regulatory requirements to support the adoption of innovative industrial technologies			2017
Showcase Ontario's clean-tech expertise in Ontario government buildings	$75		2017
Total Funding Range	$215-311 million		

Source: Government of Ontario, *Climate Change Action Plan* (June 2016).

The government has released few other details about its support for the clean tech sector. Preliminary announcements (made prior to the release of the Action Plan) include:

- $74 million to partner with the Ontario Centres of Excellence to develop clean tech companies in the province, and to help other companies adopt their technologies, and
- $25 million to improve energy efficiency in small and medium-sized businesses, a program to be delivered by the Canadian Manufacturers & Exporters trade association.[50]

The Action Plan states that the green bank (see Section 6.3.1) will help companies and homeowners adopt clean technologies,[51] so once established it could help connect clean technology companies with local customers. The Action Plan also commits $75 million (as shown in Table 5) for the provincial government to procure clean technology for its own operations.

The ECO agrees that helping clean tech companies survive the "valley of death" can be a legitimate and important use of GGRA funds. The Action Plan does not, however, address four obvious questions.

Helping clean tech companies survive the "valley of death" can be a legitimate and important use of GGRA funds.

1. Will these initiatives produce direct GHG reductions?

The government claims that clean tech support will both support economic/export development and reduce GHG emissions. This raises an obvious question of cost-effectiveness: how many emission reductions will be produced by a given investment? It may make sense for Ontario to provide financial support to a broad range of clean tech companies as a part of economic development, but this support should not come from the GGRA unless the company will achieve significant emission reductions. Many "clean tech" processes may primarily produce other environmental benefits, i.e., eliminate a hazardous waste or reduce water consumption. As a side effect, each may have a small impact on GHG emissions.

But should this indirect relationship suffice for using GGRA funds to support the company? In the ECO's view, companies should be eligible for support from GGRA funds only if there is a direct and substantial connection between their proposed clean tech innovation and additional GHG emission reductions (see Chapter 5).

Recommendation: Government support for clean tech from the GGRA should have a direct, substantial and transparent connection to additional GHG reductions.

2. Will the reductions occur in Ontario?

A second obvious question is whether the proposed emission reductions will take place in Ontario. By definition, export oriented companies are selling their innovations outside Ontario. As indicated in Chapter 5, the *Climate Act* is not clear whether GGRA funds may be used to support emission reductions outside of Ontario. Emission reductions that occur outside Ontario will not contribute to achieving Ontario's emission reduction targets in section 6 of the *Climate Act*.

3. Can the government pick winners?

Even with GGRA support, not all companies will succeed. Failure of private companies that have received public funding may be embarrassing, even infuriating, but any venture capital program has to expect some degree of failure. Innovation, by definition, requires taking risks, especially attempts to develop transformative technologies. If clean tech companies were guaranteed to succeed, they would not face a "valley of death" and would not need government help.

The ECO believes that enhanced government support for this sector can be justified even though some firms may ultimately prove unsuccessful.

4. Will the effect of a GGRA investment in clean tech be frustrated by regulatory and procurement barriers to the use of Ontario clean tech innovations in Ontario?

In addition to funding challenges, there are many unintended obstacles to increased use of innovative clean technology in Ontario. For example, the MOECC has a long-standing difficulty in providing timely regulatory approvals for innovative technologies (see Chapter 4). Public sector procurement rules can also impede uptake of innovative technology, by preventing public sector tenders from stipulating levels of performance that only one or two companies can meet.[52] It will be important for the government to reduce these barriers in order to increase the pace of GHG emission reductions, and to allow Ontario low-carbon clean tech companies to sell their innovations domestically.

Recommendation: Government should reduce approval and procurement barriers to the use of low-carbon clean tech innovations within Ontario, especially those that have been developed with public funds.

6.4 How Many Reductions by 2020?

The initiatives described in the previous section will take time to produce significant results. In the ECO's view, many of the Action Plan's emission reduction claims for 2020 are the results of existing programs and would have happened anyway. Others are over-optimistic. Most of the 9.8 Mt of reductions that the Action Plan estimates will occur by 2020 are supposed to come from three sources:

- subsidizing the global adjustment, i.e., electricity prices (3 Mt),
- increasing the biomass component of transportation fuels (2 Mt), and
- subsidizing equipment upgrades by industry (2.5 Mt).

6.4.1 Electricity Pricing Subsidy

The Action Plan commits to spend between $1-1.3 billion from the cap and trade proceeds to "keep electricity rates affordable" by offsetting "the cost of greenhouse gas pollution reduction initiatives that are currently funded by residential and industrial consumers through their [electricity] bills".[53] No supporting details have been provided. Government documents suggest that $1-1.3 billion from cap and trade proceeds will be used to provide price relief for mid-size commercial and industrial customers, in a manner yet to be determined.[54]

The Plan claims that the pricing subsidy will result in 3 Mt in estimated GHG reductions in 2020, but without specifying any credible mechanism to achieve these results.[55] Based on the ECO's analysis, the proposed subsidy will not meet any of the key policy objectives for effective emission reductions. It will not:

1. address a market failure,
2. (durably) incentivize behavioural or technological change, or
3. address emissions from uncapped sources.[56]

Little room to reduce electricity emissions below baseline

An electrical subsidy cannot be expected to produce material additional emission reductions within the electricity sector. Electricity is already the smallest and cleanest of Ontario's major energy sources.[57] In 2014 and 2015, 91 and 90 per cent of Ontario's electricity, respectively, came from low-emission sources, with only 9-10 per cent from fossil fuels (natural gas), as shown in Figure 4.

The proposed electricity subsidy will not meet any of the key policy objectives for effective emission reductions.

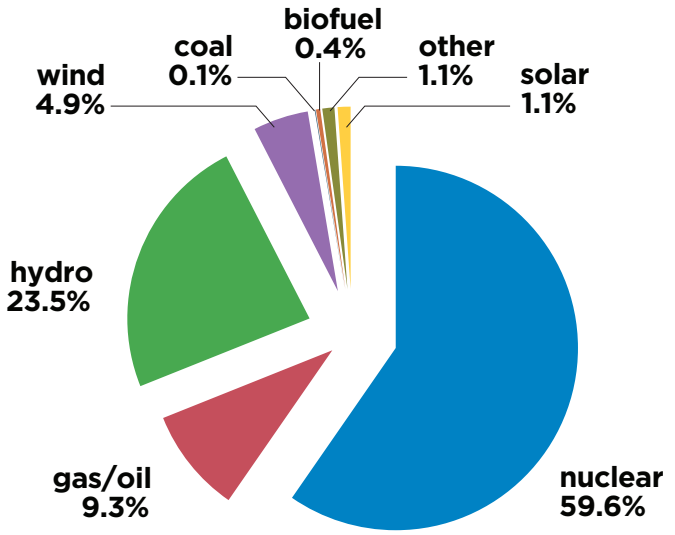

Figure 4: Sources of Ontario's electricity in 2014

Source: Independent Electricity System Operator.

The Action Plan does not propose to increase spending or otherwise improve electricity conservation or low-carbon generation. Even if the government decides to increase spending on electricity conservation or low-carbon generation beyond what is currently planned, it would be very difficult to deliver 3 Mt worth of emission reductions by 2020, because baseline emissions are already so low.

The government's 2013 Long Term Energy Plan (LTEP) estimated emissions from the electricity sector will be only 4.61 Mt in 2020, with a range from approximately 3.5 Mt to 10 Mt, all from natural gas-fired electricity generation.[58] The Independent Electricity System Operator (IESO)'s most recent technical report, released in summer 2016, estimates even lower emissions (3.4 Mt) in 2020, in part because the price impact of the cap and trade program will reduce the operating hours of natural gas-fired generation.[59] Put another way, a further 3 Mt emissions reduction in 2020 would require almost a 90 per cent reduction in the electricity sector's emissions (and its use of natural gas), in comparison to the IESO's most recent estimate. The Action Plan proposes no mechanism to achieve this.

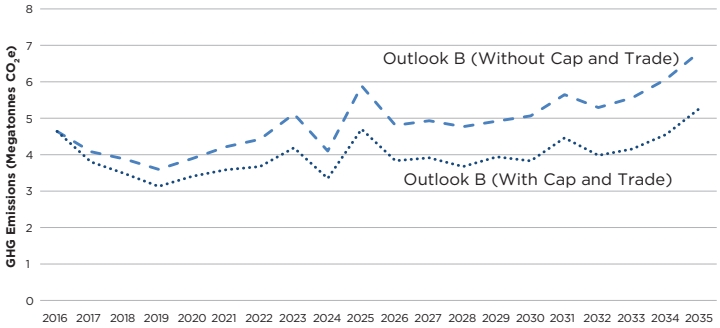

Figure 5: Projected impact of cap and trade on Ontario's electricity sector emissions

Source: Independent Electricity System Operator.

On the contrary, the Ministry of Energy has reduced the ability of the electricity system to keep GHG emissions low, and to support clean tech innovation in Ontario, by suspending the Large Renewable Procurement process. In addition, electricity system GHG emissions will rise steeply if the Canadian Nuclear Regulatory Commission decides not to allow the Pickering nuclear station to continue to operate while other nuclear stations are refurbished.

Existing conservation and clean generation programs are baseline, not additional

The "greenhouse gas pollution reduction initiatives that are currently funded by residential and industrial consumers through their [electricity] bills" referred to in the Action Plan are existing electricity sector initiatives to which the government committed in the 2013 LTEP. They include conservation programs, renewable electricity targets, and nuclear refurbishment. These initiatives work together to keep emissions from Ontario's electricity sector low, and are funded (in part or in full) through the Global Adjustment, a component of electricity bills.

In 2014, 20 per cent of the Global Adjustment was spent on wind and solar, 45 per cent on nuclear, and 4 per cent on conservation, as shown in Figure 6. Any emissions reductions that result from these existing initiatives in the approved 2013 LTEP are not due to the GGRA or the Action Plan and therefore should not count as additional.

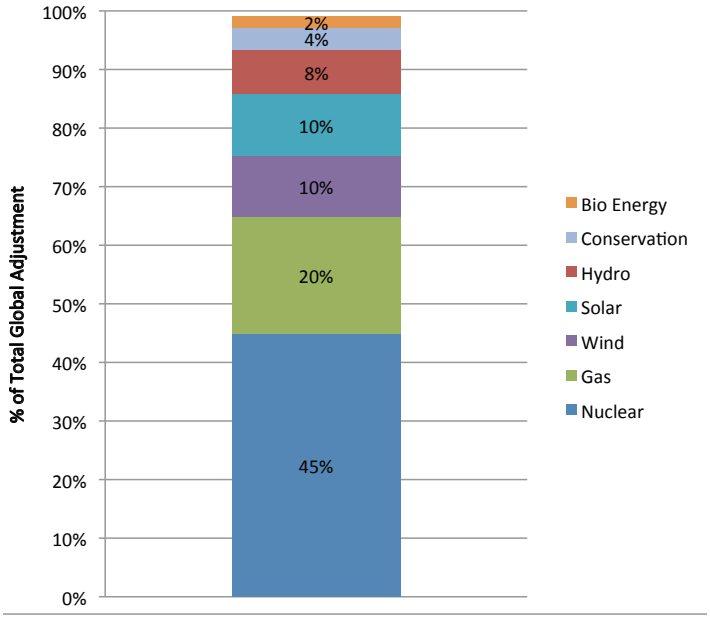

Figure 6: Estimated components of the Global Adjustment based on type of electricity resource

Source: Ontario Energy Board, Independent Electricity System Operator[60]

Fuel switching?

In communications to the ECO, the Ministry of Energy claims to have documents to show that the proposed subsidy will achieve the claimed 3 Mt reduction by incenting fuel switching from fossil fuels to electricity. The ECO requested these documents, but they were not provided. Without evidence, the ECO is not persuaded that the proposed subsidy will incent sufficient fuel switching to deliver additional GHG reductions, much less a 3 Mt reduction by 2020.

It is true that switching from fossil fuels to electricity could reduce total GHG emissions, especially if Ontario continues to green its electrical supply. The IESO's Ontario Planning Outlook, released in September 2016, includes several conceptual outlooks for the next twenty years that assume increased renewable supply and increased electrification of vehicles and transit, residential and commercial heating, and industrial energy use. In such a future, overall Ontario emissions would drop, especially if new electric load is concentrated off peak.[61] Ontario has huge daily, weekly and seasonal swings in electricity demand, with gas-fired emissions at peak, but with ample low-emission electricity available off peak.[62]

However, the ECO has seen no evidence that this future can be achieved without much higher carbon pricing. On the contrary, current trends may encourage fuel switching the other way. In recent years, both petroleum and natural gas have become cheaper and electricity more expensive. While Ontario residential electricity prices are average for North America,[63] it is the change in rates from their previous (low) level that is most visible to consumers. Union Gas estimates that between 2006 and 2015, the cost of heating with natural gas declined by 31%, while the cost of heating with electricity and other fuels increased by 38%.

In terms of future electricity pricing, Ontario Power Generation has asked the Ontario Energy Board for a 2/3 price increase in the amount it charges for its nuclear-fired electricity, which provides about 30 per cent of Ontario's electricity supply.[64] At the same time, Ontario's plans to subsidize natural gas expansion to additional communities may encourage additional Ontario residents and businesses to switch away from electricity (and propane) to natural gas.[65]

In the face of these trends, cogent evidence would be needed to show that the proposed subsidy to all mid-size industrial and commercial customers will produce any additional emission reductions below the current baseline, much less 3 Mt in 2020. The Ministry of Energy has not demonstrated a plausible mechanism for this subsidy to produce emission reductions that are either

transformative or durable, especially after the end of the subsidy. The ECO is also concerned about the possibility of double counting. Fuel switching by industrial and commercial businesses is the basis of emission reductions claimed elsewhere in the Action Plan.

In sum, the ECO has seen no evidence that the proposed subsidy of electricity rates is either an effective or a cost effective way of reducing greenhouse gas emissions.

Recommendation: Subsidizing electricity rates should not be considered an acceptable use of GGRA funds.

6.4.2 Ethanol in Gasoline

The Action Plan estimates that 2 Mt of the reductions necessary in 2020 will come from increasing the availability and use of lower carbon fuel in internal combustion engines for transportation. Since transportation is Ontario's largest source of GHG emissions, it makes sense to put a high priority on bringing those emissions down. The tools to achieve this 2 Mt reduction are stated to be:

1. a Renewable Fuels Standard ("RFS"),[66]
2. assistance to fuel distributors to sell high-blend sustainable biofuels, and
3. a pilot program to use waste and agricultural methane as a transportation fuel source.

The government provides almost no details as to how these initiatives are to achieve the planned reductions by 2020. Most of the reductions are presumably to come from increasing the use of corn-based ethanol in gasoline. Much of this ethanol comes from corn grown in Ontario,[67] although a Sarnia plant to make sugar (ethanol feedstock) out of corn stover (stalks and leaves) is scheduled for construction by 2018.[68]

Renewable versus Low-Carbon Fuel Standard

The Action Plan is ambiguous. It refers both to *lower carbon* fuel such as propane and liquefied gas, and to *renewable* fuel. These two concepts are not the same. Lower carbon fuels, such as propane, are not necessarily renewable, and renewable fuels do not necessarily have a lower carbon footprint than gasoline. The Greener Diesel regulation, and the British Columbia Greenhouse Gas Reduction (Renewable & Low Carbon Fuel Requirements) Act and Renewable & Low Carbon Fuel Requirements Regulation, are examples of fuel standards that require both a renewable content and a lower greenhouse gas emission performance requirement.

Renewable Fuels Standard

Transportation in Ontario is almost entirely reliant on fossil fuels. The goal of a Renewable Fuels Standard is to bring down emissions from existing internal combustion engines, by boosting the renewable content of their fuels, even if total kilometres driven remain the same. (Other transportation and land-use initiatives are necessary to eventually reduce the total kilometres driven.)

Ontario's existing renewable transportation fuel mandates are:

- the Ethanol in Gasoline regulation that has, for ten years, required a 5 per cent blend of ethanol in gasoline.[69] In fact, Ontario gasoline contained about 7 per cent ethanol in 2016,[70] and
- the *Greener Diesel* regulation that required a 2 per cent blend of low-carbon biofuels in diesel in 2015, 3 per cent in 2016, and 4 per cent starting in 2017.[71]

Transportation in Ontario is almost entirely reliant on fossil fuels.

There will likely be several different compliance pathways possible under an Ontario RFS regulation.[72] This may include biogas/methane (renewable natural gas) for natural gas vehicles. However, it is likely that, for 2020, a major compliance pathway for this RFS will be through blending more ethanol into the ~16 billion litres of gasoline that Ontarians use every year.[73]

Does corn-based ethanol reduce GHG emissions from gasoline?

The Ontario government claims that increasing the amount of ethanol in gasoline blends will reduce GHG emissions from gasoline by 5 per cent by 2020. The fundamental justification for adding biomass-based ethanol to gasoline is that the carbon in biomass comes from the air, and not from fossil fuels, even though some fossil fuel carbon is released in growing, transporting, refining and delivering biomass-based ethanol.[74]

Does ethanol reduce GHG emissions?

There has been a substantial debate about the GHG benefits of ethanol.[75] [76] In 2014, the U.S. Congressional Budget Office concluded that reductions in greenhouse gas emissions due to the federal Renewable Fuel Standard would be "small in the near term but could be larger over the long term." This conclusion was based on the finding that:

> The production and use of different types of renewable fuels involve different amounts of greenhouse gas emissions. Estimates of those emissions are uncertain, and researchers' predictions vary considerably. However, available evidence suggests that replacing gasoline with corn ethanol has only limited potential for reducing emissions (and some studies indicate that it could increase emissions). The success of the RFS in reducing the emissions from transportation fuels will depend mainly on the extent to which it causes people to substitute advanced biofuels—particularly cellulosic biofuels—for gasoline or diesel over the long run.[77]

This was still the Congressional Budget Office's position in November 2015.[78]

The U.S. Environmental Protection Agency (EPA) was expected to provide a definitive answer. It is required to provide an objective analysis of the environmental effects and unintended consequences of biofuels (including ethanol) to Congress every three years, and to analyze and address any negative air quality impacts from the Renewable Fuel Standard.[79] Unfortunately, the EPA has not delivered either of these reports. The EPA also failed to deliver on its own commitment to update its lifecycle analysis as the science on biofuels evolved.[80]

Despite these U.S. concerns, the ECO accepts the Ontario government's claim that increasing the proportion of ethanol in Ontario gasoline would reduce GHG emissions. This claim is based on Canadian modelling software, called GHGenius.[81] GHGenius is incorporated by reference into regulations in both Ontario and British Columbia,[82] and has successfully withstood at least one court challenge.[83] The ECO is not aware of any better modelling software for this purpose currently available in Canada. In addition, biomass-based fuels (together with afforestation/reforestation) feature "particularly prominently" in integrated assessment models of available low-carbon pathways.[84]

Ethanol in Ontario gasoline would reduce GHG emissions.

The most recent public version of GHGenius, 4.03a, concludes that adding corn-based ethanol to Ontario gasoline will reduce GHG emissions by about 1.09 kg/L, although it is not certain that all the reductions would occur in Ontario. Version 4.03a is dated 2013, when the federal government stopped keeping it up to date. To evaluate this emission reduction claim in light of current science, measurements, and assumptions, the ECO commissioned a custom run of a proprietary version of GHGenius, 5.0 Beta 2 (see Appendix B available online at eco.on.ca). The up-to-date model concludes that adding corn-based ethanol to Ontario gasoline will reduce GHG emissions by about 1.29 kg/L; again, not all these reductions would necessarily occur in Ontario.[85]

The ECO has reviewed the principal arguments against GHG benefits from ethanol, and confirmed that GHGenius has made a reasonable effort to address these concerns. For example, GHGenius contains recent data on a wide range of relevant inputs, including the impact of growing corn on soil carbon levels and nitrous oxide emissions.[86] GHGenius analyses the fossil fuel and other energy required to produce and deliver ethanol, from the field to the vehicle. It concludes that producing one megajoule of ethanol and delivering it to a vehicle consumes 0.5492 megajoules of energy, mostly from natural gas.

Despite its GHG benefits, ethanol may have other environmental impacts that are not captured in GHGenius. One common critique of ethanol is that it encourages farmers to grow more corn, at the expense of natural ecosystems and of food crops. For example, conversion of pasture, conservation grasslands and bee-friendly cultivated crops to corn likely harm both managed and wild pollinators. It reduces forage availability and increases the use of chemicals that negatively affect pollinators and their ecosystem services. [87] Accordingly,

> every scenario of a sustainable global future must address the real and genuine concerns related to large-scale deployment of bioenergy…includ[ing] biophysically and societally acceptable limits of land requirements….food security and water and nutrient availability.[88]

The area seeded to grain corn in Ontario increased 28 per cent in the decade after Ontario adopted its 5 per cent ethanol-in-gasoline mandate.[89] On the other hand, the total area being farmed in Ontario dropped from 13,310,216 acres (5,386,453 ha) in 2006 to 12,668,236 acres (5,126,653 ha) in 2011.[90] This was due in part to a large drop in cattle production. This suggests that Ontario ethanol production has not yet significantly displaced natural ecosystems, with the possible exception of hedgerows and buffer strips within farms.

A higher ethanol mandate could increase the incentive to grow corn at the expense of natural ecosystems and pollinator-friendly crops. Appropriate precautions should therefore be included in the proposed Renewable Fuels Standard regulation to protect valued ecosystems and biodiversity, including pollinators, whether or not the corn or other biomass is grown in Ontario. As documented in the ECO's recent report, *Putting Soil Health First*,[91] a renewed focus on soil health in Ontario agriculture could allow biomass to be grown and harvested while building up carbon stocks in Ontario soils, both reducing greenhouse gas emissions and the need for pesticides and increasing resilience to the impacts of climate change.[92]

Recommendation: A Renewable Fuels Standard regulation should include a low-carbon performance standard. It should only incent the production of biofuels that are grown sustainably, without damaging natural ecosystems or biodiversity, and while building up soil carbon.

How much ethanol?

Ontario could theoretically quadruple the use of ethanol in Ontario vehicles, but the practical impact by 2020 is likely to be much less.

First, the ECO has not seen any analysis of whether biofuel production could be more than doubled in Ontario by 2020, without adverse environmental effects or at all, in order to increase ethanol levels in Ontario gasoline to 15 per cent. Nor have we seen any analysis of whether ethanol refining capacity could be more than doubled in Ontario by 2020.

Second, there is a physical limit on the amount of ethanol that can be successfully blended with gasoline and used in a conventional engine. This limit, sometimes called a "blend wall," is 15 per cent ethanol (by volume, or v/v) for cars built on or after 2001; 10 per cent for older vehicles.[93] Under O. Reg. 535/05, Ontario requires 5 per cent (v/v) ethanol in gasoline, yet in practice Ontario gasoline contains about 7 per cent (v/v) ethanol. This means that for conventional engines, Ontario can increase the ethanol level by at most 8 per cent (v/v) before hitting the 15 per cent limit.[94] Increasing the ethanol content of all Ontario gasoline from its current 7 per cent to 15 per cent would mean using an additional 1.3 billion L of ethanol (instead of gasoline) per year by 2020. This would create an additional GHG emission reduction of about 1.8 Mt, if total fuel use does not increase.[95]

In addition, many North American vehicles that now burn conventional gasoline, are already equipped with flex engines, although their owners may not be aware of it. Since 2006, flex vehicles have had yellow gas caps or a yellow ring around the pump nozzle insertion port. There might be a sticker inside the fuel door, and the owner's manual should state which fuel types are approved for each vehicle. Between 2000 and 2014, over 1.62 million flexible fuel vehicles were sold across Canada.[96] Ontario vehicle registrations show approximately 510,098 flexible fuel vehicles in our province, or about 6.1 per cent of all vehicles.[97]

Such engines are approved to burn gasoline with up to 85 per cent ethanol, but may not have access to filling stations that sell it. Some high ethanol filling stations are already used in Ontario for fleets.[98] The Canadian Standards Board published standard CAN/CGSB-3.512-2013, *Automotive ethanol fuel* (E50-E85) to help ensure acceptable vehicle operability in Canada's cold winters. It applies to automotive fuel composed of 50 to 85 per cent (v/v) denatured fuel ethanol and gasoline, for use in flexible fuel vehicles over a wide range of climatic conditions.[99] A second Canadian standard, for a 30 per cent blend, is under consideration.

Action Plan item 1.2, Transportation, is presumably intended to encourage fuel distributors to make enriched ethanol blends available for sale to owners of flex vehicles. If so, consumers could consume an additional volume of ethanol in 2020 in their flex vehicles, with commensurate emission reductions, if the higher blend fuels were cost-competitive and if potential users were aware of, and chose, this fuelling option. If Ontario has about 500,000 flexible fuel vehicles, and if all of them had full access to 85 per cent ethanol and chose to use it all the time, they could theoretically consume another 1.3 billion litres per year of ethanol.[100]

However, high-level blends are not likely to be cheaper than standard gasoline, because both the federal and provincial governments tax the fuel based on its volume basis, not on its energy content. Since a litre of E85 only contains 70 per cent of the energy of a litre of gasoline, more litres of E85 must be purchased to travel the same distance. The cost advantage of ethanol under Ontario's cap and trade program will only be a few cents per litre, which is not enough to offset the extra taxation of high level blends. Without tax reform, the ECO would not, therefore, expect high-level blends to materially increase ethanol consumption by 2020.

Is a renewable fuel mandate a cost effective way to reduce GHG emissions?

The Ecofiscal Commission estimates that the current ethanol mandate has total costs to consumers and to the government of approximately $185 per tonne of GHG emissions reduced.[101] This is much higher than the price on carbon that the government proposes to apply to other parts of the economy through cap and trade, which is closer to $16 to $18 per tonne. While the ECO has not evaluated the Ecofiscal Commission's estimate, California also has high per ton costs for its renewable fuel standard (over $100 U.S. for most of 2016):

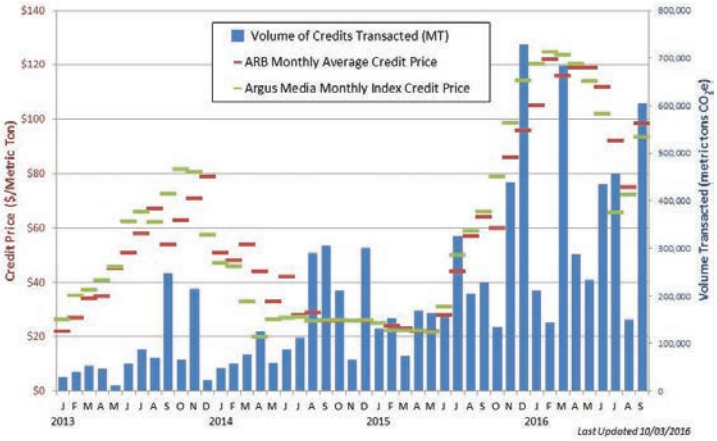

Figure 7: Monthly Low-Carbon Fuel Standard Credit Price and Transaction Volume

Source: California Air Resources Board, Low Carbon Fuel Standard, Monthly Credit Price and Transaction Volumes

This is an example of a larger problem. The Action Plan promises a suite of policies aimed at reducing emissions across the entire Ontario economy. The ECO supports comprehensive action on climate change and recognizes that the cap and trade program alone is not sufficient to enable Ontario to meet its GHG reduction targets, especially the later (2030 and 2050) ones that will require deeper decarbonisation.

But not all of these policies are equally cost effective.

Economic theory suggests that, to achieve emission reductions at the least possible economic cost, the *marginal abatement cost* of carbon pollution should be as close as possible to the same for all economic sectors. The marginal abatement cost reflects the cost of one additional unit or tonne of carbon that is abated, or not emitted, and reflects the combined impact of all government policies, explicit and implicit, that affect the cost of carbon pollution, including regulatory pollution standards as well economic instruments like cap and trade.

Not all policies are equally cost effective.

It is difficult for Ontario to account for the interactions between its own policies, let alone those of other levels of government, and the total implicit (hidden) and explicit (visible) carbon price they impose. It is also difficult to identify which emission reductions are due to which federal, provincial or other initiatives. Even at the provincial level, some of the policies and programs proposed in the climate action plan overlap confusingly with the cap and trade program and with utility-based conservation programs. However, it is clear that some, such as the proposed renewable fuel mandate, will have implicit prices much higher than the visible price imposed by cap and trade.

This does not necessarily mean that the proposed renewable fuel standard should be abandoned. Despite economic theory, a uniform economy-wide carbon price has proved difficult to reconcile with practical politics.[102] However, consistent with its commitment to Open Government, the government should make public all data necessary to assess the effectiveness and cost-effectiveness of its emission reduction programs.

Recommendation: The government should make public all data necessary to assess the effectiveness and cost-effectiveness of its emission reduction programs.

6.4.3 Low-Carbon Technology Adoption by Industry

The third initiative in the Action Plan for which significant 2020 emissions reductions are claimed is the commitment to "help Ontario businesses and industries increase their use of low-carbon technologies" and improve energy productivity. The Action Plan indicates this is expected to cost $875 million - $1.1 billion and to deliver 2.5 Mt of emissions reductions in 2020.[103]

This commitment would be delivered through the green bank and would presumably include investments in both fuel switching and energy efficiency. Fuel switching and energy efficiency are both important GHG reduction tactics for businesses and industries. However, the claim that this will produce additional 2.5 Mt emissions reduction by 2020 seems optimistic.

Fuel Switching

The Action Plan commits $40-$60 million to help coal-intensive industries transition to less carbon-intensive fuels.[104] This would build on O. Reg. 79/15 (Alternative Low-Carbon Fuels), which exempts industrial facilities in the cement, lime, and iron and steel sectors from requiring a waste disposal site approval[105] to burn biomass or municipal waste in place of coal.

As the industries covered by this regulation must heat raw materials to very high temperatures (i.e., they require a high amount of thermal energy), fuel switching is one of the key GHG abatement options available to them. For example, in the cement sector, experts estimate that fuel switching could result in the largest share of emission reductions, followed by substituting alternative materials in clinker production,[106] and thermal energy and electricity efficiency improvements.[107] The practice of fuel switching in the cement sector is well-established in other jurisdictions.[108] The Intergovernmental Panel on Climate Change has estimated that fuel switching in high-emitting industries could result in emission reductions of 10-20 per cent per year.[109] Depending on uptake, the MOECC is projecting reductions of 5-10 per cent per year in the affected sectors. There is a limited range of fuels that can be used, as they impact production. Companies' fuel choices will likely be dictated by what is readily available in a stable local supply, so at this early stage it is not clear what amount of GHG savings will be achieved as a result of this regulation.

Facilities would still need approval from the MOECC under section 9 of the *Environmental Protection Act* to switch to alternative fuels, as would most other industrial facilities seeking to make significant changes to their equipment and production processes that might reduce emissions. The time required to obtain these approvals could delay emission reductions. In 2015, the average delay to obtain such approval was approximately two years. The MOECC hopes to reduce this delay to one year in 2017, by converting most air permits to a *permit by rule* or Environmental Activity and Sector Regulation approach. However, more complex approvals, such as those typically needed by the large emitters who will require cap and trade allowances, will still require individualized approvals from the MOECC, and may also require air approvals from the federal government under its new multi-material air pollution regulation. The MOECC has committed in the Action Plan to establishing a service standard for decisions on alternative fuel applications.

Even if the MOECC is successful in reducing its approval timeframe to its target of one year, approvals delays seem likely to reduce the emission reductions that Ontario industries can achieve by 2020.

Approvals delays seem likely to reduce the emission reductions that Ontario industries can achieve by 2020.

Industrial Energy Efficiency

It may also take more time than expected to deliver large emission reductions from industrial energy efficiency measures. The technical potential is there. A recent study conducted for the Ontario Energy Board estimates that Ontario industry's use of natural gas (the primary fossil fuel used by industry) could be reduced by about 25 per cent by 2020 if all cost effective best-available technology was immediately adopted. This would reduce greenhouse gas emissions by 4.6 Mt, which is about five times the amount of natural gas savings (and emissions reductions) expected by 2020 under the gas utilities' current budget for industrial gas conservation programs.[110]

However, it is not realistic to expect such technology to be adopted immediately, even with GGRA support. Industrial energy efficiency projects may require significant changes to production processes, and are often considered through a multi-year planning and budgeting framework, with process equipment only replaced at its end of life. In addition, there is the long-standing problem with approvals delays, described above. While industrial natural gas conservation programs have achieved good results, the disappointing results achieved in the first five years of the IESO's industrial electricity conservation programs illustrate the long time horizon for most industrial conservation projects. Many promising projects have been identified through engineering studies, but only a small percentage of projects have yet been completed.[111]

In total, the Action Plan has not established a credible foundation for the 2.5 Mt emission reductions predicted for 2020 from this program.

6.5 Recommendations

The ECO has been calling for action on climate change for many years, and applauds the Action Plan's broad scope and high level of ambition. The Action Plan contains valuable initiatives with good longer term emission reduction potential, including the green bank, low-carbon mobility, and helping clean tech companies survive the "valley of death". To improve the transparency of the Action Plan, and the effectiveness of its initiatives in producing emission reductions, the ECO recommends:

Recommendation: In developing the green bank, the government should:

- **follow the four OECD principles,**
- **require it to achieve additional emission reductions in Ontario, and**
- **ensure accountability and transparency for its financial and emission reduction results.**

Recommendation: The government should do more to discourage, and to make unnecessary, travel by petroleum-fueled vehicles. It should also stop supporting projects and processes that encourage urban sprawl.

Recommendation: Government support for clean tech from the GGRA should have a direct, substantial and transparent connection to additional GHG reductions.

Recommendation: Government should reduce approvals and procurement barriers to use of low-carbon clean tech innovations within Ontario, especially those that have been developed with public funds.

In relation to the 2020 emission target, the ECO cannot support the government's claim that the Plan will reduce annual emissions by 9.8 Mt in 2020. Some of the claimed reductions are the results of existing programs and would have happened anyway. Others are over-optimistic or have not been supported by adequate evidence and analysis:

Principal Action Plan Claims for 2020	ECO Evaluation
• 3 Mt from subsidizing the Global Adjustment portion of electricity prices, Ministry of Energy	No additional emission reductions have been demonstrated from subsidizing the Global Adjustment portion of electricity prices for some customers.
• 2 Mt from raising the ethanol content of gasoline and subsidizing the availability of high ethanol blends	If Ontario can more than double its ethanol use by 2020, raising the ethanol content of gasoline from 7 per cent to 15 per cent could plausibly produce additional GHG reductions of about 1 to 1.8 Mt. This reduction would be achieved by regulation, not by investments from the GGRA, and could be eroded if total distance driven increases. Modest additional reductions could come from subsidies to improve the availability of high ethanol blends.
• 2.5 Mt from subsidizing technology adoption by industry	The Action Plan does not give enough information for the ECO to evaluate what, if any, additional emission reductions will come from technology adoption by industry by 2020.

For these shorter term programs, the ECO recommends:

Recommendation: Subsidizing electricity rates should not be considered an acceptable use of GGRA funds.

Recommendation: A Renewable Fuels Standard regulation should include a low-carbon performance standard. It should only incent the production of biofuels that are grown sustainably, without damaging natural ecosystems or biodiversity, and while building up soil carbon.

Recommendation: The government should make public all data necessary to assess the effectiveness and cost effectiveness of its emission reduction programs.

ONTARIANS TAKING ACTION

ZooShare

ZooShare, a Toronto-based, community-owned co-operative, is working to establish North America's first zoo-biogas plant. Working in conjunction with the Toronto Zoo, the plan is to build a biogas plant that will capture methane generated from manure and food waste and use it to produce electricity. By diverting the animals' manure and food waste from the waste stream, ZooShare estimates this will reduce greenhouse gas emissions by the equivalent of 10,000 tonnes of CO_2 each year. As a side benefit, valuable nutrients will be returned to the soil in the form of a high-quality fertilizer.

Endnotes

[1] Ontario's GHG reduction target for 2020 is 15 per cent below 1990 levels. This translates into a target of 155 Mt.

[2] Government of Ontario, *Climate Change Action Plan*, June 2016. www.ontario.ca/page/climate-change-action-plan

[3] *Climate Change Mitigation and Low-carbon Economy Act, 2016*, section 7.

[4] In August 2016, three of the world's largest insurers, Aviva, Aegon NV, and MS Amlin, along with the Institute and Faculty of Actuaries and Open Energi, released a joint statement calling on the members of the G20 to end coal, oil, and gas subsidies by 2020. Their rationale? Climate change is the "mother of all risks," exacerbated by hundreds of billions in government subsidies for fossil fuels every year. Overseas Development Institute, news release, *Major insurers urge G20 leaders to commit to 2020 fossil fuel subsidy phase out,* accessed August 2016. https://www.odi.org/news/803-media-note-major-insurers-urge-g20-leaders-commit-2020-fossil-fuel-subsidy-phase-out

[5] Institute for Competitiveness and Prosperity, report, *Toward a Low-Carbon Economy: The costs and benefits of cap-and-trade*, p.44, April 2016. www.competeprosper.ca/work/working_papers/working_paper_25

[6] Environmental Commissioner of Ontario, report, *Conservation: Let´s Get Serious Annual Energy Conservation Progress Report – 2015/2016,* chapter 4, 2016.

[7] Government of Ontario, *Climate Change Action Plan*, p.8, June 2016. www.ontario.ca/page/climate-change-action-plan

[8] Government of Ontario, *Climate Change Action Plan*, p.17, June 2016. www.ontario.ca/page/climate-change-action-plan

[9] OECD, report, *Green Investment Banks: Scaling up Private Investment in Low-carbon, Climate-resilient Infrastructure*, 2016.

www.oecd-ilibrary.org/finance-and-investment/green-investment-banks_9789264245129-en

[10] Government of Ontario, *Climate Change Action Plan*, p.16, June 2016. www.ontario.ca/page/climate-change-action-plan

[11] Efficiency Vermont, website, *Services*, accessed October 2016. www.efficiencyvermont.com/services

[12] NY Green Bank, report, *2016 Business Plan,* June 27, 2016. greenbank.ny.gov/-/media/greenbanknew/files/2016-NYGB-Business-Plan.pdf

[13] Connecticut Green Bank, website, *About Us*, accessed October 2016. www.ctgreenbank.com/about-us/

[14] Environmental Commissioner of Ontario, report, *Conservation: Let´s Get Serious Annual Energy Conservation Progress Report – 2015/2016,* chapter 4, 2016.

[15] Environmental Commissioner of Ontario, map, *Broader Public Sector Buildings Energy Use Intensity.* eco.on.ca/maps/2016-lets-get-serious/

[16] Independent Electricity System Operator (IESO), website, *Conservation First Framework,* accessed August 2016. www.ieso.ca/Pages/Conservation/Conservation-First-Framework/default.aspx

[17] City of Toronto, website, *Home Energy Loan Program (HELP)*, accessed August 2016. www1.toronto.ca/wps/portal/contentonly?vgnextoid=7e00643063fe7410VgnVCM10000071d60f89RCRD

[18] National Audit Office, report, *Department of Energy & Climate Change, Green Deal and Energy: Company Obligation,* April 2016. www.nao.org.uk/report/green-deal-and-energy-company-obligation/

[19] OECD, report, *Green Investment Banks: Scaling up Private Investment in Low-carbon, Climate-resilient Infrastructure,* 2016.
www.oecd-ilibrary.org/finance-and-investment/green-investment-banks_9789264245129-en

[20] Over the past ten years, however, transportation emissions have seen a slight decrease; nevertheless, the sector is the highest emitter and its share of emissions is growing relative to the other emitting sectors.

[21] Advisory Panel on the Coordinated Review of the Growth Plan for the Greater Golden Horseshoe, the Greenbelt Plan, the Oak Ridges Moraine Conservation Plan and the Niagara Escarpment Plan, report, *Planning for Health, Prosperity and Growth in the Greater Golden Horseshoe: 2015-2041,* (the 'Crombie Report'), 2015.

[22] Environmental Commissioner of Ontario, report, *Conservation: Let´s Get Serious Annual Energy Conservation Progress Report – 2015/2016,* chapter 3, 2016.

[23] Environmental Commissioner of Ontario, report, *Annual Energy Conservation Progress Report – 2009 (Volume Two),* p.53, 2009.

[24] Metrolinx, report, *Discussion Paper for the Next Regional Transportation Plan,* p.16, August 2016. www.metrolinx.com/en/regionalplanning/rtp/RTP_Discussion_Paper_EN.pdf

[25] Ministry of Finance, report, *2016 Ontario Budget.* www.fin.gov.on.ca/en/budget/ontariobudgets/2016/

[26] Metrolinx, report, *Discussion Paper for the Next Regional Transportation Plan,* p.16-19, August 2016. www.metrolinx.com/en/regionalplanning/rtp/RTP_Discussion_Paper_EN.pdf

[27] *Ibid,* p.62.

[28] Environmental Commissioner of Ontario, report, *Conservation: Let´s Get Serious Annual Energy Conservation Progress Report – 2015/2016,* Appendix A, p.169, 2016.

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[30] Metrolinx, report, *Discussion Paper for the Next Regional Transportation Plan,* p.55, August 2016. www.metrolinx.com/en/regionalplanning/rtp/RTP_Discussion_Paper_EN.pdf

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[32] MaRS, report, *A Bright Green Future: Cleantech Asset Map: An analysis of the convergence of technology, policy and capital in Ontario,* 2010. www.investtoronto.ca/InvestAssets/PDF/Reports/MRI-asset-maps.pdf

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[34] Ecofiscal Commission, report, *Choose Wisely, Options and Trade-offs in Recycling Carbon Pricing Revenues,* p.34-35, April 2016. ecofiscal.ca/wp-content/uploads/2016/04/Ecofiscal-Commission-Choose-Wisely-Carbon-Pricing-Revenue-Recycling-Report-April-2016.pdf

[35] Ecofiscal Commission, report, *Choose Wisely, Options and Trade-offs in Recycling Carbon Pricing Revenues,* p.iv, April 2016. ecofiscal.ca/wp-content/uploads/2016/04/Ecofiscal-Commission-Choose-Wisely-Carbon-Pricing-Revenue-Recycling-Report-April-2016.pdf

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[38] Clean Energy Canada, report, *Tracking the energy revolution – Canada 2015,* 2015.

cleanenergycanada.org/trackingtherevolution-canada/2015/assets/pdf/TrackingtheEnergyRevolution-Canada2015.pdf

[39] TSX Venture Exchange, retrieved from www.tsx.com/listings/listing-with-us/sector-and-product-profiles/clean-technology

[40] Vicky Sharpe, *Protect Your Pension and the Planet,* January 19, 2015.

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See also Analytica Advisors, report, *2015 Canadian Clean Technology Industry Report Synopsis*, 2015. www.analytica-advisors.com/assets/file/2015%20Report%20Synopsis%20Final_wcovers.pdf

[42] Ontario Capital Growth Corporation, website, *Ontario Emerging Technologies Fund,* accessed October 2016. www.ocgc.gov.on.ca/index_en.php?page=ontario-emerging-technologies-fund

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[50] Government of Ontario, news release, *Ontario Invests Nearly $100 Million to Boost Cleantech Innovation and Create Jobs,* February 2016. news.ontario.ca/opo/en/2016/02/ontario-invests-nearly-100-million-to-boost-cleantech-innovation-and-create-jobs.html

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[52] Government procurement rules typically require public bodies to obtain multiple bids before selecting a vendor.

[53] Government of Ontario, *Climate Change Action Plan,* p.67, June 2016. www.ontario.ca/page/climate-change-action-plan

[54] Government of Ontario, backgrounder, *Keeping Clean, Reliable Electricity Affordable and Lowering People's Bills,* September 12, 2016. news.ontario.ca/opo/en/2016/09/keeping-clean-reliable-electricity-affordable-and-lowering-peoples-bills.html (On September 13, 2016, the Ministry of Energy announced three additional initiatives to provide price relief for electricity customers, including a rebate on the HST portion of electricity bills for residences, small businesses, and farms, but it appears that these will not be funded through the GGRA. Government of Ontario, news release, *Ontario Reducing Electricity Costs for Families and Businesses,* September 13, 2016. news.ontario.ca/mei/en/2016/09/ontario-reducing-electricity-costs-for-families-and-businesses.html)

[55] Government of Ontario, *Climate Change Action Plan,* p.67, June 2016. www.ontario.ca/page/climate-change-action-plan

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[57] Environmental Commissioner of Ontario, report, *Conservation: Let´s Get Serious Annual Energy Conservation Progress Report – 2015/2016,* chapter 4, 2016.

[58] Ontario Power Authority, slideshow, *Air Emissions Forecast: 2013 LTEP: Module 5,* slides 11, 14, January 2014. powerauthority.on.ca/sites/default/files/planning/LTEP-2013-Module-5-Air-Emissions.pdf

(This projection included continued spending on conservation, nuclear refurbishment, and meeting targets for non-hydro renewables and hydro, all assumptions which are currently still valid in 2016 because there have been no major policy changes since then. Nuclear refurbishment timetables have changed slightly, but should not have a major impact on 2020 emissions.)

[59] The emissions projection in this report was done prior to the Ministry of Energy's September 27, 2016 announcement that it would suspend the planned procurement of approximately 1,000 MW of renewable electricity generation. The Ministry claimed that "no additional emissions are being added to the electricity grid" as a result of this decision, but did not provide supporting evidence. Government of Ontario, news release, *Ontario Suspends Large Renewable Energy Procurement,* September 27, 2016. news.ontario.ca/mei/en/2016/09/ontario-suspends-large-renewable-energy-procurement.html

[60] Ontario Energy Board, report, *Regulated Price Plan Price Report: November 1, 2013 to October 31, 2014,* p.18-20, October 17, 2013; Independent Electricity System Operator, information provided to the ECO in response to ECO inquiry, October 16, 2015.

[61] If sufficient clean electricity generating capacity does not exist, shifting load onto the electric system at times of peak demand could drive up emissions from natural gas fired electricity and simultaneously put difficult and expensive demands on the local electrical distribution system and ratepayers.

[62] Ontario uses about twice as much electricity on a hot summer weekday as we do on a mild night or weekend, and much of the peak electricity comes from gas-fired generation.

[63] Hydro Quebec, report, *Comparison of Electricity Prices in Major North American Cities: Rates in effect April 1, 2015,* 2015. www.hydroquebec.com/publications/en/docs/comparaison-electricity-prices/comp_2015_en.pdf

[64] Ontario Power Generation is currently paid $59.29/MWh for electricity produced from its nuclear facilities, and has applied to the Ontario Energy Board for a new regulated rate that would begin at $65.81 in 2017 and rise to $99.91/MWh by 2021. (Ontario Power Generation, EB-2016-0152 Application, Exhibit A1, Tab 2, Schedule 1, May 27, 2016.) In total, nuclear power provides about 60% of Ontario's electricity, but only half of that comes from Ontario Power Generation. The rest is from Bruce Nuclear Power.

[65] Union Gas has estimated that 22% of residences not heated by natural gas are currently heated with electricity. (Union Gas, EB-2015-0179 Application and Evidence, RE: EB-2015-0179 – *Union Gas Limited ("Union") – Expansion of Natural Gas Distribution,* Exhibit A, Tab 1, July 23, 2015.)

[66] California plans to obtain a significant portion of its 2020 emission reductions through a Renewable Fuels Standard. The US also has a Renewable Fuel Standard with volumes of renewable fuels defined by the Energy Independence and Security Act of 2007 (EISA). These volumes are expected to increase each year through 2022. (U.S. EPA, website, Program Overview for Renewable Fuel Standard Program, accessed October 2016. www.epa.gov/renewable-fuel-standard-program/program-overview-renewable-fuel-standard-program

[67] Ontario and Quebec form the backbone of corn for grain production in Canada. According to the Census of Agriculture, Ontario accounted for 61.7% of seeded area in 2011, with Quebec following at 30.2% and Manitoba at 6.4%. While corn for grain is the third largest grain crop in Canada (after wheat and canola), it ranks as the number one crop in Ontario in terms of production and farm cash receipts. (Statistics Canada, website, *How is corn produced?* accessed October 2016. www.statcan.gc.ca/pub/96-325-x/2014001/article/11913-eng.htm#a5)

[68] See cometbiorefining.com/news.html

[69] Since 2005, Ontario has required ethanol to be blended into gasoline. See O. Reg. 535/05 (Ethanol in Gasoline) made under the *Environmental Protection Act.*

[70] The federal Renewable Fuel Regulation, SOR/ 2010-109, also requires 5% ethanol in most Canadian gasoline, and 2% in most Canadian diesel transportation fuel. These requirements may be met by pooling and trading.

[71] O. Reg. 97/14 (Greener Diesel - Renewable Fuel Content Requirements for Petroleum Diesel Fuel) made under the *Environmental Protection Act.*

[72] Based on experience in other jurisdictions, such as British Columbia, there are several different ways that fuel suppliers can ensure renewable fuel content in gasoline. See British Columbia Ministry of Energy and Mines, report, *Renewable and Low Carbon Fuel Requirements Regulation,* 2012. www.empr.gov.bc.ca/RET/RLCFRR/Documents/RLCF-007-2012%20Summary.pdf Also see British Columbia, website, *Renewable & Low Carbon Fuel Requirements Regulation,* accessed October 2016. www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/renewable-low-carbon-fuels

[73] In 2015 Ontario consumed 16,261,678,000 L of gasoline for on road purposes. (Statistics Canada, website, *Sales of fuel used for road motor vehicles, by province and territory (Quebec, Ontario, Manitoba, Saskatchewan)*, accessed August 2016. www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/trade37b-eng.htm)

Across Canada, the natural gas vehicle number is estimated to be about 12,000. (Ministry of Agriculture, Food and Rural Affairs, website, *Vehicle Conversion to Natural Gas or Biogas,* accessed October 2016. www.omafra.gov.on.ca/english/engineer/facts/12-043.htm)

[74] Natural Resources Canada, website, *Ethanol,* accessed October 2016. www.nrcan.gc.ca/energy/alternative-fuels/fuel-facts/ethanol/3493

[75] Congressional Budget Office, report, *The Renewable Fuel Standard: Issues for 2014 and Beyond,* 2014. www.cbo.gov/sites/default/files/113th-congress-2013-2014/reports/45477-Biofuels2.pdf

[76] For example, an August 2016 study published in the journal Climatic Change examined the carbon balance of US biofuels compared to conventional gasoline. The study, which was funded in part by the American Petroleum Institute, concluded that the US biofuels policy has resulted in a net increase, rather than decrease, in CO_2 emissions. (John M. DeCicco et al, periodical (Climate Change 138:3), *Carbon balance effects of U.S. biofuel production and use,* p.667–680, October 2016. link.springer.com/article/10.1007/s10584-016-1764-4#MOESM1)

[77] Congressional Budget Office, report, *The Renewable Fuel Standard: Issues for 2014 and Beyond,* 2014. www.cbo.gov/sites/default/files/113th-congress-2013-2014/reports/45477-Biofuels2.pdf

[78] Congressional Budget Office, report, *Answers to Questions for the Record Following a Hearing on the Renewable Fuel Standard Conducted by the Subcommittee on Environment and the Subcommittee on Oversight of the House Committee on Science, Space, and Technology,* 2015. www.cbo.gov/publication/51049

[79] US Environmental Protection Agency, report, *Memorandum: Lifecycle Impacts of Renewable Fuel Standard Project,* October 15, 2015. www.epa.gov/sites/production/files/2015-10/documents/newstarts_10-15-15_rfs.pdf

[80] Specifically, due to conflicting scientific opinions about biofuels, potential influences outside of the EPA's regulatory control, and divergent RFS interests, these reports are important to objectively analyze the environmental impacts and unintended consequences of the US biofuel policy. (US Environmental Protection Agency, report, *EPA Has Not Met Certain Statutory Requirements to Identify Environmental Impacts of Renewable Fuel Standard,* August 18, 2016. www.epa.gov/sites/production/files/2016-08/documents/_epaoig_20160818-16-p-0275.pdf)

[81] This software helps policymakers and industry understand the GHG intensity of different renewable fuels and anticipate GHG savings through different fuel options. This modelling software performs a life-cycle analysis, accounts for soil carbon content, and also takes into account vehicle characteristics. As with any modelling software, there are some limitations. For example, it does not incorporate indirect land use changes (ILUC), or the refinery efficiency benefits of obtaining some octane from ethanol. ILUC refers to changes in land use that occur because of bioenergy production, but are geographically disconnected from it.

[82] See for example, s.11.06, BC. Reg. 394/2008 (Renewable and Low Carbon Fuel Requirements Regulation), made under the *Greenhouse Gas Reduction (Renewable and Low Carbon Fuel Requirements) Act.*

[83] *Syncrude Canada Ltd. v. Canada (Attorney General),* 2014 FC 776 (CanLII), 2014-08-06. www.canlii.org/en/ca/fct/doc/2014/2014fc776/2014fc776.html

[84] Schleussner et al, periodical (Nature Climate Change 6), *Science and policy characteristics of the Paris Agreement temperature goal,* p. 831, September 2016.

[85] Don O'Connor, memo, *Ethanol GHG Emissions in Ontario Transportation Sector,* September 5, 2016.

The model expects emissions associated with gasoline production in Ontario will be lower, in part because Ontario will use more of Western Canada's light crude oil. However, combustion emissions from gasoline will be slightly higher because the updated model assumes short lived gases are fully oxidized to carbon dioxide. The model updates for ethanol include new data on farm energy use and ethanol plant operation, both of which help decrease emissions associated with ethanol. See Appendix B to the report, available online at eco.on.ca.

[86] These are important factors because, as shown in our white paper, *Soil Health in Ontario,* conventional corn and soy agriculture has helped to drive down soil carbon levels in Ontario by approximately 30% in the last 25 to 30 years, essentially mining carbon out of the soil. Conventional corn agriculture also depends heavily on artificial nitrogen fertilizers which result in the release of nitrous oxide, a greenhouse gas 298 times more powerful than carbon dioxide.

[87] Meghan Sapp, article, *US Geological Survey study says biofuel crops in the Dakotas harming bees,* August 2016. www.biofuelsdigest.com/bdigest/2016/08/29/us-geological-survey-study-says-biofuel-crops-in-the-dakotas-harming-bees/

[88] Schleussner et al, periodical (Nature Climate Change 6), *Science and policy characteristics of the Paris Agreement temperature goal,* p. 831, September 2016.

[89] From 1,600,000 acres (647,497 ha) in 2005 to 2,055,000 acres (831,629 ha) in 2015. Ministry of Agriculture, Food and Rural Affairs, website, *Field Crops,* accessed October 2016. www.omafra.gov.on.ca/english/stats/crops

[90] Ministry of Agriculture, Food and Rural Affairs, website, *Ontario Farm Data, Census of Agriculture, 1996, 2001, 2006, and 2011,* accessed October 2016. www.omafra.gov.on.ca/english/stats/census/summary.htm

[91] Environmental Commissioner of Ontario, report, *Putting Soil Health First, A Climate-Smart Strategy for Ontario,* November 2016.

[92] Regenerative Organic Agriculture, and 4 per 1,000 initiative. Ronald F. Follett et al., periodical (BioEnergy Research 5:4), *Soil Carbon Sequestration by Switchgrass and No-Till Maize Grown for Bioenergy,* p.866–875, December 2012. link.springer.com/article/10.1007/s12155-012-9198-y

[93] US Environmental Protection Agency, website, *Ethanol Waivers (E15 and E10),* accessed October 2016. www.epa.gov/gasoline-standards/ethanol-waivers-e15-and-e10

[94] The ECO has not reviewed whether a 15% ethanol content would create corrosion concerns.

[95] As per GHGenius 5.0 modelling, Don O'Connor, memo, *Ethanol GHG Emissions in Ontario Transportation Sector,* September 5, 2016.

[96] Canadian Vehicle Manufacturers' Association, letter, *British Columbia Discussion Paper – Climate Leadership Plan, July 2015 – CVMA Submission,* 2015. engage.gov.bc.ca/climateleadership/files/2015/12/047_-Canadian-Vehicle-Manufacturers-Association.pdf

[97] There are 451,621 active flex fuel vehicles (all classes) registered in Ontario and 58,477 flex fuel vehicle registrations (all classes) expired within 6 months in Ontario. Ontario Ministry of Transportation, information provided to the ECO in response to ECO inquiry, September 21, 2016.

[98] Drive Clean, website, *Ethanol (E85) Flex Fuel,* accessed August 2016. www.driveclean.ca.gov/Search_and_Explore/Technologies_and_Fuel_Types/Ethanol_(E85)_Flex_Fuel.php

[99] Public Works and Government Services Canada, website, *CGSB Publishes New Edition of Standard for Automotive ethanol fuel (E50-E85),* accessed October 2016. www.tpsgc-pwgsc.gc.ca/ongc-cgsb/publications/nouvelles-news/e50-e85-eng.html

[100] Assumes the average Ontario vehicle uses 2,000 litres of gasoline per year, therefore a FFV with E85 fuel would use 2400 litres of ethanol per year if it operated 100% of the time on E85. Also assumes 35% of Canada's 1.62 million FFV are located in Ontario. (Canadian Vehicle Manufacturers' Association, letter, *British Columbia Discussion Paper – Climate Leadership Plan, July 2015 – CVMA Submission,* 2015. engage.gov.bc.ca/climateleadership/files/2015/12/047_-Canadian-Vehicle-Manufacturers-Association.pdf)

[101] Canada's Ecofiscal Commission, report, *Course Correction: It's Time to Rethink Canadian Biofuel Policies,* October 2016. ecofiscal.ca/wp-content/uploads/2016/10/Ecofiscal-Commission-Course-Correction-Biofuels-Report-October-2016.pdf

[102] Mark Jaccard, Mikela Hein and Tiffany Vass, School of Resource and Environmental Management Simon Fraser University, report, *Is Win-Win Possible? Can Canada's Government Achieve Its Paris Commitment . . . and Get Re-Elected?* September 2016. rem-main.rem.sfu.ca/papers/jaccard/Jaccard-Hein-Vass%20CdnClimatePol%20EMRG-REM-SFU%20Sep%2020%202016.pdf

[103] Government of Ontario, *Climate Change Action Plan,* p.36, 72, June 2016. www.ontario.ca/page/climate-change-action-plan

[104] *Ibid,* p.35.

[105] See Section 27 of the *Environmental Protection Act.*

[106] Clinker is a stage in the manufacture of cement.

[107] Arjun Gupta, Carbon War Room, report, *Gigaton Analysis of the Cement Industry: The Case for Rapid Adoption of Proven Technologies,* p.4, March 2011.

[108] Vito Albino, et al., Network for Business Sustainability, report, *Alternative energy sources in cement manufacturing: A Systematic Review of the Body of Knowledge,* p.7, 2011. nbs.net/wp-content/uploads/NBS-Systematic-Review-Cement-Manufacturing.pdf

[109] Intergovernmental Panel on Climate Change, report, *IPCC Fourth Assessment Report: Climate Change 2007: Working Group III: Mitigation of Climate Change,* 2007. Section 7.3.3 Fuel switching, including the use of waste materials.

[110] ICF International, report, *Natural Gas Conservation Potential Study: Final Report,* exhibit 160, p.140, 2016. www.ontarioenergyboard.ca/oeb/_Documents/EB-2015-0117/ICF_Report_Gas_Conservation_Potential_Study.pdf

[111] Econoler & Cadmus, report, 2014 *Evaluation of Industrial Energy Efficiency Programs,* p.xi, Table 3, 2015. www.powerauthority.on.ca/sites/default/files/2014-Evaluation-of-the-Industrial-Initiatives.pdf

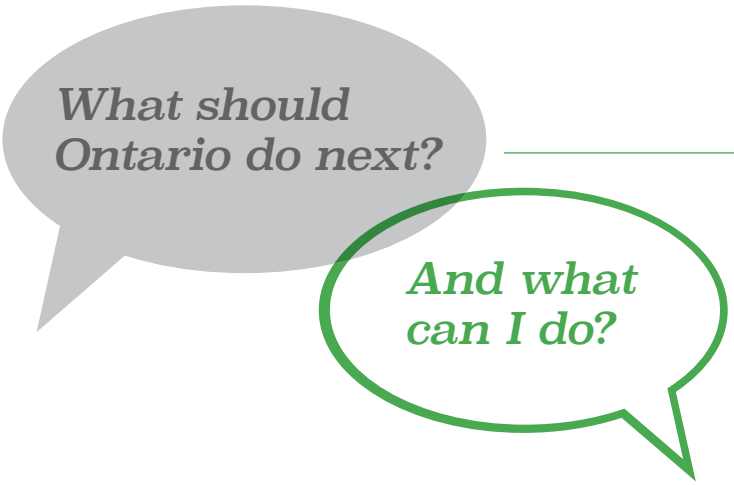
Chapter 7

Closing Thoughts: Knowledge + Action = Hope

ABSTRACT

This has been an exciting and important year. There has been encouraging international, national and provincial progress to reduce global greenhouse gas (GHG) emissions. Yet, on all aspects of climate change (science, mitigation and adaptation), there is a chasm between what the government says, and what the public understands. To bridge this chasm, our government needs to do a better job putting words into action, showing the public that it truly takes climate change seriously. One important example of this is for government to spend the cap and trade revenue well to reduce Ontario's GHG emissions.

When government leads through strong action, citizens will be more likely to take climate change seriously too. As proud Ontarians, there is much we can each do to turn our provincial pride into action. It's not too late.



7.1 Great Progress Since Last Year

This has been a very exciting and important year. In July 2015, my office's last report on Ontario's greenhouse gas emissions concluded:

> *The science is clear and beyond dispute: human-caused climate change is already affecting Ontario. Profound changes in our economy and way of life are essential, and the provincial government has a clear leadership role to play in enabling and promoting these changes. The province must create a policy environment that will steadily reduce the carbon footprint of our economy and lifestyles. The costs of climate inaction are material, while the potential economic opportunities from transitioning to a low-carbon economy are substantial.*
>
> *Ontario has made noteworthy strides in climate change policy since 2007, particularly by closing its coal-fired power plants and thus decarbonizing its electricity sector to a large degree. Unfortunately, this bold action was followed by a period of relative inaction. As a result, under the current suite of policy initiatives, Ontario will not meet its 2020 GHG emissions reduction target; nor will it ensure the province is prepared to manage climate change risks.*

Since then, there has been encouraging international, national and provincial progress to reduce global GHG emissions.

There has been encouraging international, national and provincial progress to reduce global GHG emissions.

7.1.1 International

Along with the Paris Agreement – which came into force on November 4 – two other major international agreements were reached in 2016. In October, the world community came together to discuss the reduction of hydrofluorocarbons (HFCs); powerful greenhouse gases that are primarily used for refrigeration and air conditioning. Driven by a growing demand for cooling, particularly in developing countries with a rapidly expanding middle class and hot climates, emissions of HFCs have increased by up to 10 per cent each year. Pursuant to the Kigali Amendment to the Montreal Protocol,[1] agreement was reached on a schedule for drastically reducing the use of HFCs over the next several decades. According to the United Nations Environment Programme, this agreement is the "single largest contribution the world has made towards keeping the global temperature rise 'well below' 2 degrees Celsius."[2]

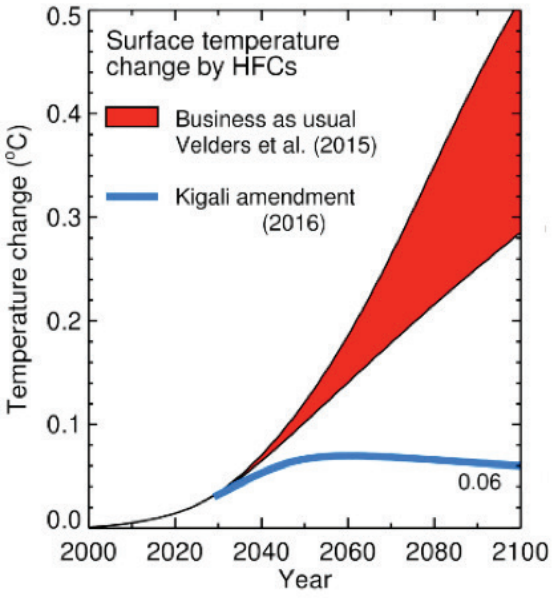


Figure 1: Projected global temperature change under a business as usual pathway versus one with the Kigali amendment in place.

Source: Guus Velders (Dutch National Institute for Public Health and the Environment), *Surface temperature change by HFCs*, 2016.

As a developed country, Canada will be required to phase out the production and consumption of HFCs starting in 2019, reducing them to about 15 percent of 2011-2013 average levels by 2036.[3] Both the federal government and Ontario will need to amend their ozone-depleting substance regulations to incorporate the Kigali Amendment.[4]

Aircraft operators will offset their increased emissions by buying offset credits and/or allowances.

Also in October, the International Civil Aviation Organization adopted a Carbon Offsetting and Reduction Scheme for International Aviation. As discussed in Chapter 3, while emissions associated with domestic aviation are the responsibility of each individual country and therefore covered by the Paris Agreement, emissions from international aviation – approximately 1.3 per cent of global CO_2 emissions[5] – have remained outside of the international framework. While the scheme does not place a limit on emissions, it is designed to offset increases in total CO_2 emissions from international civil aviation (i.e., civil aviation flights that depart in one country and arrive in a different country). Similar to a cap and trade program, aircraft operators will offset their increased emissions by buying offset credits from crediting mechanisms and/or allowances from emissions trading schemes.

Together, these three developments in 2016 have galvanized unprecedented attention and hoped-for action on climate change in countries around the world.

7.1.2 National

Canada's commitment (or intended contribution) under the Paris Agreement is to reduce greenhouse

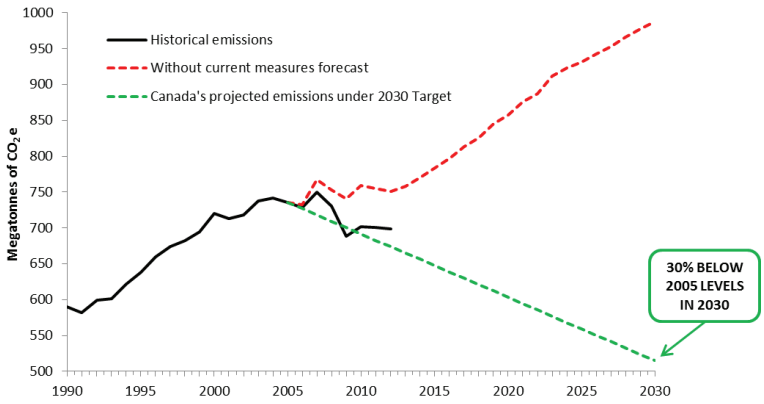


Figure 2: Canadian emissions under 2030 target

Source: Government of Canada, *Canada's INDC Submission to the UNFCC*, 2015.

gases by 30 per cent below 2005 levels by 2030.[6] While far less ambitious than Ontario's emission reduction targets, this goal may still be challenging to achieve, given Canada's economic dependence on oil and gas, and the dependence of some provinces and territories on coal-fired electricity.

The federal government has announced that it intends to achieve this target, in part, by implementing a minimum carbon price of $10 per tonne beginning in 2018. The revenues generated by this levy will be returned to each province or territory to use as they deem appropriate.

A national minimum carbon price is an excellent and long-awaited step. It should help drive innovation and investment in the low-carbon economy, and should help moderate the risk of carbon leakage, at least within Canada.

However, it is not yet clear how this minimum federal carbon price will be reconciled with the cap and trade program in Ontario and Quebec. The central feature of the federal announcement is a minimum annual carbon price, which rises $10 per year until 2022. The cap and trade programs in Ontario and Quebec operate on multi-year compliance periods. While each program has a floor price for the government allowance auctions, the actual prices of allowances and offsets are set by the carbon market. The simplest method of reconciling the two systems would be an

equivalency agreement. The federal government may be willing to accept the existing Ontario/Quebec cap and trade program as an adequate equivalent, since both provinces are expected to achieve their proportionate share of the federal INDC commitment: emissions that are 30 per cent below their respective 2005 levels by 2030.

7.1.3 Provincial

I warmly congratulate the Ontario government for finally putting a price on carbon pollution.[7] This is one of the many tools that the government needs to reach its future GHG reduction targets as shown below in Figure 3.

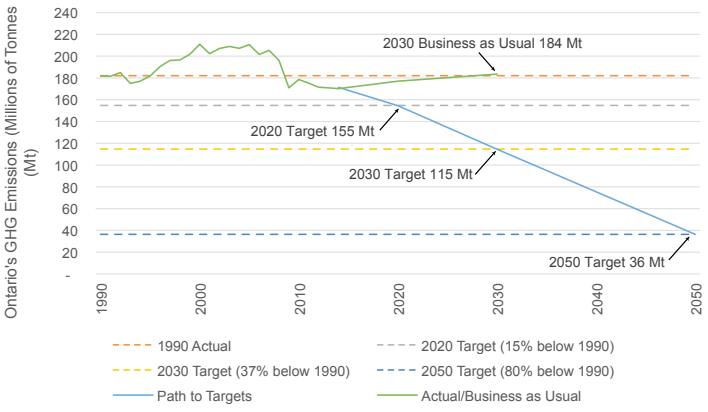


Figure 3: Ontario GHG emissions and projected path to targets.

Source: Chart created using information from: the Government of Canada, *National and Provincial/Territorial Greenhouse Gas Emission Tables*, 2016; Ministry of the Environment and Climate Change, *Ontario's Climate Change Strategy*, 2015; and Institute for Competitiveness and Prosperity, *Toward a low-carbon economy: the costs and benefits of cap-and-trade*, 2016.

As described in Chapter 4, Ontario's new *Climate Act* establishes a cap and trade program that is intended to cover 82 per cent of Ontario's direct GHG emissions. Ontario's GHG reduction targets, while ambitious, are consistent with those of other countries and are amply justified by climate science. Emission reductions can also have many other benefits for Ontario's environment and economy.

I warmly congratulate the Ontario government for finally putting a price on carbon pollution.

In general, the cap and trade program is reasonable and well-designed, balancing the urgent need for GHG reductions with the cost to Ontario citizens and businesses and the need to build public and non-partisan support.

As shown in Chapter 4, there are good reasons to link Ontario's carbon market with Quebec and California, as planned for 2018, provided that California can surmount the legal problems with its cap and trade program. The link is likely to keep allowance prices modest for the next few years, perhaps just above the floor price. This should dramatically lower the cost for Ontario emitters, while still creating a modest price signal for domestic emission reductions.

Putting *any* price on carbon pollution is a long-overdue social, cultural and economic shift. I am glad to see that all three political parties now support a price on carbon. The government also deserves kudos for its active role in national and international cooperation on climate change mitigation. Ontario has been a prominent subnational jurisdiction in multi-lateral initiatives, such as the Under 2 MOU, and hosted the Climate Summit of the Americas, which helped pave the way for the Paris Agreement.

Putting *any* price on carbon pollution is a long-overdue social, cultural and economic shift.

7.2
Earning Ontarians' Support

On all aspects of climate change (including science, mitigation and adaptation), I see a chasm between what the government knows, and what the public understands. From my visits around the province, many Ontarians do not understand why an economic transformation is necessary. Many don't understand the urgency or magnitude of climate change. Few understand how climate change will alter Ontario.

> Chasm between what the government knows, and what the public understands.

Most don't want the government to push up the cost of the fossil fuels that they use, such as gasoline and home heating oil. They don't want to change their lifestyles, they don't think other people are doing much, and they don't think they should have to either. Few people know that Ontarians are big carbon polluters, contributing far more than our fair share to global carbon pollution. Even fewer understand how or why cap and trade works the way it does.

Even when they are presented with all the facts, most people still don't get really mobilized about climate change. Why?

7.2.1 Action Speaks Louder Than Words

One reason is that our government *says* climate change is dire, but it doesn't act that way. People are social animals and we take our cues from each other. If I see that smoke is rising from my office building but no one else seems to be reacting, I may not react either. If the government doesn't treat climate change as an emergency, then most people will feel that they don't need to either.

Today, governments talk more about climate change, but it is hard to see dramatic change in their day-to-day conduct. Most ministries ignore climate change most of the time. Most politicians fly and drive much as before. Cars rule most roads. Gas is cheap. Public buildings waste energy. Land use planning rules permit sprawl and the destruction of natural areas.

Some government rules and decisions provide even stronger evidence that our governments are not much worried about climate change. Despite repeated promises of reform, both Ontario and the federal government still subsidize fossil fuels. The Ministry of Agriculture, Food and Rural Affairs subsidizes the destruction of wetlands that are essential to climate resilience.[8] The Ministry of Energy is subsidizing the expansion of natural gas pipelines, and has suspended the Large Renewable Procurement program for electricity supply. It is counting on natural gas to take up the slack if the Pickering Nuclear Plant licence is not extended.

To earn public support for dramatic action on climate, both in reducing emissions and adapting to future change (see Box 7.2.2), the government must consistently show the public that it takes climate change seriously. When climate change becomes a visible, central consideration whenever the government makes rules or spends money, citizens will be much more likely to take its climate change talk seriously.

> Our government *says* climate change is dire, but it doesn't act that way.

7.2.2 What About Adaptation?

This report examines Ontario's progress on climate change mitigation, i.e., reducing emissions of greenhouse gases. But the impacts of climate change are already here and getting worse. It is equally important for Ontario to adapt to those impacts, i.e., to reduce or eliminate the negative effects (or take advantage of the positive effects) of climate change on both our built and natural environment. The ECO will examine adaptation in a future report, but we would be remiss if we didn't at least mention this important climate change issue here.

Most Ontario individuals, communities, businesses and governments are not prepared for the impacts of climate change nor how fast they are coming. This leaves us vulnerable to both slow and fast climate shocks.

Ontario's existing built environment – including our water treatment, sewage, transportation and electrical transmission systems – was designed for a limited range of climate conditions based on historical benchmarks. As shown in Chapter 1, climate change is making these historical benchmarks obsolete. Extreme weather is becoming more common and more damaging. Once-in-every-100-years storms have become so common they hardly make the news. The U.S. had eight once-in-every-500-years disasters in just over 12 months, including the one-in-1000 year storm that flooded Louisiana in August 2016.

Adaptation includes identifying our vulnerabilities and re-thinking the built environment to better cope with this new normal. It also includes identifying the vulnerabilities of the natural environment caused or exacerbated by climate change. Increased temperatures and changing rain and snow patterns may radically reshape Ontario's ecology, altering habitat for wildlife, placing greater pressure on some species at risk, while enabling forest fire, pests, invasive species and diseases to spread further and more rapidly.

The Ontario government has taken some steps on adaptation. It appointed an expert panel in 2007, which called for comprehensive adaptation preparation across government; hosted an adaptation summit in 2008; and released an adaptation plan, *Climate Ready*, in 2011. This plan laid out 37 actions the province intended to take to prepare Ontario for the impacts of climate change.[9] The first and only progress report was published in 2012,[10] but an updated *Climate Ready* has been promised for 2017.

In the meantime, the Ontario government has begun to recognize the importance of adaptation for infrastructure. For example:

- The Minister of the Environment and Climate Change's (MOECC) September 2014 mandate letter indicated that adaptation should be considered in public infrastructure investments. This commitment was reiterated in the September 2016 mandate letters for both Treasury Board Secretariat and MOECC.
- The *Infrastructure for Jobs and Prosperity Act, 2015* states that "...infrastructure should be designed to be resilient to the effects of climate change."
- In May 2016, the Ministry of Municipal Affairs and the Ministry of Natural Resources and Forestry released proposed amendments to four land use plans in the Greater Golden Horseshoe,[11] which if adopted, would require municipalities to complete a climate vulnerability assessment for new infrastructure projects.
- In September 2016, the MOECC posted a draft guidance document to assist proponents to incorporate climate change mitigation and adaptation considerations into Environmental Assessments.[12]

Some jurisdictions are much farther ahead in preparing for climate change.

Some jurisdictions are much farther ahead in preparing for climate change. Germany, for example, performed a nation-wide vulnerability assessment, which now allows it to prioritize public and private investment in resilience. The assessment identified regions and systems that are particularly endangered by climate change now, in the near future (2021 to 2050) and the distant future (2071 to 2100) and evaluated their potential impacts and adaptive capacity. As a result, the 16 responsible federal authorities and institutes identified six overarching priority areas of vulnerability for action:[13]

1. Damage caused by rising heat stress in urban areas;
2. Effects on water use from increased warming and summer drought;
3. Damage to buildings and infrastructure through heavy rains and flash floods;
4. Damage to buildings and infrastructure by river flooding;
5. Damage to coasts; and
6. Changes in the composition and the natural development phases of species.

Similarly, the United Kingdom government has invested heavily in adapting to a greater frequency and severity of floods. These investments followed recommendations made by Sir Michael Pitt in his report on the disastrous £3 billion floods of 2007.[14] The broad range of his recommendations illustrates the wide scope of adaptation requirements to even a single type of climate-related disaster, including:

1. Knowing when and where it will flood (through forecasting, modelling and mapping);
2. Reducing the risk of flooding and its impact (e.g., through better building, planning, drainage, flood defence, improved flood risk legislation and insurance);
3. Improving local and national response frameworks for rescue and care in an emergency;
4. Minimizing the loss of power and water supplies and disruptions to other essential services (e.g., by delivering greater resilience in critical infrastructure, more effective management of dams and reservoirs, and better information sharing and engagement);
5. Helping people protect their families and homes (e.g., raising awareness before emergencies through the media and weather and flood warnings, and providing advice during the emergency); and
6. Identifying roles, responsibility and funding for recovery operations.

Many of the conclusions reached in both Germany and the UK have obvious relevance to Ontario, and show the enormous amount of work to be done on adaptation.

7.2.3 Using the Money Well

One important opportunity for the government to show how seriously it takes the threat of climate change is in how it uses the money it earns from selling GHG allowances. Even among those who support a price on carbon, many are not sure that the government will spend the money well.

As shown in Chapters 4 and 6, modest carbon prices are predicted to produce only modest emission reductions, not the economic and energy system transformation that Ontario needs to meet its *Climate Act* emission targets. How will Ontario achieve the rest? The government is putting its faith in its Climate Change Action Plan, to be funded by cap and trade revenues through the Greenhouse Gas Reduction Account (GGRA).

Much could be achieved through the careful and strategic use of cap and trade revenues. As shown in Chapter 6, there is no shortage of good ideas for transforming Ontario to a low-carbon economy, all vying for financial support. Within government, vigorous competition for cap and trade revenues has greatly raised the awareness and interest of most ministries in energy and climate issues, when previous attempts to do so had failed. This new-found awareness could, and should, be incorporated into the full range of government regulatory, funding and approvals programs, with potentially enormous impact.

Chapter 5 proposes a transparent and accountable documentation process to ensure that cap and trade proceeds are spent lawfully and well. Unfortunately, the example of electricity subsidies (see Chapter 6) demonstrates how hard it is for the government to resist the temptation to divert cap and trade revenues to other priorities. If the GGRA is siphoned off to fund existing programs or otherwise frittered away:

- It sends a powerful signal to the public that preventing climate change is not, after all, very important;
- It may erode public faith in whether the government can be trusted, since the government continues to claim that auction proceeds are being used only for emission reductions;
- It may undermine the legal and political support for cap and trade; and
- Ontario may throw away an irreplaceable opportunity to build a prosperous, competitive low-carbon economy. Climate change will not wait, and neither will our competitors. If Ontario wants a low-carbon economy, we have to build it. It will not happen by itself.

If Ontario wants a l ow-carbon economy, we have to build it. It will not happen by itself.

7.2.4 Leadership

Above all, I have found a thirst across the province for clear, inspiring leadership on climate change. Many Ontarians want to know what they can do that will matter. They don't want to be fobbed off with busywork or distractions like the Blue Box; they want a task that makes a real difference.

So far, most feel they have not found one.

7.3
What Can I Do?

It would be easy to despair about climate change, to give up and to look the other way. There is an antidote to that despair:

Knowledge plus action equals hope

Climate change does not have to be left entirely to governments. As proud Ontarians who care about each other and the beautiful place we live in, we can turn that pride and care into action. Since part of every kilo of carbon dioxide that we emit will affect the climate for 1,000 years or more, it matters what each of us does to reduce our own emissions, and that we encourage others to do so too.

It's not too late.

Most people already know many things they and their friends and neighbours can do to reduce their carbon footprint. For example, active transportation, such as walking, roller blading and bicycling, can be fast, fun and healthy. Driving an electric vehicle, or one that uses renewable or low-carbon fuels, can dramatically reduce emissions. Tap water has a lower carbon footprint than bottled water, is better regulated, and is almost free. Local food creates less transportation emissions, tastes better and supports local farmers. Programmable thermostats reduce energy use and bills. Living in a compact, complete community reduces emissions by reducing commutes, which also reduces stress. Tree planting creates carbon sinks and is deeply satisfying.

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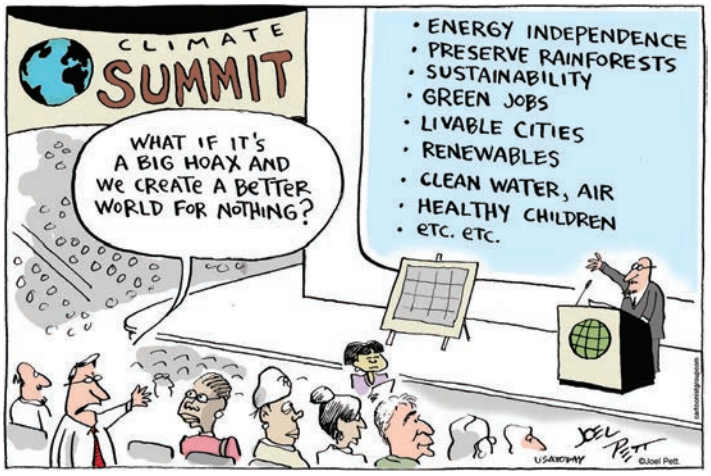
And here are some other ideas:

1. Be optimistic. Take responsibility. What you do, matters.
2. Be heard. Speak up on the issues you care about. We have the great privilege of living in a democracy. Speak with your neighbours, friends and relatives as well as your elected representatives. Comment in public forums. Encourage others to do the same.
3. Be curious. Ask hard questions, listen to the answers, engage in respectful conversation with those of different opinions.
4. Be passionate. Write a letter to a young person you love, to be opened in 2030. Tell them how you will express that love in concrete actions about climate change. Then do it.
5. Be informed. Know your carbon pollution footprint, and reduce it. Carbon calculators are readily available, such as at carbonfootprint.com or carbonzero.ca.
6. Be canny. Use your hard-earned dollars to buy sustainable products with low carbon footprints.
7. Be caring. Help prepare yourself, your family and your community for the wilder weather ahead.

No one can do everything, but everyone can do something.



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Chapter 7. Closing Thoughts

Endnotes

[1] The 1987 Montreal Protocol on Substances that Deplete the Ozone Layer was established to reduce the production and use of ozone-damaging chemicals, such as refrigerants.

[2] United Nations Environment Programme, website, Countries agree to curb powerful greenhouse gases in largest climate breakthrough since Paris, accessed October 18, 2016. http://www.unep.org/newscentre/Default.aspx?DocumentID=27086&ArticleID=36283&l=en

[3] Environmental Investigation Agency, website, Historic global deal to cut super-pollutant HFC gases, accessed October 18, 2016.

[4] Ontario Regulation 463/10: Ozone Depleting Substances and Other Halocarbons, under the Environmental Protection Act, 1990 and Ozone-depleting Substances Regulations, 1998 under the Canadian Environmental Protection Act, 1999.

[5] International Civil Aviation Organization, website, Carbon Offsetting and Reduction Scheme for International Aviation, accessed October 18, 2016, http://www.icao.int/environmental-protection/Pages/A39_CORSIA_FAQ1.aspx.

[6] United Nations Framework Convention on Climate Change, website, INDCs as communicated by Parties, http://www4.unfccc.int/submissions/INDC/Published%20Documents/Canada/1/INDC%20-%20Canada%20-%20English.pdf

[7] The government took its first major step towards mitigating greenhouse gas emissions when it closed Ontario Power Generation's coal-fired power plants. The last of the coal plants closed in April 2014. This is still Canada's largest contribution to reducing GHG emissions, and the main reason that Ontario met its GHG reduction target for 2014.

[8] The Ministry of Agriculture, Food and Rural Affairs' Agriculture Drainage Infrastructure Program defines policies for providing grants under the *Drainage Act*, which can lead to the destruction of some wetlands. However, the ministry stipulates that grants will not be paid on the construction or improvement of drainage systems that drain through or from provincially significant wetlands as identified by the Provincial Policy Statement.

[9] See Environmental Commissioner of Ontario, Special Report, Ready for Change, 2012, for a review of this plan.

[10] Government of Ontario, report, Climate Vision: Climate Change Progress Report (Technical Appendix), 2012.

[11] Proposed Growth Plan for the Greater Golden Horseshoe, 2016; Proposed Greenbelt Plan (2016); Proposed Oak Ridges Moraine Conservation Plan (2016); and Proposed Niagara Escarpment Plan, 2016.

[12] Environmental Registry # 012-5806

[13] Umwelt Bundesamt, report, Germany's vulnerability to Climate Change: Summary, November 2015, p. 52. ;

[14] Michael Pitt, report, Learning Lessons from the 2007 Floods, 2008.

Recommendations

Summary of recommendations from the ECO's 2016 Greenhouse Gas Progress Report

Ontario's Greenhouse Gas Emissions (Chapter 3)

The provincial government should report regularly to Ontarians on the province's entire climate change footprint, not only on Ontario's direct greenhouse gas emissions as calculated pursuant to international guidelines.

The provincial government should give a higher priority to reducing Ontario's methane and black carbon emissions.

Cap and Trade (Chapter 4)

Ontario should be more transparent about which entities are receiving free allowances, and why.

Ontario needs a contingency plan for the possibility that California's cap and trade program may not continue to operate in its present form, and/or may not be reauthorized after 2020.

Ontario should follow the UK example and set legally binding carbon budgets well in advance, within which a cap and trade program would operate.

The government must prioritize the approval of offset protocols to enable the creation of a timely and ample supply of high-quality Ontario offsets.

The Greenhouse Gas Reduction Account (Chapter 5)

The Ministry of the Environment and Climate Change should publicly adopt a complete set of evaluation criteria for proposed Greenhouse Gas Reduction Account expenditures and an explicit policy on how it allocates GGRA funds between competing objectives.

The Greenhouse Gas Reduction Account should only be used to pay for new or expanded initiatives that will directly produce emission reductions on top of those that will be created by existing programs, by the cap and trade program and by initiatives already funded through the Greenhouse Gas Reduction Account.

The government should keep detailed records of the justification for each Greenhouse Gas Reduction Account expenditure, in a form that can readily be provided to the Legislative Officers. The Minister of the Environment and Climate Change's annual public report on the GGRA should include:

1. A summary of the justification for each initiative funded, including:
   a. the name and sector of the recipient;
   b. the amount received;
   c. any matching funds;
   d. the anticipated additional GHG reductions;
   e. how and when it will achieve these reductions; and
   f. the cost-effectiveness of the reductions, and
   g. other material health, safety, environmental, social and economic consequences of the initiative

2. Analysis of the total funds spent, by sector;

3. Analysis of the total GHG reductions and other public benefits achieved, by year and by sector, as a result of the GGRA investment;

4. Administrative costs funded, by agency/ ministry;

5. How long term transformative change is being balanced with the need for short term reductions, and

6. Recommendations for improvements for subsequent years.

The Climate Change Action Plan (Chapter 6)

In developing the green bank, the Ontario government should:

- follow the four OECD principles,
- require the green bank to achieve additional emission reductions in Ontario, and
- ensure accountability and transparency for its financial and emissions reduction results.

The government should do more to discourage, and to make unnecessary, travel by petroleum-fueled vehicles. It should also prioritize funding for projects and transit that support dense, complete communities. Government support for clean tech from the Greenhouse Gas Reduction Account should have a direct, substantial and transparent connection to additional greenhouse gas reductions.

Government should reduce approval and procurement barriers to the use of low-carbon clean tech innovations within Ontario, especially those that have been developed with public funds.

Subsidizing electricity rates should not be considered an acceptable use of Greenhouse Gas Reduction Account funds.

A Renewable Fuel Standard regulation should include a low-carbon performance standard. It should only incent the production of biofuels that are grown sustainably, without damaging natural ecosystems or biodiversity, and while building up soil carbon.

The government should make public all data necessary to assess the effectiveness and cost-effectiveness of its emission reduction programs.

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Ontario and Canadian Government Ministries, Agencies, and Officers of the Legislature

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